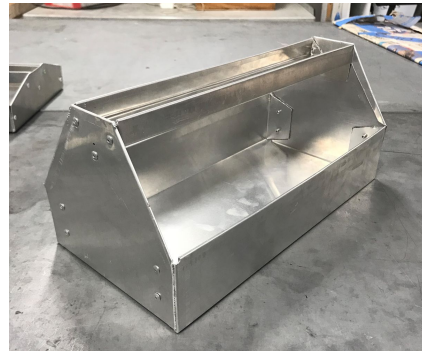


# TVCoG Lesson Plan

## I. Lesson Information

- a. **Lesson Title:** Building a Sheet Metal Toolbox  
(also counts for Metal Shop orientation)
- b. **Lesson Length:** 4 hours
- c. **Number of participants:** 4



## II. Learning Outcomes: Objectives

- a. **Audience**
  - Anyone interested in learning basics of sheet metal forming
  - No previous knowledge necessary
- b. **Objectives**
  - Sheet metal pattern making
  - Sheet metal cutting
  - Sheet metal bending
  - Riveting



## III. Content Outline, Questions, and Key Terms (Lesson Content/Skills)

### a. Content Outline and Background Information

- 1) Sheet metal pattern making
  - a) Like a cube made out of origami
  - b) Folds take up space, based on thickness of sheet metal
  - c) Helpful to practice with cardboard or paper first
    - i) Plan out order of bends so don't run into each other
  - d) Straight lines and right angles are key for boxes
  - e) Use scribes as a best practice instead of a pen/marker to mark on sheet metal (sharpie fine this time)
- 2) Sheet metal cutting
  - a) Shear
    - i) Long flat cuts
  - b) Band saw
    - i) For smaller, detailed, and/or inside cuts
- 3) Sheet metal bending
  - a) Brake
    - i) Used to fold sheet metal
    - ii) Clamping pressure enough to hold sheet metal in place but not forced down
    - iii) Clamp should be back at least 1.5 times the material thickness from the apron (bending part) as to not damage the clamp. Beyond that, it'll lead to bigger bending radii.
  - b) Hemming
    - i) Get rid of rough, sharp edge on sheet metal
    - ii) Like sewing
    - iii) Fold as much as possible on the brake, flip upside down and press down to close the gap to 180 degrees
      - (1) Don't put undue pressure on the brake, can also use a hammer for the second step

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- 4) Riveting
  - a) Drill press based on hole size
  - b) Pop rivet gun used to insert rivets
  - c) Have to drill out to remove them

## b. Major Messages, Big Concepts

- Always square edges
- Measure twice, cut once
- Sheet metal has thickness, bends have radii

## c. New and Key Terms

- **Brake** - metalworking machine used to bend sheet metal
- **Shear** - metalworking machine used to cut sheet metal
- **Hemming** - when the sheet metal is folded back on itself
- **Rivet** - permanent mechanical fastener

## d. Possible misconceptions (m) and prior knowledge/skills (pk)

- Sheet metal cutting (pk)
- Sheet metal bending (pk)
- Drilling (pk)
- Riveting (pk)
- Right angles and boxes are easy to make (m)

## IV. Lesson Delivery Procedure(s) and Strategies

Time	Procedure - hands-on demonstration, example
2 min	<b>a. Set-Induction and Lesson Opening</b> <ol style="list-style-type: none"><li>1) Basic, getting attention since already know what class they signed up for<ol style="list-style-type: none"><li>a) <b>Focus/Attention Getter:</b> Introduce self, go around saying name, why signed up for class, what do during the day</li><li>b) <b>Interest Builder:</b> "Sheet metal seems like it should be simple to work with, but in order to end up with an object you're proud of, there are some specific ways of forming it that you'll want to know."</li><li>c) <b>Relevance:</b> "You'll learn skills that'll be applicable and helpful for any future sheet metal projects that you'll want to do."</li><li>d) <b>Student Objective:</b> "By the end of today's class, you should be walking out of here with a usable toolbox."</li></ol></li></ol>
	<b>b. Body of the lesson</b>
15 min	<ol style="list-style-type: none"><li>1) Metal shop orientation/safety</li><li>2) Walk through the process of making the toolbox</li></ol>
5 min	<ol style="list-style-type: none"><li>3) Sheet metal pattern making<ol style="list-style-type: none"><li>a) Have example paper patterns for the toolbox and handle, show and explain it</li><li>b) Use pattern and t-square and demonstrate how scribe works on sheet metal<ol style="list-style-type: none"><li>i) Easier to use sharpie (width of band saw blade) in this instance</li></ol></li><li>c) Tape pattern to sheet metal, then go around with sharpie<ol style="list-style-type: none"><li>i) Mark main toolbox pattern on both sides of sheet metal</li></ol></li><li>d) Any questions?</li></ol></li></ol>
5 min	<ol style="list-style-type: none"><li>4) Sheet metal cutting</li></ol>

