Syllabus & Schedule

2.007 Design & Manufacturing I

Prereq: 2.670, 2.001
Spring 2008
3-4-5

Introduction

2.007 is a student's chance to use the material from 8.01 and 2.001 to turn their creative ideas into a robust working machine! This is what engineers do and it's the student's chance to demonstrate their engineering prowess! A student's grade is based on how well they meet weekly milestones (documented with a design notebook), a substantial mid-term closed book exam, the quality of their machine's engineering and manufacture, website and written final reflections. The real grade, however, comes from the better job offers the student is likely to get when they show off their design notebook, website and machine at job interviews!

2.007 teaches a creative design process, based on the scientific method, with lectures and the creation, engineering and manufacture of a remote controlled machine to compete in a major design contest (celebration) at the end of the semester. Students learn to identify a problem (opportunity!) and create, develop and select best strategies and concepts using fundamental principles, appropriate analysis and experimentation. Students then divide their best concept into modules and after developing the most critical modules first in descending order of criticality, proceed to system integration, testing and debugging. Project and risk management are introduced as tools to keep the development process under control in order to deliver a robust working machine on time and on budget. Fundamental principles are emphasized including Occam's razor, Abbe Errors, Reciprocity, Saint-Venant's Principle, Sensitive Directions, Self-Help, Centers-of-Action, Structural Loops, the Golden Rectangle… The physics and application of machine elements to enable students to create and engineer their machines are introduced by lectures (pre-recorded), the text and in-class examples. Throughout the course, engineers' professional responsibilities are stressed. Students are assumed to be competent at parametric solid modeling, spreadsheets or MatLab and basic machine shop skills. Educational, reference and design assistance materials are provided on-line to enable students to learn as much as they want/need whenever they want/need.

2.007 this year:

1. The first half of lectures will assume the reading assignments in the FUNdaMENTALS book have been done by the students before class and lecture will thus be for a) answering questions on the readings (students can drop their questions in a box at the front of the class as they enter, or ask them out loud); b) doing engineering design examples (e.g., proof of concept calculations and using the methods taught in the FUNdaMENTALS book.

2. The second half of the lectures will be for realistic sketching and solid modeling the concepts shown to be viable in the first half of lecture (as opposed to quick stick figure

concept sketches needed to get the idea across so the engineering design analysis can be done). Students will be expected to "sketch along" and turn their sketches in at the end of class into lab-section marked bins. Participation in this active learning can thus also help a student's grade as well as help the student to become a better design engineer.

a. **Important – by the 1st day of class**: The drawing and visualization part of 2.670 is being woven into 2.007 this year; hence it is vital that by 11:00 AM February 7th, as part of the units you receive for 2.670, each student must be familiar with SolidWorks. Go to the ME server. Download and install the software. https://meche.mit.edu/resources/computing/software/ (certificates required)
Do the self-taught tutorial so you will be familiar and reasonably competent with the program, (basic parts and assemblies). Much more detail will then be taught in 2.007 lectures, so bring your laptops to lecture!
b. **Special SolidWorks Training Sessions**: Feb. Wed. 6th and Thurs. 7th, 15:00-17:0 and 19:00-21:00 in Bldg. 35's Ralph Cross Lab.
    i. All four 2-hour sessions will be identical; please come to whichever is convenient.
    ii. These are optional but recommended! By special arrangement, Marie Planchard, SolidWorks' Director of Education Marketing is donating her time.
    iii. If you have a laptop, bring it with SolidWorks loaded. The training files are available at http://pergatory.mit.edu/2.007 and should be downloaded before hand.

By Popular Request, returning to 2.007 this year:

1. A substantial mid-term exam on Topics 1-10 that will be given in-class on **Thursday March 20** SO DO NOT BE LATE FOR CLASS AND MAKE SPRING BREAK PLANS ACCORDINGLY. THERE IS NO MAKE UP EXAM (folks with official MIT events like sports will of course be accommodated, please see Prof Slocum).
2. Students do NOT have to be in their assigned lab section for the entire 4 hour period. Students will form 4 person Peer Review Teams and each team need only schedule one hour per week to meet with their lab instructor. Students can then design and build their machines anywhere/anytime they want/can. 2.007 instructors will be on-call in the Pappalardo lab every afternoon 1-4:30 pm for consultation (you can ask for help from any instructor).

Course Objectives (learning outcomes)

The objective of the course is to enable students through lecture and hands-on experience to:

1. Learn a ***design process***, based on the scientific method, to combine creative thinking with engineering principles (physics) to turn ideas into robust reality:
    - Identify a problem (opportunity!).
    - Use ***FUNdaMENTAL*** principles and ***appropriate analysis*** and ***experiments*** to generate, select and develop ideas
    - Generate & create ***strategies*** for solving the problem
    - Generate & create ***concepts*** for implementing the selected "best" ***strategy***
    - Break the ***concept*** into ***modules*** and develop the ***most critical module*** first

- Complete the detailed engineering design of the ***modules*** and manufacture, test and debug them
- Integrate ***modules*** and test, debug and modify the system as needed
- Document the results (closing the design loop)
- Operate their machine in a final celebration with other students and their machines
- Reflect on the above process with respect to what worked and didn't and why and what would be done differently next time

2. Effectively utilize fundamental design principles, machine elements and manufacturing and assembly techniques
3. Assess risks, develop countermeasures and manage projects to be "on-time" and "on-budget"
4. Develop visual thinking (and drawing skills)
5. Practice professionalism, be safety conscious and maintain high ethical and professional standards

Practicing designer engineers often follow this type of systematic process; and they receive raises, responsibility and reflect well on themselves and their profession. Bad designers are of little use to anybody. A bad designer:

- Has no respect for project management and thinks they can just cut-&-fit on the fly.
- Thinks they can see it all in their head and does not need to sketch, test and plan.
- Works late hours the night before the due date to produce something.
- Gets at best a "D" in 2.007, regardless of how they do in the contest (history has shown they will do poorly)

2.007 is about learning a process for design by systematically engineering and building a machine. It is NOT a course about just building a machine based on what you already think you know in order to compete in the contest. Without knowing a process of design and fundamental principles, you will not be able to compete on real design projects in the real world and your job will be outsourced!

Instructor in charge:
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Tubilla Kuri, Fernando	Section Instructor, ftubilla@mit.edu Room 35-136, 617-308-7020

Webpage and e-mail lists (official course business ONLY)

http://pergatory.mit.edu/2.007/
2.007-all@mit.edu - E-mail Entire Class
2.007-staff@mit.edu - E-mail Instructors
2.007-court@mit.edu - For any questions regarding the contest rules
2.007-uas@mit.edu - E-mail UA's

2.007-secN@mit.edu (N= 01 to 13) - E-mail Your Section

The Textbook, which incorporates the lecture notes, (*FUNdaMENTALS of Design*) will be posted on the course website, along with a LOT of other information that can help you design your machine. Students should look to the website for notices and look through the web site and find the goodies that are placed there! This is excellent training for the real world!

Text Book

The textbook (*FUNdaMENTALS of Design*) is on-the course website. You will also find your 2.001 text extremely useful! Reference books (e.g., Machinery's Handbook) are available in the Pappalardo Lab.

- **Incredibly useful handbooks every practicing design engineer should own:**
  - Machinery's handbook, Industrial Press
    Available online at MIT if you have a certificate:
    http://www.knovel.com/knovel2/Toc.jsp?SpaceID=10110&BookID=309
  - R. J. Roark, W. C. Young, Formulas for Stress and Strain, McGraw-Hill Book Company
- **Suggested readings for those who are interested in the process of design include:**
  - G. Pahl and W. Beitz, Engineering Design, A Systematic Approach, Springer-Verlag, New York, 1988
  - N. P. Suh, The Principles of Design, Oxford University Press, New York, 1990
- **For students interested in hardware details:**
  - Shigley, J. E., Mitchell, L. D., Mechanical Engineering Design, McGraw-Hill Book Company, New York 1983.
  - Slocum, A. H., Precision Machine Design, Society of Manufacturing Engineers, Dearborn, MI., 1995

Lectures

Tuesday and Thursdays in Room 1-190, 11:00 a.m. – 12:30 p.m. Lectures on the Course Topics have been pre-recorded and a DVD will be provided to each student. The DVD includes pdfs of the lecture notes and spreadsheets that should be useful. The lecture notes will not be printed and handed out.

Students are expected to watch the pre-recorded lecture on a topic and read the notes BEFORE the topic is scheduled for in-class discussion. In class, the focus of the lectures will be "designers in action" using the material that is in the lecture, so the student needs to be familiar with the material before lecture. See the attached schedule for lecture topics. The course closely follows the schedule! Lectures only last through March 23rd so come to them and learn!

It is highly advisable for students during the first week when not much is due, to watch all the lectures, so the student can become preloaded with course knowledge which will help them early-on to develop their machines.

Recitation

There is no formal recitation. 2.007 students are to arrange additional meeting time with their lab instructors as needed. Prof. Slocum will generally be available after class. Please e-mail him if you want to confirm a specific meeting time.

Labs

2.007 students are assigned by the registrar to a lab section from **1-5:00 pm** M, T, W, R. The labs are only scheduled in the afternoons and they are 4 exciting hours to give students more scheduled build time:

- Students in a lab section will be divided into groups of 4 to form peer-review groups which will be responsible for reviewing each others' work before it is turned in for weekly evaluation by the section instructor. Each peer review group will then meet with their section instructor once per week for about an hour to review their work.
- Students thus do not need to be in lab for the entire 4 hours, they only need to meet with their lab section instructor in their peer-review group when scheduled. It is critical that students do not miss their weekly meeting time with their lab instructors.
- It is assumed that students are responsible enough to schedule their time, such that if they cannot be in the lab for a four hour period on their scheduled lab day, they will come to the lab at another time (preferably in the morning hours when the lab is not crowded).
    - There will always be 2.007 instructors in the lab in the afternoons and many UAs too and students should feel free to ask any instructor or UA or lab technician for advice!
- We will experiment with in-lab quizzes on safety and how-to-do-stuff.

Labs start the second week of class in the Pappalardo Lab, BUT you must get your kit and locker assignment as directed in the first lecture or you will be bumped from the class!

- Your 2.670 toolbox is your "passport" to getting into the lab. Bring it and put it in your locker!
- There are no scheduled weekend or evening hours for the shop!
- The Pappalardo Lab opens at 8:30 AM and closes at 4:30 PM, so create a normal working person's schedule! Students may not skip other classes to spend extra time in the lab.
- Use the early mornings when the lab is not crowded. Accomplish a little bit each week according to schedule! If you "wait until the last minute", you will fail (D and lower grades are indeed "earned" by students who try and do everything at the last minute, even if their machines work) not only in 2.007, but also in the real world!
- You are free to use another shop if you have access to one.
- *Most of lab time should be for you to explore ideas by creating hands-on experiments. Instructors will spend little time "leading the group." Your instructor is your coach, advisor and mentor*.

Sections

It is important for students to realize that each instructor is responsible for their own section. This means that much of the organization of the class is very decentralized and instead in control of lab section leaders. As a result, assignments and expectations may vary somewhat between sections. Furthermore, the schedule that has been laid out above is only a guideline. For example, many Monday lab sessions interfere with holidays, often throwing off their schedules. As a result, even the major assignments (ex. Milestones and Milepebbles) may be due in different weeks depending on your section. If you have any questions as to what is due, or what expectations are for each assignment, **ask your TA**. If you ask peers or TAs outside of your section you risk receiving faulty information.

