Drawings for Manufacture

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Where to Start when Creating Engineering Drawings

Ask yourself……..

• How is the part going to be made?
• Have standardized sizes and parts been used where applicable?
• What are the important/critical dimensions of the part?
• How accurate does the part need to be (Tolerances)?
• What material does the part need to be made of to satisfy the design requirements (Environment, strength, cost)?
• Is the part optimized for the manufacturing methods to be employed?
What to Think About when Creating a Set of Engineering Drawings

- Engineering Drawings are a set of instructions to be adhered to by the manufacturer
- The instructions must be as clear and concise as possible
- Consider the machines, tools, materials and skill capabilities of the manufacturing process
- Relationships of dimensions to one another
- Views necessary to adequately convey features of part (Third angle projection, section views and detailed views)
- Surface finishes (O-ring sealing surfaces, cosmetic finishes etc)
- Always consider the cost of manufacturing your part
Example 1 Specification Drawing

Important Specifications:

• Origin location
• Dimension tolerances
• Entity relationships
• Geometric callouts
• Material
Example 1 Shop Drawing

Important Specifications:

- Origin location
- Dimension tolerances
- Entity relationships
- Geometric callouts
- Material
Example 2

Important Specifications:

- Origin location
- Dimension tolerances
- Material designation
- Geometric callouts

DIMENSIONS ARE IN INCHES
TOLERANCES:
TWO PLACE DECIMAL  +/- .01”
THREE PLACE DECIMAL  +/- .003”
UNLESS OTHERWISE SPECIFIED
Example 3

<table>
<thead>
<tr>
<th>SERIES</th>
<th>NAME</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEBLE 16-G01-15</td>
<td>AEBLE 16-G01-15</td>
<td>AEBLE 16-G01-15</td>
</tr>
</tbody>
</table>

**UNIVERSITY OF VICTORIA**

**PILLOW BLOCK**

**QUANTITY: 2**

**SCALE: 1:1**

**WEIGHT:**

**SHEET 1 OF 1**

**NOMINAL SIZE: 16-16 A1**

**FINISH:**

**NONE**

**APPLICATION:**

**DO NOT SCALE DRAWING**

**COMMENTS:**

**FOR MECH200 ROTOR ASSEMBLY**

**REFERENCE:**

**DRAWN:**

**CHECKED:**

**APPROVED:**

**DATE:**

**END APPR:**

**MFG APPR:**

**NOTE:**

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Example 4
Tolerancing

Things to consider...

• What needs to be have tolerances and what doesn't (Nominal Sizes)
  - Nominal Size (Nom.) is the supplied material size without machining

• Precision Required (number of decimal places).
  - Excessive tolerancing can be extremely time consuming resulting in high manufacturing costs

• Avoid tolerance accumulation/stacking
### Tolerances Related To Machining Processes and Sizes

<table>
<thead>
<tr>
<th>Range of Sizes To and including</th>
<th>Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0.010 to 0.599</td>
<td>0.00015  0.0002  0.0003  0.0005  0.0008  0.0012  0.002  0.003  0.005</td>
</tr>
<tr>
<td>From 0.600 to 0.999</td>
<td>0.00015  0.00025  0.0004  0.0006  0.001  0.0015  0.0025  0.004  0.006</td>
</tr>
<tr>
<td>From 1.000 to 1.499</td>
<td>0.0002  0.0003  0.0005  0.0008  0.0012  0.002  0.003  0.005  0.008</td>
</tr>
<tr>
<td>From 1.500 to 2.799</td>
<td>0.00025  0.0004  0.0006  0.001  0.0015  0.0025  0.004  0.006  0.010</td>
</tr>
<tr>
<td>From 2.800 to 4.499</td>
<td>0.0003  0.0005  0.0008  0.0012  0.002  0.003  0.005  0.008  0.012</td>
</tr>
<tr>
<td>From 4.500 to 7.799</td>
<td>0.0004  0.0006  0.001  0.0015  0.0025  0.004  0.006  0.010  0.015</td>
</tr>
<tr>
<td>From 7.800 to 13.599</td>
<td>0.0005  0.0008  0.0012  0.002  0.003  0.005  0.008  0.012  0.020</td>
</tr>
<tr>
<td>From 13.600 to 20.999</td>
<td>0.0006  0.001  0.0015  0.0025  0.004  0.006  0.010  0.015  0.025</td>
</tr>
</tbody>
</table>

- Lapping & Honing
- Grinding, Diamond
- Turning & Boring
- Broaching
- Reaming
- Turning & Boring
- CNC Milling
- Manual Milling
- Drilling