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- a) Shear
    - i) Demonstrate how to do a long cut on the shear, lining it up squarely
  - b) Band saw
    - i) Adjust band saw height to just above sheet metal
    - ii) Demonstrate how to cut a triangle out of the material
  - c) Snips
    - i) used for getting in to hard to reach spots from band saw
  - d) Any questions?
- 10 min** 5) Sheet metal bending
- a) Brake
    - i) Show accurate clamping pressure
    - ii) Demonstrate a 90 degree bend
  - b) Hemming
    - i) Demonstrate a hem on the brake
    - ii) Demonstrate a hem with hammer
  - c) Show how to bend with clamp if can't get specific spacing or direction needed on the brake
  - d) Pay attention to bend numbers on templates
- 10 min** e) Any questions?
- 6) Riveting - can show later, after they get closer to finishing the box
- a) Show set up for drilling holes once toolbox is folded
    - i) Clamps to keep bent in parts from bending away
    - ii) Punch center before drilling so drill bit goes in where intended
  - b) Demonstrate how a pop rivet gun is used
- 1 min** c) Any questions?
- 7) Finishing
- a) File down or grind away any sharp edges
    - i) Make sure wheel turns in direction of the fold, not away from it (will bend it back)
  - b) Sanding, bead blasting
  - c) Any questions?
- 1 min** **c. Conclusion**
- 1) Show example finished toolbox, just one possibility of many
    - a) "And now it's time for you to actually build your own toolbox!"
- 3-4 hrs** **d. Extended Activity/Practice**
- 1) Building their own toolboxes
    - a) Wander around
    - b) Make sure things are going smoothly, no one's going to hurt themselves or majorly mess up their toolbox, etc.
    - c) Answer questions
    - d) People can leave when they're done making their toolbox
  - 2) If share emails, can send resource links, Fusion360 info, etc.
    - a) Fusion360 sheet metal abilities:  
<https://www.google.com/url?q=https://www.youtube.com/watch?v%3DnEjFMYNGY4g&sa=D&ust=1535483214405000&usg=AFQjCNFGDn1fFg9de6dr4vk-jTRGou0UJA>

# TVCoG Lesson Plan

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## V. Assessment and Evaluation

List the ways you can assess whether your students are working towards the learning objectives.

- Able to produce a feasible pattern
- Able to cut the sheet metal for the pattern properly
- Able to bend the sheet metal following the pattern
- Able to drill holes and rivet the toolbox together
- Ultimately, a finished, usable toolbox

## VI. Diversity and Enhancements

List any items that you will include in this lesson to increase the content for diverse learners.

- Specific design features they'd want for their toolbox
  - Different end designs
  - Dividers inside the box
  - Punching words into the side before bending

## VII. Classroom Management and Logistics

List any classroom management and/or logistic items

- Band saw
- Shear
- Brake
- Safety equipment (safety glasses, earplugs)

## VIII. Safety/Equipment Reviews and Considerations

List any safety items you need to review with your students (or equipment care)

- Long hair tied back
- No jewelry, watches, etc.
- Safety glasses at all times
- Earplugs when using the band saw
- Gloves are optional when handling sharp-edged sheet metal

## IX. Resources: Instructional/Content Aids, Materials, Small Equipment

Instructional Aids	Materials (per student)	Small Equipment (per student)
<ul style="list-style-type: none"> <li><input type="checkbox"/> Example pattern</li> <li><input type="checkbox"/> Example toolbox</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Cardboard/paper 24" x 12"</li> <li><input type="checkbox"/> Cardboard/paper 14" x 4"</li> </ul> <p>Used galvanized steel:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Sheet metal 24" x 12" 20 gage (~0.0375" thick)</li> <li><input type="checkbox"/> Sheet metal 14" x 4" 20 gage</li> <li><input type="checkbox"/> Rivets 14 1/8" diameter, for 0.075" in grip range</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Pencil &amp; sharpie</li> <li><input type="checkbox"/> Ruler</li> <li><input type="checkbox"/> Scissors</li> <li><input type="checkbox"/> Paperclips</li> </ul> <p>Can share:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Snips</li> <li><input type="checkbox"/> Hammer</li> <li><input type="checkbox"/> Center punch</li> <li><input type="checkbox"/> Pop riveter</li> <li><input type="checkbox"/> 1/8" drill bit</li> <li><input type="checkbox"/> Drill</li> <li><input type="checkbox"/> Tape</li> </ul>