Changing your lab section

This year's new system of peer review groups who meet weekly with their lab instructor and then students are on their own to come to lab whenever they wish to work on their machines; this means there should be no need to change lab sections! In the first lab section, peer review groups can form according to schedule compatibility. This said, lab section changes will only be possible in the case of a severe conflict.

Safety

You **MUST** wear safety goggles or safety glasses (polycarbonate eyeglasses are fine) and closed-toed shoes at ALL times in the Pappalardo lab. Violators will be asked to leave immediately and not to return until outfitted appropriately. Tie your hair back and take off your jewelry before coming to class.

Ethics & Professionalism

As in the real-world, unethical and unprofessional behavior will NOT be tolerated. When in doubt, ask any staff member for guidance! Nevertheless, every student must write their name in several places on their critical components (especially drills and batteries!) as critical components have been known to get "lost". If you have a problem or see a potential problem brewing between others in lab, please let an instructor know as soon as possible Do not let things fester! (yet try to work things out with your peers).

Contest Kits

Contest kits and lockers will be given out between 12:00 and 3:00 PM after the first lecture in the Pappalardo Lab. There are a lot of materials required for 2.007, but due to the fantastic generosity of our corporate sponsors, there is **no lab fee for consumables** and you get to keep your machines at the end (including the motors used on your machine)! You must bring your 2.670 toolkit to lab, as you will need it. Your kit will be in your locker.

One of the most common operations in the shop is drilling a simple hole and every student is provided with their own cordless drill kit. This will greatly increase productivity. The power supply for your machine will be ONE battery from the drill and it is your responsibility to keep it charged.

Write your name on all your kit contents!

Your first action with your kits is to write your name on the drill, motors and critical items! Keep components locked up. If you lose anything you need to buy your own replacement! Consumable materials will be replaced by UA's provided justification is given for their consumption.

Equipment Charge - $120 to be paid the 1st day of class when collecting kit

Payment via *Cash* or *Check* made out to MIT Mechanical Engineering.

This nominal fee is assessed to cover the cost of your drill, calipers and teaching materials, which are yours to keep. **You will not receive your kit without payment**. Consider this an investment in your future!

Design Notebooks and a personal 2.007 website

Like any good engineering project, 2.007 runs on a schedule! As you develop your machine, you MUST keep a ***Design Notebook***, which will be an important part of your grade. (on course website see *Guide to Lab and Design Notebooks*). Ideally, this is a bound (spiral is OK) book in which you do all your sketches, calculations (printouts can be pasted in) etc. This notebook is a complete diary of what you did to create your machine. We recognize that you may also want to keep other 2.007 materials in it as well, so a 3-ring binder is OK, but it would be better to get in the industry groove and keep a real notebook. Make sure to date each entry. In the real world, this is a critical document, especially if the need arises for intellectual property litigation, or product liability. In 2.007, bring your Design Notebook to lab each week. Your instructor will want to see your Design Notebook each week to check on your progress (how well you meet milepebbles and milestones) and to see how well your PEER Review Evaluation Process is being done. You will create spreadsheets, solid models… and these can be printed and pasted in your design notebook.

It is also ***strongly suggested*** that each student create a personal 2.007 website (use your own Athena space), which is also a good place to post milestone reports as well as the details of your machine development. Ideally each week you would summarize progress made and post it on your website. You can even just scan in pages from your design notebook. Having an up-to-date website will also help your instructor. At the end of the class, the website will become your first portfolio entry. Having a quality portfolio is great asset for job interviews!

