Course	Agricultural Science II
Unit	Agricultural Mechanics II
Subunit	Material Selection, Plan Reading, and Interpretation
Lesson	Making and Reading Working Drawings
Estimated Time	50 minutes

Student Outcome

Interpret a working drawing.
Prepare a working drawing.

Learning Objectives

1. Explain why working drawings are important.
2. Define a working drawing.
3. Explain what views should be included in a working drawing.
4. List some symbols and lines used in drawings and plans.
5. Explain how a working drawing is prepared and dimensioned.

Grade Level Expectations

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
   - ☐ PPt 1 – Common Drawing Symbols
   - ☐ PPt 2 – Common Lines and Dimensioning Techniques
   - ☐ PPt 3 – Dimensioning a Drawing
2. *Agricultural Mechanics Unit for Agricultural Science II* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2002.
3. *Curriculum Enhancement for Agricultural Mechanics Unit for Agricultural Science II*, "Unit VI – Material Selection, Plan Reading, and Interpretation." University of Missouri-Columbia: Instructional Materials Laboratory, 2004.

Supplemental Information

1. Print
   - ❑ Althouse, A., C. Turnquist, W. Bowditch, and K. Bowditch. *Modern Welding.* Tinley Park, IL: Goodheart-Willcox, 2000.
   - ❑ Huth, M., Wells, W. *Understanding Construction Drawings.* 3rd ed. NY: Cengage Delmar Learning, 2004.
   - ❑ Jeffus, L. *Welding Principles and Applications.* 5th ed. Clifton Park, NY: Thomson-Delmar Learning, 2004.
   - ❑ Koel, L. *Construction Print Reading.* NY: Delmar Learning, 1999.

2. Electronic Media
   - ❑ Google SketchUp. Google, 2008. Google offers a free version of its design software, SketchUp. This is a powerful drawing program that is easy to teach and learn. The software comes with a tutorial package as well as very detailed instructions. Dimensions and annotations can be added to drawings to make them applicable for use in designing a project. Accessed October 26, 2007, from http://sketchup.google.com/.

Interest Approach

1. Point out a tool, machine, or structure in the shop, such as a plane, band saw, or workbench. It should be an object for which the instructor has a photo or photos and a complete working drawing. Show students the photo or photos. Ask them if they could build the object using the photo as a guide, assuming they had the tools and skills. Could they send the photo to someone who'd never seen the object before and expect that person to build it? Would the parts be likely to interchangeable? Show students the working drawing or drawings. Guide the discussion to the conclusion that drawings are a way of communicating between the planner and the builder and ensuring consistency.

2. Utilize the free SketchUp software from Google to have students design a project. Once the students have designed the project, have them create a cut list and materials list from the drawing.

Communicate the Learning Objectives

1. Explain why working drawings are important.
2. Define a working drawing.
3. Explain what views should be included in a working drawing.
4. List some symbols and lines used in drawings and plans.
5. Explain how a working drawing is prepared and dimensioned.

Instructor Directions	Content Outline
Objective 1 *Begin the lesson by discussing reasons for making working drawings. Some of this information is also included in the first Interest Approach at the beginning of the lesson. That question can be used to introduce the topic, and the discussion can be summarized with the content outline material. The instructor should add any other reasons he or she feels are relevant. Working drawings can be shown or passed out to students as examples.*	**Explain why working drawings are important.** Working drawings are a way of communicating between the planner and the builder. They help standardize the building process and ensure consistency. They help ensure accurate repairs. Knowing how to read existing working drawings allows a builder to make his or her own working drawings.

Instructor Directions	Content Outline
Objective 2 *Discuss working drawings and how they are different from simple sketches. Explain to students how much detail they will need to include in the drawings they make.*	**Define a working drawing.** A working drawing is a drawing that includes all the dimensions and specifications necessary to build an object. It may or may not be drawn to scale, but the general shape and arrangement of parts in relation to each other should be clear. Drawn to scale means that a unit of measurement used on the drawing directly corresponds to another unit used to measure the actual object.
Objective 3 *Discuss what views need to be included in a working drawing. If example drawings were shown or distributed to students, these can be referred to.*	**Explain what views should be included in a working drawing.** A working drawing should include as many views as needed to show all the parts of the object and how they work together. For many objects, views of the front, top, and one side are sufficient. If needed, other views, detail views, or sectional views, which show the interior of the object, can be added.
Objective 4 *Discuss symbols and lines used for making working drawings. Focus on symbols students are likely to use and encounter. Refer to PPts 1 and 2.* ☐ PPt 1 – Common Drawing Symbols ☐ PPt 2 – Common Lines and Dimensioning Techniques	**List some symbols and lines used in drawings and plans.** There are many symbols and lines used for indicating features and construction materials in drawings that would otherwise be difficult to represent. Because these lines and symbols are standardized, any builder can look at another builder's plans and quickly understand it. 1. Some symbols may be in the same scale as the rest of the drawing and represent features such as doors and windows. 2. Symbols can be used to indicate where electrical or plumbing fixtures are located. 3. Symbols can also be used to indicate the grade or type of material used, such as rough or finished wood, steel, or brick. Lines are distinguished by their form and thickness. Some common lines and what they are used for are listed below.

Instructor Directions	Content Outline
	1. Border line – a heavy solid line used to enclose the entire drawing or separate one drawing from another 2. Object or visible line – a solid line used to show the visible edge of the object 3. Hidden line – a dashed line used to show edges that cannot be seen 4. Dimension line – a thin solid line with arrowheads at the ends that is used to indicate the length, width, or height of an object 5. Extension line – a thin line used to mark the corner or edge of an object 6. Break line – a solid line with zigzags that is used to indicate that part of the object has been left out 7. Center line – a thin line that is made of long, short, long segments and used to indicate the center of a round object 8. Leader line – a line with one arrowhead that is used to point out some feature of the object
Objective 5 *Explain how to draw and dimension a working drawing. Some general information is included below; discuss any other information about completing working drawings as needed. Refer to PPts 2 and 3.* ☐ PPt 2 – Common Lines and Dimensioning Techniques ☐ PPt 3 – Dimensioning a Drawing	**Explain how a working drawing is prepared and dimensioned.** Draw a border line along each side of the paper. 1. This establishes the work area for the drawing and gives it a finished look. 2. Border lines are generally placed 1/2 in. from the edge of the paper. Add a title block to the drawing. 1. A title block gives information about the whole drawing. 2. Typical information found in a title block includes (a) who made the drawing, (b) when it was made, (c) the name of the drawing, and (d) the scale of the drawing. Determine the scale, if the drawing is to be made to scale. Decide on the views that will be drawn and where they will be positioned. 1. A typical working drawing includes three views of the object. The front view is located in the lower left-hand corner, the top view is directly above it, and an end view is to the right.

Instructor Directions	Content Outline
	2. Using a layout like the one mentioned above means that dimensions can represent more than one view, which helps keep the drawing uncluttered and easy to read. Make the working drawing using a sharp lead pencil. Add dimensions and any construction notes using dimension, extension, and leader lines.
Application:	Other activities 1. If time allows, have students prepare a working drawing of a small shop project. If the students have no plan for their chosen shop projects, they should draw up plans at this time.
Closure/Summary	Working drawings are important because they allow planners and builders to communicate, they help standardize the building process and aid in making repairs, and because knowing how to read drawings enables a builder to make his or her own working drawings. A working drawing should include all the dimensions and specifications necessary to build an object. A working drawing should include as many views as needed to show all the parts of the object and how they work together. Views should be laid out so that the drawing is uncluttered and easy to read.
Evaluation: Quiz	Answers: 1. d 2. c 3. b 4. a 5. c 6. h 7. g 8. b 9. d 10. f 11. a 12. e 13. Student should list two of the following benefits of using a working drawing: a. Efficiency in construction process

Instructor Directions	Content Outline
	b. Consistency and accuracy in final product c. Accuracy of a repair 14. a. Person who made the drawing b. When the drawing was made c. Name of the drawing d. Scale of the drawing