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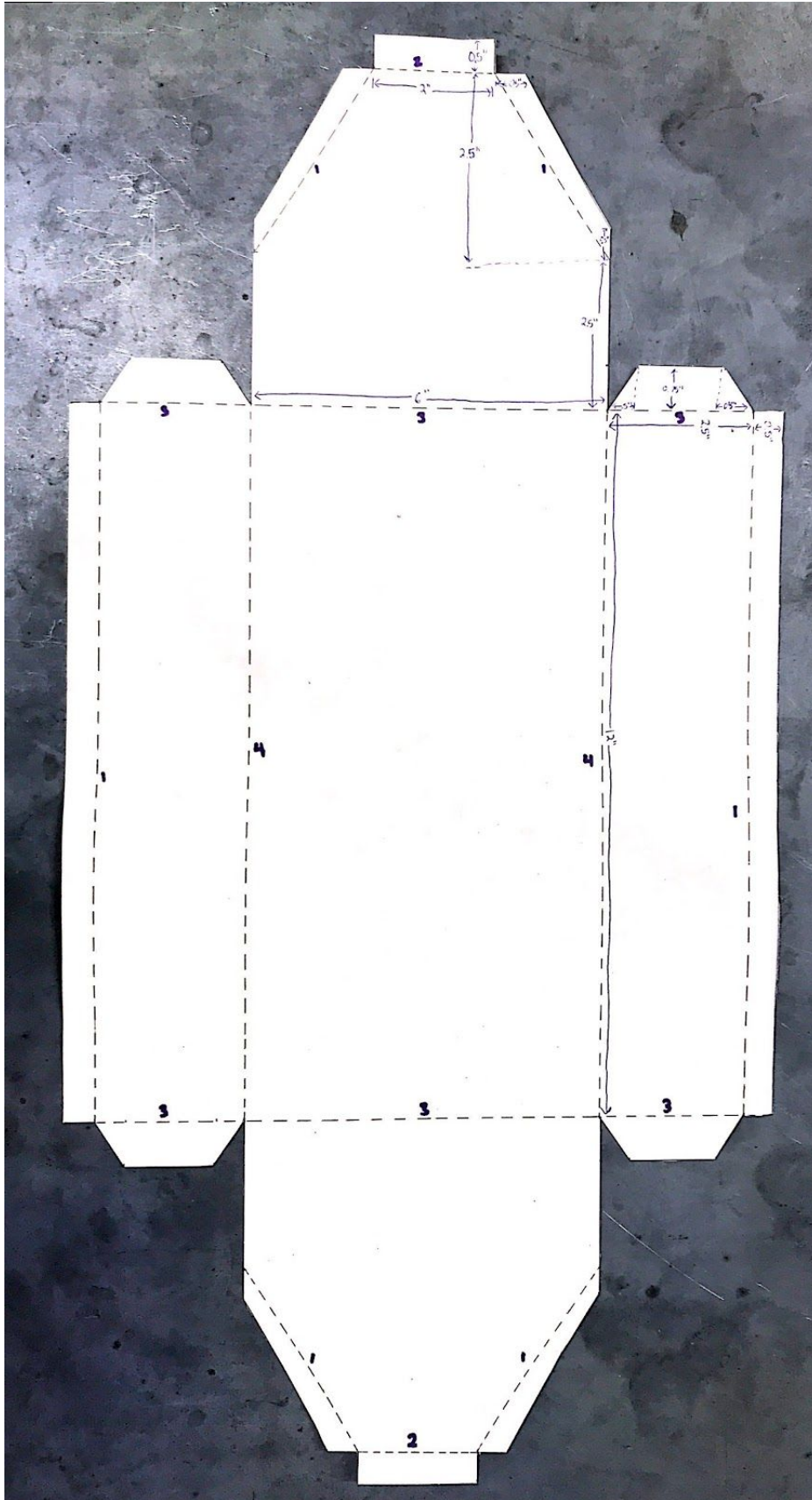
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## References and web links

- Shop Notes: Quick and Easy Sheet Metal Projects
  - <http://www.shopnotes.com/files/issues/108/quick-and-easy-sheet-metal-projects.pdf>
- Instructables: Designing for Sheet Metal
  - <http://www.instructables.com/id/Designing-for-Sheet-Metal/>
- YouTube: Making a Sheet Metal Tool Tray
  - <https://www.youtube.com/watch?v=sL48yxgB5ls>

# TVCoG Lesson Plan

## Box Pattern:



# TVCoG Lesson Plan

Handle Pattern:

