See the project resource page on the 2.000 web site
Project I purpose, goal and grading

**Purpose:**
- The purpose of this project is to expose you to a “real world” engineering problem.
- What you will get out of this project:
  - Experience in mechanical design
  - Experience with solid modeling
  - Some manufacturing experience

**Grading**
- 50% Grade from group
  - You will have $xx,xxx to split among the group members
  - The split will determine your grade
- 50% Grade From Instructors
  - Meeting deadlines
  - CAD model
  - Design reasoning & explanation
  - Creativity

**Main Goal**
- For a given speed, design a pump which will most rapidly empty a gallon of water
Organization and execution

Break into teams of 4-6 students from your lab section

What you should do to start (start the design process):
• Determine how the goal relates to the geometry of the pump (hint: think displacement)
• THINK about what affects the displacement of the pump
• Model your pump’s geometry and discuss how to best accomplish the goal
• Develop equations that relate the displacement of your pump to the gear geometry
• Develop a concept (idea) for your pump

What I need from you in the end:
• 3 quantities for making your gears (see appended spread sheet example)
• You will receive a part file from me once I have these 3 numbers
• DXF files for making your housing and endplates
# Project schedule updates

<table>
<thead>
<tr>
<th>Approx</th>
<th>START</th>
<th>WHAT</th>
<th>DUE</th>
<th>PTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 9</td>
<td>Project mgmt spread sheet</td>
<td>Day 11</td>
<td>[ 20 ]</td>
<td></td>
</tr>
<tr>
<td>Day 10</td>
<td>HMK 6: 1 page concept &amp; equations + SIMPLE 1 page explanation</td>
<td>Day 14</td>
<td>[ 80 ]</td>
<td></td>
</tr>
<tr>
<td>Day 12</td>
<td>Gear characteristics</td>
<td>Day 14</td>
<td>[ 10 ]</td>
<td></td>
</tr>
<tr>
<td>Day 12</td>
<td>CAD files &amp; DXF files</td>
<td>Day 16 (via zip disk)</td>
<td>[ 90 ]</td>
<td></td>
</tr>
</tbody>
</table>

$$\Sigma: \ 200$$
# Gear geometry

<table>
<thead>
<tr>
<th>Name</th>
<th>Variable</th>
<th>Units</th>
<th>Equations/How to Get It</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Teeth</td>
<td>([ N ])</td>
<td>teeth</td>
<td>You choose this to get right gear or speed ratio</td>
</tr>
<tr>
<td>Pitch (diametral)</td>
<td>([ p ])</td>
<td>1 / in</td>
<td>(N/\text{PD}) (mating gears must have same pitch!!)</td>
</tr>
<tr>
<td>Pressure Angle</td>
<td>([ \phi ])</td>
<td>deg.</td>
<td>Usually Standard (14.5°, 20°, 25°)</td>
</tr>
<tr>
<td>Addendum Diameter</td>
<td>([ AD ])</td>
<td>in</td>
<td>(\text{PD} + 2*\text{a})</td>
</tr>
<tr>
<td>Dedendum Diameter</td>
<td>([ DD ])</td>
<td>in</td>
<td>(\text{PD} - 2*\text{d})</td>
</tr>
<tr>
<td>Pitch Diameter</td>
<td>([ PD ])</td>
<td>in</td>
<td>You Choose (use this diameter to calculate Torque)</td>
</tr>
<tr>
<td>Addendum</td>
<td>([ a ])</td>
<td>in</td>
<td>1.00/(p)</td>
</tr>
<tr>
<td>Dedendum</td>
<td>([ d ])</td>
<td>in</td>
<td>1.25/(p)</td>
</tr>
<tr>
<td>Min. teeth for no undercut=</td>
<td></td>
<td></td>
<td>(2/\sin^2(\phi))</td>
</tr>
</tbody>
</table>

These are different!!
**Constraints**

YOU ARE NOT CONSTRAINED TO THIS # OF TEETH!!!

*YOU MUST MAKE THE HOUSINGS, KEYS, PORTS, AND ENDPLATES
*I WILL PROVIDE THE SHAFT AND GEAR (YOU MUST GIVE ME THE 3 GEAR PARAMETERS

**BUSHINGS**
You will need 4 (1 for each side of shaft)

**GOAL: FOR A GIVEN SPEED, MAKE A PUMP WHICH WILL MOST RAPIDLY EMPTY A GALLON OF WATER**

PLACE BOLT HOLES FOR GOOD SEALING I RECOMMEND PLACING THEM SO PERIMETER OF HOLE IS AT LEAST 0.125 INCHES FROM A POTENTIAL LEAKING SPOT

YOU ARE NOT CONSTRAINED TO THIS SHAPE!!!

1/4 inches thick

1/2 inches thick

IF THIS WERE A STEROID VERSION OF A PUMP, WE WOULD TAKE MORE CARE IN CHOOSING THE NUMBER OF BOLTS AND IN CHOOSING THEIR POSITION SO AS TO GET BETTER SEALING, BUT SINCE WE ARE LIMITED IN TIME AND BY THE WATERJET, PLEASE STICK TO 8 HOLES!
Calculations

Before you design your gear pump, you need to make a spreadsheet which calculates several gear parameters. There is a link to a tutorial for using the spreadsheet on the web page for project 1. This will help you in choosing your dimensions.

Reproduce this spreadsheet using the equations in the handout. Use my numbers to check your calculations.

You will use formulas to calculate the numbers in red.

Type these 3 columns in by hand.

This column can be calculated.

Remember, waterjet cuts a maximum pressure angle of 30°!
Standard (given) parts [2 keys]
Standard (given) parts [2 shafts]

**Material:** 6061 T6 Aluminum

**SECTION B-B**

- **B**

**SECTION C-C**

- **C**

- **D**

**DETAIL D**

 SCALE 4 : 1

**SECTION B-B**

**2.000**

**TITLE:** Gear Pump Shaft

**Drawn By:** Martin Culpepper

**Date:** 04/03/00

**Units:** Inches

**Scale:** 2:1

**Version:** 1

**Group Members:**

- Member #1
- Member #2
- Member #3
- Member #4
- Member #5
- Member #6

**Material:**

- **R.062** ± **0.005** TYP
- **0.750** ± **0.005**
- **1.250** ± **0.005**
- **2.000** ± **0.010**
- **0.015 @ 45 Deg. TYP**

**Member # 1**

**Member # 2**

**Member # 3**

**Member # 4**

**Member # 5**

**Member # 6**
Standard (given) parts  [ 4 bushings]

Material: Powder Metal Bronze

SECTION A-A

A

.025 @ 45 Deg.

.063 .250

.503

A

.025 @ 45 Deg.

.025 @ 45 Deg.

.025 @ 45 Deg.