Lesson Plan Author(s) Names and Affiliation: This lesson plan is designed locally by two Ph.D. students from the department of Industrial Engineering and supervised by a faculty member from the department Mojahed Alkhateeb, Header Alrufaifi, and Dr. Jeremy Rickli

Title: Valve Disassembly and Reverse Engineering

Subject Area: Industrial & Systems Engineering

Learning Activity Description: Kids are curious of knowing how stuff function and how to fix them or make them better. The activity will ask students to reverse engineer a valve in order to introduce them to the concepts of product design, manufacturing, and disassembly. Students will disassembly an existing valve, record the components and order of disassembly, and identify manufacturing processes used to make individual valve components. The activity will give them a hands-on introduction to product design and manufacturing.

Lesson Activity Objective: Students will learn about concepts in product design and manufacturing processes and give them a hands-on experience of disassembling an object and reassembling it using basic tools.

Lesson Activity Outcomes: Students will get the ability to identify a product and know how it is functioning. Also be able to identify how it was designed and what are the manufacturing processes that were involved in making the product. Also making them comfortable and not afraid of disassembling and reassembling any object in the future and giving them self-confidence on their ability to do so.

Materials/Supplies Listed: Plastic valve, Metal valve, screw drivers, wrenches.

Teacher Procedures: Presenting concept about reverse engineering, remanufacturing, and few manufacturing processes such as injection molding, casting, and machining. Then students will perform the following activities.

1. Form groups of two or three depending on the number of students.
2. Distribute two types of valves among the groups.
3. Students will collect the required tools to perform the disassembly activity.
4. Students will fill up the sheet of paper provided and record observation.
5. Students will exchange knowledge of the other types of valves and suggest improvements.
**Preparation Time for Learning Activity:** The activity time will be divided between making the activity itself and listening to the small presentation and recording the observations for a total of 40 minutes:

- Reverse engineering background: 2 min
- Manufacturing processes introduction: 5 min
- Disassembly operations background: 2 min
- Recording activity example: 2 min
- Measuring example: 2 min
- Disassembly activity and recording: 20 min
- Assembly and cleaning up: 5 min

**Room set-up:** All the valves and tools will be on the table along with the observation sheet. Student will be divided onto a team of two student per each team. Each team will be given a valve and an observation sheet. They will set on ground in the high bay and first listen to the presentation and then they will conduct the activity and record observation.

**Group Strategies (example, group size, expected time for groups, etc.):** Student will be divided onto a team of two student per each team. Each team will be given a valve and an observation sheet. The expected time to perform the activity is around 40 min. See appendix.

**Student Products/Artifacts/work pages:** There are two outcomes from the activity; the bill of material table to fill up and the precedence diagram see appendix.

**Assessment Criteria/Rubric:** The assessment will be based on the student ability to correctly fill out the bill of materials and the assembly sequence and understanding of the activity and their ability to disassembly, reassemble the valve and on their observations and their ability to fill up the table correctly.

**Closing/Transition to next activity:** when the students complete the activity, they will clean up and return the valves and the tools to the table exactly to where they get it from. Then will form groups with their leaders to move to the next activity.

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Appendix
### For plastic valve

<table>
<thead>
<tr>
<th>Part number</th>
<th>Part Name/Description</th>
<th>Material</th>
<th>Manufacturing Process</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knob</td>
<td>Plastic</td>
<td>Injection Molding</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Label</td>
<td>Paper</td>
<td>Print and cut</td>
<td>1</td>
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<tr>
<td>3</td>
<td>Screw</td>
<td>Metal</td>
<td>Machining</td>
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<td>4</td>
<td>Shaft</td>
<td>Plastic</td>
<td>Injection Molding</td>
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<tr>
<td>5</td>
<td>Bolt</td>
<td>Plastic</td>
<td>Injection Molding</td>
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<tr>
<td>6</td>
<td>Seals</td>
<td>Rubber</td>
<td>Injection Molding</td>
<td>3</td>
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<td>7</td>
<td>Main valve body</td>
<td>Plastic</td>
<td>Injection Molding</td>
<td>1</td>
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<tr>
<td>8</td>
<td>Side release screw</td>
<td>Metal</td>
<td>Machining</td>
<td>1</td>
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<tr>
<td>9</td>
<td>Seal</td>
<td>Rubber</td>
<td>Injection Molding</td>
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### For metal valve

For metal valve
<table>
<thead>
<tr>
<th><strong>Part number</strong></th>
<th><strong>Part Name/Description</strong></th>
<th><strong>Material</strong></th>
<th><strong>Manufacturing Process</strong></th>
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<tbody>
<tr>
<td>1</td>
<td>Bolt</td>
<td>Steel</td>
<td>Machining</td>
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<tr>
<td>2</td>
<td>label</td>
<td>Aluminum</td>
<td>Machining</td>
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<td>3</td>
<td>Knob</td>
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<td>Shaft</td>
<td>Steel</td>
<td>Machining</td>
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<td>7</td>
<td>Bolt cover</td>
<td>Steel</td>
<td>Casting &amp; Machining</td>
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<td>8</td>
<td>Seal for bolt cover</td>
<td>plastic</td>
<td>Injection Molding</td>
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<td>9</td>
<td>Moving cylindrical moving part</td>
<td>Steel</td>
<td>Casting &amp; Machining</td>
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<td>Main valve body</td>
<td>Steel</td>
<td>Casting &amp; Machining</td>
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Draw precedence diagram

1. Cut machining threading
2. Label
3. Weld
4. Cut casing
5. Cast machining disk
6. Cast casing machining
7. Mill inner
8. Mill outer
9. Thread outer
10. Mill inner
11. Assemble main valve body with upper part assembly
12. Milling cylinder seat
13. Castings machining
14. Main valve body casting machining
15. Assemble main valve body with upper part assembly