2.72 Elements of Mechanical Design

Spring 2009

Schedule

Overview

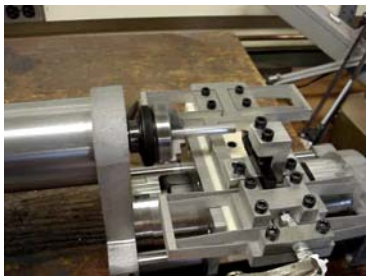
- Syllabus
- Project

Groups

- Lab
- Project

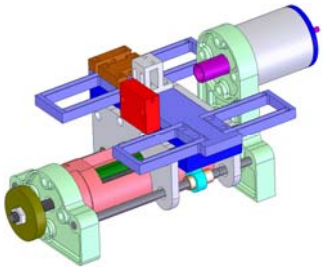
Questions

Assessment



Reading assignment for next class:

- Shigley Mischke on shaft deflections & stress
  - *Sections 3.1, 3.2, 3.4, 3.7, 3.8, 3.10 – 3.11*
- Refresh on beam bending
- Refresh on 1st and 2nd order system vibrations



Purpose and pace of course

In-depth treatment of principles and practices required to synthesize, model, design, fabricate & characterize.

APPLIED ENGINEERING

- Teaching emphasis, style and grades reflect this
- You will be expected to practice what you see in lecture

Reading ~ 50% of grade…

2/3 semester of lectures

Info sources: Teaching staff & texts

Prof. Martin Culpepper

TA: Jon Hopkins

Required text:	Mechanical Engineering Design (Shigley / Mischke)
Useful text:	Design of Machinery (Norton)
	Machinery's Handbook

"The man who sets out to carry a cat by its tail learns something that will always be useful and which never will grow dim or doubtful." --Mark Twain

Thoughts, decisions & actions based on understanding:

- Models and their associated equations are idealizations
- Only "perfect" model is a physical embodiment
- The limits/power of modeling and simulation
- Mechanical system design is cost and time intensive.

Mastery of:

- Concepts, principles & design processes necessary, but not sufficient
- Math, physics and engineering models are necessary, but not sufficient
- Practical skills and best practices are necessary, but not sufficient
- The judicious use of (a), (b) and (c) is necessary

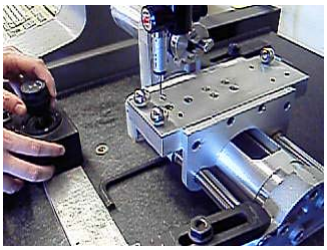
Design project

"In theory there is no difference between theory and practice. In practice there is." --Yogi Berra

2.72 will focus on

(i) understanding concepts, principles, design process, best practices, mathematics, physics and engineering modeling; and

(ii) rigorous application of the same to realize a complex and high quality mechanical design.



You will learn by

(i) Doing…

(ii) Gaining insight via interaction with staff

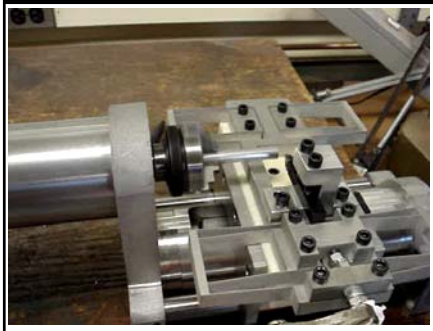
Project:

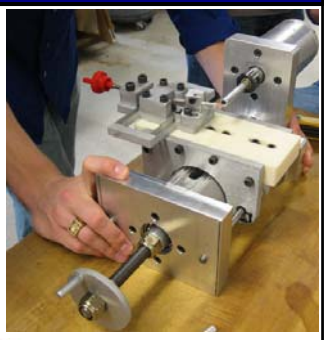
(i) Teams of 6 work to model, design, build and characterize one lathe

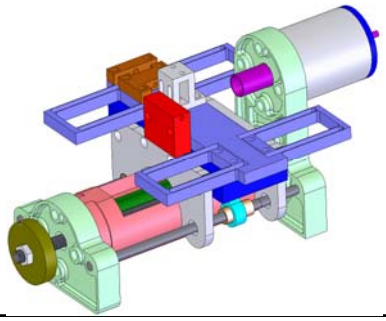
(ii) You can all build copy in parallel, group must do at least one

(iii) Meeting functional requirements is critical to passing

Project: Desktop lathe







Documentation

Images and video

- Take pictures/video as you go
- Due in soft copy on the day their corresponding hardware/results are due
- TA has camera if needed

You must keep a dedicated design notebook

- Keep your ideas, calculations, and records in one organized place
- Bring your notebook to all 2.72 events
- Notebooks will be collected periodically, used to generate final grades
- Legible and organized!
- Staple or glue in loose papers, no 3-ring binders will be accepted
- DO NOT take class notes in this notebook

