2.000 PROJECT 1: External gear pump

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

START	WHAT	DUE	PTS
Day 9	Project mgmt spread sheet	Day 11	[20]
Day 10	HMK 6: 1 page concept & equations + SIMPLE 1 page explanation	Day 14	[80]
Day 12	Gear characteristics 1 page explanation	Day 14	[10]
Day 12	CAD files & DXF files	Day 16 (via zip disk)	[90]
		Σ:	200

Gear geometry

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

These are different!!

Constraints

Key   Ø.125   .500

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

TITLE: Prototype 2.000 Gear Pump / Motor

Drawn By: Martin L. Culpepper

Date: 02/23/01

Scale: 1: 1   Revision: A

Default Tolerance

x.xx   ± 0.01
x.xxx   ± 0.005
x.xxxx   ± 0.0005

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.188

Ø.375

Ø.125

Shaft

2.000

1.250

.750

NOTE: CENTER OF KEY LIES ON PERIMETER OF SHAFT

Gear

.658   0.510

Port   .500

Ø.435

*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)

3.958 MAX!!!

ALL BOLT THROUGH HOLES MUST BE Ø.197

(PD)

Endplate

3.500 MAX!!!

YOU ARE NOT CONSTRAINED TO THIS SHAPE!!

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 ATLEAST 0.125 INCHES FROM
A POTENTIAL LEAKING SPOT

YOU ARE NOT CONSTRAINED
TO THIS SHAPE!!!

¼ inches thick

0.25" MIN!!!

½ inches thick

Housing

Housing

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 spread sheet which calculates several gear parameters. There is a link to a tutorial for using the spread sheet 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°!

Microsoft Excel - gear_pumps_motor-4

File Edit View Insert Format Tools Data Window Help

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F22 =

	A	B	C	D	E	F	G
1	*External Gear Pump Parameter Calculation Sheet*						
2	*2.972 Understanding How Things Work*						
3							
4	Input Values in **BLUE**, Do **NOT** Change Values in **RED**						
5							
6	Group	?					
7	Date:	?		**Put your stuff here**			
8							
9		**Value**	**Variable**	**Dimension**	**How To Get It**		
11	**No. of Teeth**	11	[N]	teeth	You Choose		
13	**Pitch (Diametral)**	6.93	[p]	1 / in	= N/PD		
15	**Pressure Angle**	30.0	[φ]	degrees	Usually Standard (14.5, 20, 25, 30)		
17	**Adendum Diameter**	1.875	[AD]	in	= PD + 2*a		
19	**Dedendum Diameter**	1.226	[DD]	in	= PD - 2*d		
21	**Pitch Diameter**	1.587	[PD]	in	You Choose		
23	**Adendum**	0.144	[a]	in	= 1.00/p		
25	**Dedendum**	0.180	[d]	in	= 1.25/p		

Minimum Number of Teeth to Avoid Undercut

Pressure Angle	For No Undercut	For Acceptable Undercut
degrees	*# teeth*	*# teeth*
14.5	32	20
20.0	18	14
25.0	12	10

Input to Omax Waterjet Software

No. Teeth	11	teeth
Pitch	6.93	1 / in
Pressure Angle	30.0	degrees

◄ ► ►| \ **Sheet1** / Sheet2 / Volumetric Efficie ◄ |

Ready

Standard (given) parts [2 keys]

TITLE: Key [Dowel Pin]