Milestones and MilePebbles

Milestones are major events were significant pieces of work have been completed. The major milestones for this course are:

1. Final strategy (4-6 pages: overall description, FRDPARRC sheet, pictures of sketch models, sketches, scoring calculation, appropriate analysis, description of bench level experiments).
2. Final concept (4-6 pages: overall description, FRDPARRC sheet, pictures of sketch models, sketches, appropriate analysis (e.g., time to move, power budget), description of bench level experiments, preliminary solid model).
3. Demonstration of most critical module; and MCM detailed engineering report (overall description, 4-6 pages: FRDPARRC sheet, pictures of sketch models, sketches, appropriate analysis, picture of module, solid model).
4. Assembly and integration of all modules (3-5 pages per module: overall description, Solid model of machine and part drawings, critical calculations).
5. Demonstrate working machine (3 pages: overall description, Picture of machine and a critical analysis of what works and what does not work and why and how to fix it or what countermeasure you will now implement. Describe plan for remainder of shop build time).
6. Reflection (4-6 pages: Self-evaluation of machine performance in final contest (what did and did not work and why) and what you would do differently next time.) Final lab notebook check off, follow-up.

These 6 milestones are to be documented in order to best allow your instructor (or anyone else) to understand how you created your machine. The documentation of your milestones can then be entered into your website which will also be of great help when you look for engineering employment!

Milepebbles are things to be done each week. Milepebbles will be evaluated by your lab instructor when you meet with them on a weekly basis.

In general, the Milestones should be brief documents approximately 3-5 pages in length (including pictures/sketches). Think of them as executive summaries of the topic at hand. The gory detail is to be in your design notebook (which if you are smart, you will periodically scan and upload to your website). Milepebbles, on the other hand, require no report; grading of milestones is based upon your lab notebook and discussion with your TAs.

Contest Preparation

The final celebration ("contest") is the ultimate 2.007 experience. It is analogous to having your product first used by a customer. Thus in preparation for the contest, you complete your engineering and building and then "check off" your machine and "ship it to the customer" (you!). This is done the final week of lab, (April 30 - May 4) when your lab instructor will schedule you to have your machine sized. In addition, during the final week, you will drive your machine by itself on the table to obtain your seeding score. The shop closes Friday, May 4. The contest will be Wednesday (first round) & Thursday (final rounds) evenings, May 7 & 8.

Grading

This is very much an interactive course and you have a very low chance of passing if you do not read the textbook, come to the lectures and meet with your section instructor. Your grade is very dependent on meeting the milestones (just like in industry, your salary depends on meeting milestones). Each milestone focuses on helping you create your 2.007 machine. The mid term will help you design a better machine because you will want to know how to do real-world engineering design calculations in order to do well on the quiz!

Week	Grading Item (lab instructor will provide due date)	Points
1-6	In-lecture activity to be handed in at end of lecture (6*5)	30
1,2,4,6 10,11	Milepebbles (6*10)	60
3	Milestone 1: Final Strategy	30
5	Milestone 2: Final Concept	30
9	Milestone 3: Demonstrate Most Critical Module, MCM engineering report	30
12	Milestone 4: Assemble and integrate modules	30
13	Milestone 5: Demonstrate Working Machine, plan for remaining time	30
15	Milestone 6: Final contest, reflection, documentation	30
	In-class Exam on Topics 1-10	100
	Peer Review	30
	Machine (concept, manufacturing)	40
	Lab Notebook	40
	Website	20
	Total:	500

Grade	>%	>pts	Performance Level
A	85%	425	Great preparation, acting like a professional, did all the reading and did well on the mid term exam, successful implementation of design process and FUNdaMENTALS, well executed working deterministic machine design (no sloppiness such as sharp edges loose wires etc, the machine looks and functions like a real product).
B	70%	350	Usually prepared, did most of the reading, did OK on the exam, good understanding of the FUNdaMENTALS, machine works pretty much as designed.
C	55%	275	Often not prepared, did not do much reading, not too well on exam, poor understanding of FUNdaMENTALS, machine put together mostly by trial and error.
D	40%	200	The student either just doesn't care, was not prepared, or could not focus.
F			