*Note: The table shows the tolerances for various machining processes across different size ranges.*
Common Hole Mistakes to Avoid

No Flat bottom drilled holes

Tapped holes excessively deep
Tips and Tricks

- Incorporate devices which will allow room for inconsistencies in manufacturing and materials
- When possible draw parts to a 1:1 scale and print to get a real sense of size
- Consult the manufacturer before producing detailed drawings
- Provide the manufacturer an assembly drawing in order to help them understand the integration of the part
- Consider the cutting tools required to machine the part in order to determine if the feature is viable (Milled feature width to depth ratio)
Drafting Tips

• Text should be large enough to be read easily
• Ensure appropriate scale and location for pointer lines (arrows)
• Lines should be dark and legible
• Avoid using pale colours in drawings
• Give parts unique names and part numbers
• Maintain a revision system for updated packages
• Relax tolerances as much as possible
• Avoid the use of built-in cad software for calling out tap drill sizes (consult tap drill sizes chart or the manufacturer)
<table>
<thead>
<tr>
<th>Nom Size - T.P.I.</th>
<th>Drill #</th>
<th>Dec Equ</th>
<th>Drill #</th>
<th>Dec Equ</th>
<th>Drill #</th>
<th>Dec Equ</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 - 56</td>
<td>49</td>
<td>0.073</td>
<td>44</td>
<td>0.086</td>
<td>43</td>
<td>0.089</td>
</tr>
<tr>
<td>4 - 40</td>
<td>42</td>
<td>0.093</td>
<td>35</td>
<td>0.110</td>
<td>33</td>
<td>0.113</td>
</tr>
<tr>
<td>6 - 32</td>
<td>35</td>
<td>0.110</td>
<td>29</td>
<td>0.136</td>
<td>28</td>
<td>0.140</td>
</tr>
<tr>
<td>8 - 32</td>
<td>28</td>
<td>0.140</td>
<td>20</td>
<td>0.161</td>
<td>18</td>
<td>0.169</td>
</tr>
<tr>
<td>10 - 24</td>
<td>23</td>
<td>0.154</td>
<td>12</td>
<td>0.189</td>
<td>10</td>
<td>0.193</td>
</tr>
<tr>
<td>10 - 32</td>
<td>20</td>
<td>0.161</td>
<td>12</td>
<td>0.189</td>
<td>10</td>
<td>0.193</td>
</tr>
<tr>
<td>1/4 - 20</td>
<td>6</td>
<td>0.204</td>
<td>1/4</td>
<td>0.250</td>
<td>6.5(mm)</td>
<td>0.255</td>
</tr>
<tr>
<td>1/4 - 28</td>
<td>7/32</td>
<td>0.218</td>
<td>1/4</td>
<td>0.250</td>
<td>6.5(mm)</td>
<td>0.255</td>
</tr>
<tr>
<td>5/16 - 18</td>
<td>17/64</td>
<td>0.265</td>
<td>5/16</td>
<td>0.312</td>
<td>8(mm)</td>
<td>0.315</td>
</tr>
<tr>
<td>3/8 - 16</td>
<td>21/64</td>
<td>0.320</td>
<td>3/8</td>
<td>0.375</td>
<td>25/64</td>
<td>0.390</td>
</tr>
<tr>
<td>3/8 - 24</td>
<td>R</td>
<td>0.339</td>
<td>3/8</td>
<td>0.375</td>
<td>25/64</td>
<td>0.390</td>
</tr>
<tr>
<td>7/16 -14</td>
<td>3/8</td>
<td>0.375</td>
<td>7/16</td>
<td>0.438</td>
<td>29/64</td>
<td>0.453</td>
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<tr>
<td>7/16 - 20</td>
<td>25/64</td>
<td>0.390</td>
<td>7/16</td>
<td>0.438</td>
<td>29/64</td>
<td>0.453</td>
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<tr>
<td>1/2 - 13</td>
<td>7/16</td>
<td>0.437</td>
<td>1/2</td>
<td>0.500</td>
<td>13(mm)</td>
<td>0.512</td>
</tr>
<tr>
<td>1/2 - 20</td>
<td>29/64</td>
<td>0.453</td>
<td>1/2</td>
<td>0.500</td>
<td>13(mm)</td>
<td>0.512</td>
</tr>
</tbody>
</table>

**Note:** For tap drill and clearance drill sizes outlined in the table above are sufficient for most work conducted in the Uvic Mech Eng Machining Facility. For critical for high stress applications consult shop supervisor before selecting a tap or clearance drill.
Shim ring varies from 0.008" to 0.020" in thickness.

Corrugations vary from 0.0295" to 0.0492" in height.