Drawn By: Martin Culpepper

Date: 04/03/00 | Units: Inches

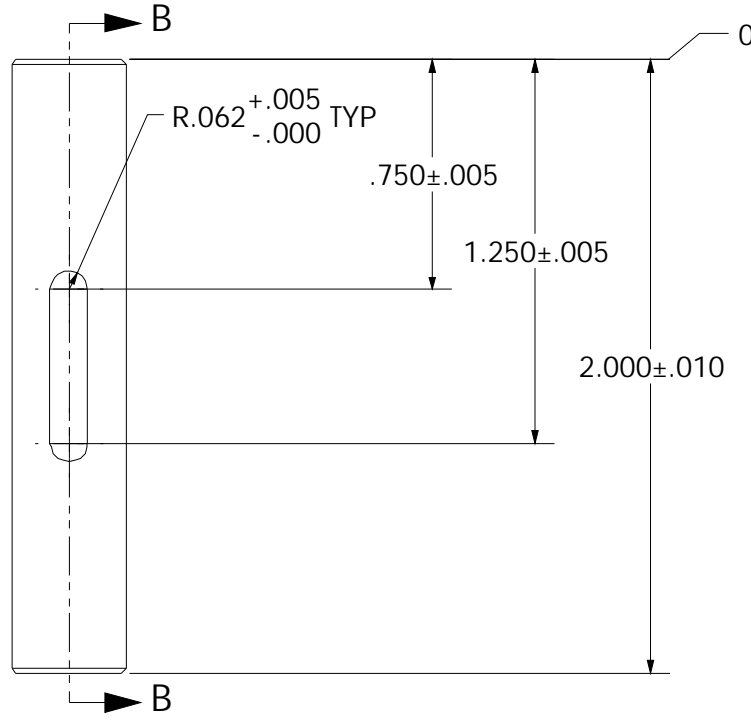Scale: 8:1 | Version: 1 | **2.000**
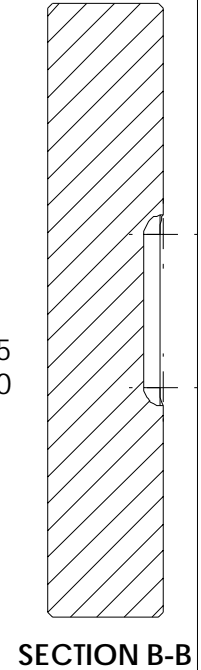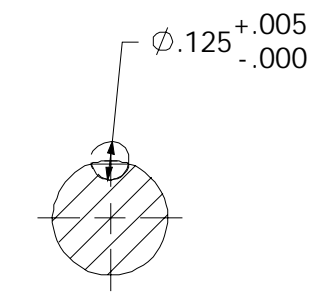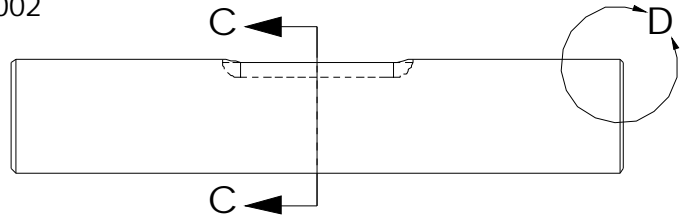
Group Members:

Member # 1 | Member # 2 | Member #3

Member # 4 | Member # 5 | Member #6

.0150 @ 45 Deg.