The key to earning an "A" is not putting in long hours, the key to earning an "A" is to follow the schedule, come to class and lab and to think creatively and deterministically (e.g., can you use a spreadsheet to justify and optimize major design decisions, such as the size of a motor?). The student's grade will thus be largely based by how well the student learns the design process taught in 2.007. If you wait until the last couple weeks to "go into hyper mode", you will fail (D grades are indeed given to students who try and do everything the last few weeks of the course, even if their machines work) not only in 2.007, but also in the real world! There is NO grading curve in this class. You do not get partial credit for a plane's landing gear that opens but breaks upon impact! We hope everyone earns an "A". What do the grades actually mean in terms of your engineering capabilities?

- An "A" is for a student who could lead the design of a major product (after they get more education and experience). These students are self-starters, love to learn for the fun of it and can learn by finding and studying needed materials when they realize they are lacking in knowledge. These are also the students who create new ideas and identify tasks to be done in order to complete a project according to schedule. (Truly understands the fundamentals [analysis] and can use them to solve challenging engineering problems.)
- A "B" is for a good solid potential engineer that sometimes needs guidance, but overall can be given a task and will complete it effectively. They can usually pick things up from references as needed. (Mostly understands the fundamentals and needs some help to address challenging problems). They still do a little too much "shoot from the hip" selection of elements because they really are not that comfortable with using analysis in their design as much as they should.
- A "C" is for the student who needs a lot of direction. Some just do not understanding the material, despite trying. Some just ask a lot of questions because they rarely study or come to class or read the notes. Some expect to be spoon fed because they do not have the time to put in the effort. On a project, they must be given a specific task and solution direction instructions. (Need help to grasp the fundamentals and needs help to understand basic problems). These people may seem like they are good creative

designers, but they are afraid of analysis and do not see how to use it to select design parameters and rather than ask, they hide.

- A "D" is for the student who is never around much but might manage to get a machine to work. They never justify any of their engineering decisions (they meet no milestones except the last one) and are not part of the team (lab section). (Have you really grasped the fundamentals? Are you really ready to move on?).
- An "F" is for a no-show student that never accomplished anything and barely even tried, but likely claims to have a good excuse.

Peer Review

Students will be responsible for using the *Peer Review Evaluation Process (PREP)* for providing feedback on each other's lab Milestone reports**. You will be part of a 3 or 4 person Peer Review Evaluation Team that you are responsible for forming in your section!** Your section instructor will review the teams' comments and will give feedback to the team on how effective they are at providing constructive criticism. This is a critical part of learning to become a great engineer. As in industry, how well you critique each other's work affects your grade (see grading). When other classes let you collaborate on problem sets and projects, try using PREP!

Course Schedule

Create a schedule for all your courses and activities, noting milestone due dates, exams, etc. Use the plan as a reminder to not fall behind! If you are falling behind, you need to ask for help, but also ask yourself if you are doing TOO much! If you follow the schedule and work smart on the milestone reports, you can earn an "A" without ever having to spend an evening or a weekend in the shop. THE DESIGN PROCESS WORKS and you can also use it in other classes! 2.007 is a 12-unit course designed to be completed on time and on budget!

Lecture Schedule & MilePebbles and MileStones Due Dates

The MilePebbles and MileStones are due in the week indicated, in your lab section.

Wk	**Mon.**	**Tues.** 11-12:30 Room 1-190	**Wed.**	**Thurs.** 11 - 12:30 Room 1-190	MilePebbles & MileStones *Due*
1	**2/4 Reg Day**	**2/5** Topic 1 *Design Process,* & Topic 2 *Generating and Creating Ideas* ***Kits today only 12:30-3:00 pm In the Lab***	**2/6**	**2/7** Special lecture by Prof. Wallace - *drafting* *Lab Conflict fixing: 12:30 pm Room 1-190*	*Milepebble 1* a) Get Kit and Locker and play with kit elements and the table b) Review website and lectures c) Attend SolidWorks training session
2	**2/11**	**2/12** Topic 3 *Fundamental Principles* & Topic 7 *Force and Torque Sources*	**2/13**	**2/14** Topic 4 *Linkages*	*Milepebble 2* a) Assemble Tamiya motor gearboxes b) Download SolidWorks, see link on website b) Make sketch models of strategy ideas