Final report

- No more than 6 pages (not including appendices)
- Purpose = convince the staff that you learned & used the course material

Mechanical laboratories

Disassemble mechanical devices/assemblies

- Take measurements, answer questions and reassemble
- Tools will be provided
- Bring your own safety glasses (we will give 1st pair)

Follow shop safety rules

Lab times

- Groups 1, 2 & 3 from 09.00pm – 12.00pm

- Groups 4, 5 & 6 from 02.00am – 05.00pm

Topic

1. Lathe disassembly
2. Bearing alignment
3. Transmission
4. IC Engine

Design laboratories

45 minute meetings

- 15 minute presentations
- 30 minute discussion/design review
- 50 inch plasma will be available

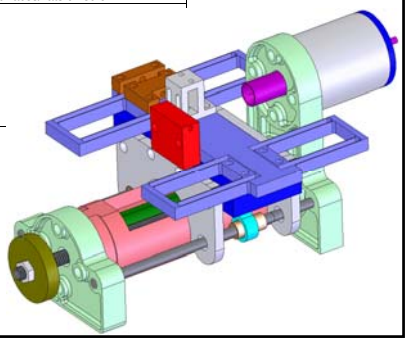
Everyone must present their part of the project

As a group:

- First tell us the purpose of the meeting
- Then immediately discuss Gantt chart
- Details of the work to date, calculations
- Have back up slides for deep dives

Parts for the lathe

	Our responsibility	Your responsibility
Spindle	• Housing blank • Shaft blank	• Housing • End cap • Shaft • Bearings • Preload mechanisms
Structure	• Headstock blank • Tail stock blank • Structure tube blank	• Rails • Finished tail stock • Finished tube • Finished head stock
Lead screw drive	• Bearings • Preload tube • Preload end cap • Lead screw bearing seat • Lead screw • Bearing preload nut • Preload washers	• Drive nut • Drive preload nut
Carriage	• Polymer bed blank* • End skirt blanks* • Handles *May cast 3 pieces as one, stay tuned…	• Finished polymer bed* • Finished end skirts* • Drive flexure coupling • Bushing flexure coupling • Bushings
Cross feed	• Tool holder • Lead screw	• Flexure bearing • Rear flexure mount • Front flexure mount • Thrust bearing • Proper dial mount surfaces/flats on screw
Miscellaneous	• Chuck • Metrology fixtures (3-ball & runout) • HSS cutting tool • Fasteners ¼ - 20 bolts – 0.50 inch long ¼ - 20 bolts – 0.75 inch long ¼ - 20 bolts – 1.00 inch long	



Use of ME Mfg. shop

"Good plans shape good decisions. That's why good planning helps to make elusive dreams come true." --Lester Bittel

Open M-F, 8am-4pm, Clean up at 3:30pm

Use of the machine shop must be scheduled

- Lab time
- Monday, Tuesday and Thursday between 8am-12pm
- Wednesdays and Fridays between 1pm and 4pm
- 10 min. late for an appointment, your appointment will be cancelled.

Process plans

- 2D printed, CAD drawing with dimensions and tolerances (NO sketches)
- 3D printed rendering of the part (e.g. screen capture from CAD)
- Properly scaled DXF (see handout) on disc/e-mail to shop manager
- Completed process plan table
- Shop manager must sign off and then you turn into Culpepper

Grading

Grading:

- 50 % Project
- 50% In-class and take-home mini-quizzes

All materials are due by 5pm

- Via e-mail to teaching assisstant, unless otherwise stated.
- Email errors will not excuse late assignments.

You must <u>understand</u> otherwise you are dangerous

- No student's group may proceed w/o grade > 80% on qualifiers
- Make up quizzes may be given, but course schedules won't change

Quizzes

- Take-home quizzes Reading quizzes In-class exercises

Rules for collaboration

You should work together & learn from one another

- What you submit MUST be your own work unless it is specified as a group submission. In the case of group submissions, everyone that worked on the submission must sign a cover page and provide bullet point summaries of what you worked on and how much of that part you did

You MUST acknowledge the contribution of others

- For example, after working an assignment independently, you compare responses with another student which alerts you to an error in your own work which you then correct. You should state at the end of your submission that you corrected your error on the basis of checking responses with the other student. No credit will be lost if the response is correct, the acknowledgment is made, and no direct copying of the other response is involved.

Course Web Site

http://pcsl.mit.edu/2_72/index.html

- Reading assignments
- Quiz materials
- Lecture notes
- Software downloads
- Homework downloads

Form groups & assign gurus

Group 1

Group 2

Group 3

Group 4

Group 5

Group 6

Assessments

Assessment A

- On web
- 15 minutes

Assessment B

- In class
- 45 minutes

Can't hurt you, only help – extra credit