.5000

R.0313

⌀.1250
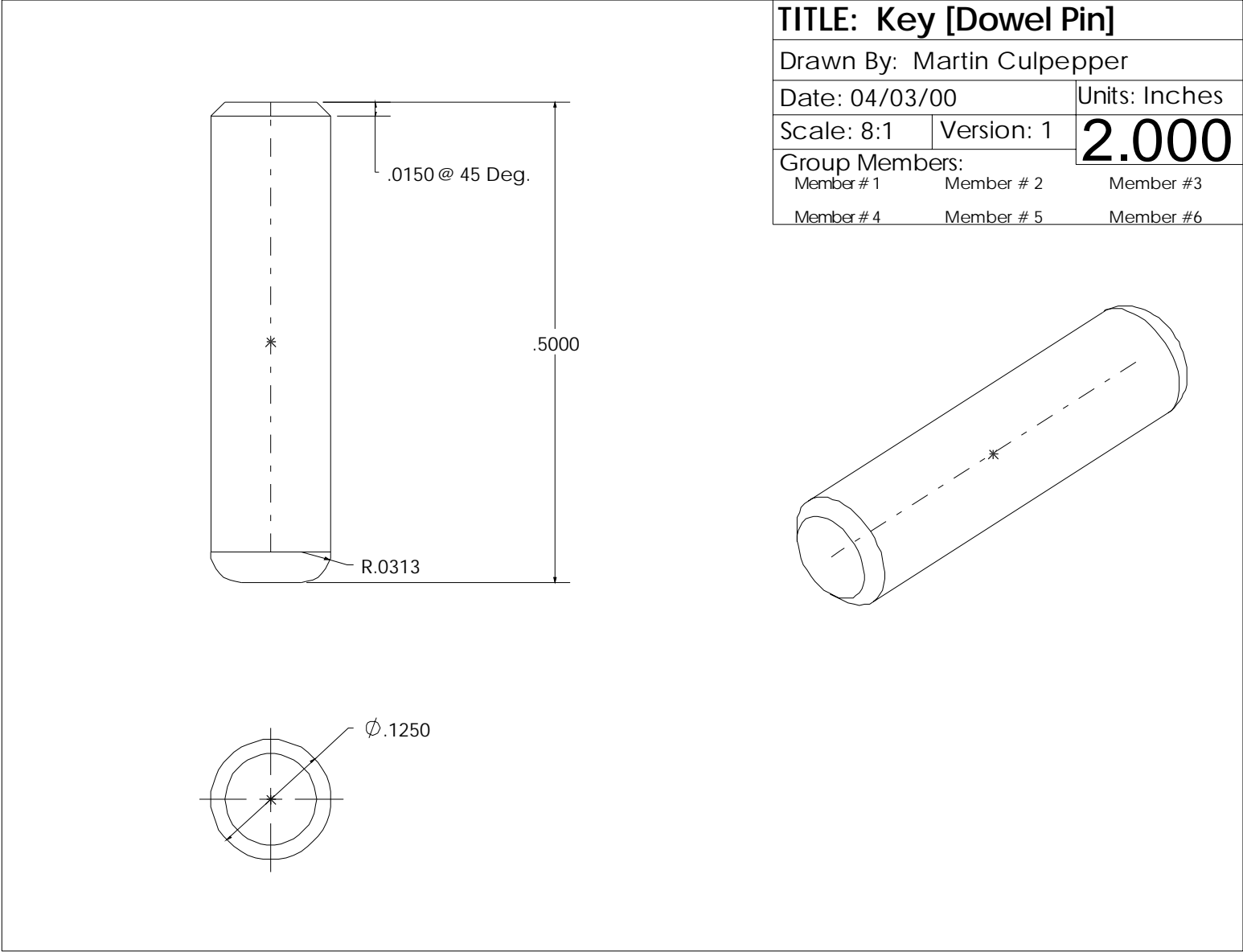
Standard (given) parts [2 shafts]

Material: 6061 T6 Aluminum

TITLE: Gear Pump Shaft		
Drawn By: Martin Culpepper		
Date: 04/03/00		Units: Inches
Scale: 2:1	Version: 1	**2.000**
Group Members:		
Member # 1	Member # 2	Member #3
Member # 4	Member # 5	Member #6

B

0

R.062$^{+.005}_{-.000}$ TYP

.750±.005

1.250±.005

2.000±.010

B

.015 @ 45 Deg. TYP

DETAIL D
SCALE 4 : 1

ϕ.125$^{+.005}_{-.000}$

ϕ.375$^{+.000}_{-.002}$

C

D

C

SECTION C-C

SECTION B-B
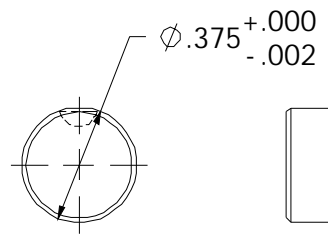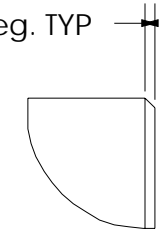
Standard (given) parts [4 bushings]

Material: Powder Metal Bronze

TITLE: Gear Pump Bushing	
Drawn By: Martin Culpepper	
Date: 04/03/00	Units: Inches
Scale: 4:1	**2.000**
Version: 1	
Group Members:	
Martin L. Culpepper Keith Waileung Amy Smith	

Ø .785

Ø .375

SECTION A-A

A

A

.063   .250

Ø .503

.025 @ 45 Deg.

.025 @ 45 Deg.   .025 @ 45 Deg.