					c) FRDPARRC 3 *Strategies* d) Preliminary analysis: scoring, power budgets for strategies
3	**2/18 Prez's Day Lab Closed**	**2/ 19** Monday schedule, no lecture, lab open. Tuesday lab people go to lab when they can	**2/20**	**2/21** Topic 5 *Power Transmission Elements I*	<u>*Milestone 1*</u> a) Start to design and build simple car b) Best *Strategy* selected & FRDPARRC'd
4	**2/25**	**2/26** Topic 6 *Power Transmission Elements II*	**2/27**	**2/28** Topic 8 *Structures*	<u>*Milepebble 3*</u> a) Appropriate analysis b) Bench level experiments c) 3 *Concepts* on FRDPARRC sheets d) Finish simple car
5	**3/3**	**3/4** Topic 9 *Structural Interfaces*	**3/5**	**3/6** Topic 10 *Bearings*	<u>*Milestone 2*</u> a) Demonstrate simple car b) Best *Concept* FRDPARRC'd and 1st-order solid model c) All *Modules* defined (ideally no more than 3)
6	**3/10**	**3/11** Topic C *Control System*	**3/12**	**3/13** Topic M: *Manufacturing*	<u>*Milepebble 4*</u> a) *Most Critical Module* (*MCM*) detailed engineering done so work can begin on building the *MCM*. b) Mfg plan for *MCM*
7	**3/17**	**3/18** Topic E *Ethics and Professionalism*	**3/19**	**3/20 Mid Term in-class Exam on Topics 1-10**	Work on *Most Critical Module* (*MCM*)
8		SPRING BREAK, RELAX (UNLESS behind, Lab is open all week)			
9	**3/31**	**4/1** *Check email and website for special guest "Designers in Action" lecture, otherwise work on your machines*	**4/2**	**4/3** *Check email and website for special guest "Designers in Action" lecture. Otherwise work on your machines.*	<u>*Milestone 3*</u> a) Demonstrate working *MCM* b) *MCM* detailed engineering report
10	**4/7**	**4/8** *Check email and website for special guest "Designers in Action" lecture, otherwise work on your machines*	**4/9**	**4/10** *Check email and website for special guest "Designers in Action" lecture, otherwise work on your machines*	<u>*Milepebble 5*</u> a) 2nd module complete
11	**4/14 Pat's Day**	**4/15 Patriot's Day, student holiday but lab is open**	**4/16**	**4/17** *Check email and website for special guest "Designers in*	<u>*Milepebble 6*</u> a) 3rd module complete b) Assemble & integrate

	Lab closed			*Action" lecture, Otherwise work on your machines*	*modules*
12	**4/21**	**4/22** *Check email and website for special guest "Designers in Action" lecture, otherwise work on your machines*	**4/23**	**4/24** *Check email and website for special guest "Designers in Action" lecture, otherwise work on your machines*	*Milestone 4* a) Demonstrate good working machine b) Plan for remaining time
13	**4/28**	**4/29** *No lecture! Work on your machines*	**4/30**	**5/1** *No lecture! Work on your machines*	*Milestone 5* a) In-class seeding contest, Get T-Shirt! b) Pack and "ship" machine **IMPOUND May 2**
14	**5/5**	**5/6** *No lecture*	**5/7 – 5/8** *No lecture!* **CONTEST NIGHTS!** **Attendance Mandatory!**		*Relax, work on reflection document*
15	**5/12-5/15** **Meet in regular lab sections and review what worked and what did not and turn in Milestone 6 Reflections**				Milestone 6 a) Reflection