



2.007 2002 Milestones

The MIT and the Pendulum

Week	Milestone	Points	
1	Play with kit & table, create solid model of table	10	Grading
2	Develop strategies, make gearbox	10	Ideas 30%
3	Evolve & refine strategies, and develop concepts	20	Analysis 25%
4	Evolve & refine concepts, identify most critical module	10	Execution 25%
5	Create modules	10	Presentation 10%
6	Detail most critical module, and start building it	10	Rhorbach peer review 10%
7	Test and evolve most critical module	15	
8	Spring break	NA	Final grade
9	Complete most critical module	15	>230 = A+
10	Design, build, test	10	200 - 230 = A
11	Design, build, test, and begin integration	10	170 - 199 = B
12	Machine ready and working	20	140 - 169 = C
13	Final debug and in-class contest	10	110 - 139 = D
14	Final Contest	80	<109 = F
15	Create awesome web page about your machine	20	BONUS Pts
	Total	250	

Most of the milestone elements should NOT be done in Lab

Most of your lab time should be spent experimenting!

It is very acceptable to work ahead!

Milestones are to be turned in the Friday of the week or their #

FRDPARRC Sheet Topic: _____ Milestone# _____ Section Instr. _____ Student: _____

Functional Requirement (Event) _____

Design Parameter (description of idea) _____

Sketch:

Analysis (physics in words) _____

Analysis

References: _____

Risks _____

Countermeasures _____

APPEND ADDITIONAL SHEETS AS NEEDED

In-Lecture Experiments and demos

- Demo the design process:
 - FRDPARRC Sheets to develop idea
 - Appropriate analysis (silicon is cheaper than iron)
 - Bench Level Experimentation (if too tough, run an experiment)
 - Sketch the idea and identify sensitive design parameters (e.g., dimensions)
 - Solid Modeling of **Components** (you need drawings to machine parts!)
 - Manufacturing drawings and process plans
- Static and dynamic friction (
- Force from a screw
- Large scale (pegboard) linkages
- Large scale gears
- Strength of materials

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Strategy & Concept				Detailed Engineering & Development						Integration & Test			!!!	WWW



Week 1: Milestone **ONE** (10 pts)

Resource Assessment

Deliverables:

NOTE these deliverables can be completed even though you have yet to meet in your lab sections

- Obtain locker and kit and check kit for completeness
 - PUT YOUR NAME ON YOUR TOOLS AND Critical KIT PARTS (motors!)
 - There are no free lost motor replacements for lost: you can buy your own replacements at Home Depot or from Amazon!
- Sign up for your lab section's email list (see syllabus for details)
- Review sample *Milestone Reports* on the web, so you know what to do in the future (not too much, not too little)
- **CAREFULLY READ AND ASSIMILATE TOPICS 1,2, AND 3!**
- Create a personal website for 2.007 where you can post your milestone summaries
 - If you build a good website as you go, you can get 20 extra bonus points added to your grade!
 - A great website that illustrates how you design is an invaluable interviewing tool
- Create a solid model of the table, post it on your website, and also turn in a hardcopy
- Play with the table and kit parts, and observe and discuss scoring physics (**Strategies**)
- Create a spreadsheet or Matlab script for at least one strategy that models its physics and scoring potential (e.g., a basic time & motion study using freshman physics knowledge)

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Week 2: Milestone **TWO** (10 pts)

Understanding the Contest & Creating **Strategies**

Deliverables:

- Play with the table and kit parts to investigate different scoring ideas (**Strategies**)
 - This includes making simple sketch models and Bench Level Experiments (BLEs)
 - Record observations, including sketches, pictures of sketch models, and analysis
- Describe the physics of the contest, including the dominant variables and means by which you can influence them (1 or 2 pages, be brief)
- Describe various scoring methods and their physics, including the dominant variables and means by which you can influence them (1 or 2 pages, be brief)
- Sketch lines of motion (actions) or simple stick figures for different **Strategies** that come to mind on printouts of your solid model of the contest table.
 - DO NOT SKETCH detailed MACHINE CONCEPTS!
- With your evaluation team, complete a Rohrbach evaluation of each other's **Strategies**
- Complete “Modular Right Angle Gearbox” design and manufacturing exercise, and demonstrate a working right angle gearbox
 - Two such gearboxes allow you to easily create a vehicle
 - If you think a vehicle may be a useful module, go ahead and assemble one and test it as a Bench level Experiment!

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Strategy & Concept			Detailed Engineering & Development						Integration & Test			!!!	WWW	



Week 3: Milestone **THREE** (20 pts)

Developing **Strategies** & Creating **Concepts**

Deliverables:

- Evolve and refine your **Strategies** with sketches, pictures of sketch models, and analysis, include:
 - Lines of motion (actions) or simple stick figures for different strategies on a printout of your solid model of the contest table. **DO NOT SKETCH detailed MACHINE CONCEPTS!**
 - FRDPARRC Sheet for **Strategies** to *exploit* the physics of the scoring methods
 - FRDPARRC Sheet for **Strategies** to defend
 - FRDPARRC Sheet for **Strategies** to attack
 - Analysis to predict your score (time budget, physics, etc)
 - Bench Level Experiments (make simple machines from kit parts and play with them!)
- Create a weighted **Strategy** selection chart to evaluate your ideas
 - Show how you combine elements of different **Strategies** to create “best overall evolved **Strategies**”
 - Be VERY CAREFUL to analyze risks and countermeasures of each **strategy!**
- With your evaluation team, complete a Rohrbach evaluation of each other’s **Strategies**
- Play with your kit elements and sketch several **Concepts** that could implement your “best” **Strategy**
 - The reality of what you can actually build may be cause for strategy modification!

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Week 4: Milestone **FOUR** (10 pts)

Developing **Concepts** & Most Critical **Module**

Deliverables:

- Based on contemplating **Concepts**, FINALIZE & LOCK-IN your **Strategy** from Milestone **Three**:
 - Present the final description of the **Strategy** in a FRDPARRC Sheet
- Evolve and refine **Concepts** for your final **Strategy**, and for the top three **Concepts** include:
 - FRDPARRC Sheet
 - Be VERY CAREFUL to analyze risks and countermeasures of each **Concept**
 - Appropriate sketches
 - Bench Level Experimentation and/or sketch models
 - Create a weighted **Concept** selection chart to evaluate your ideas
 - Show how you combine elements of different **Concepts** to create a “best overall evolved **Concept**”
- Rohrbach evaluation of each other’s **Concepts**
- Play with your kit elements and identify the most critical **Module** in your **Concept**, and sketch ideas for implementing it using the elements in your kit
 - The reality of what you can actually build may be cause for concept modification!

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Week 5: Milestone **Five** (10 pts) Developing **Modules**

Deliverables:

- Based on contemplating **Modules**, FINALIZE & LOCK-IN **Concept** using the weighted selection chart from Milestone **Four**:
 - Present the final description of the **Concept** in a FRDPARRC Sheet
- Separate your **Concept** into **Modules**:
 - Create a sketch showing how the **Modules** fit together
 - For each **Module**, create:
 - FRDPARRC Sheet
 - Be VERY CAREFUL to analyze risks and countermeasures of each **Modules**
 - Appropriate Sketches
 - Select the best version of each **Module** using a weighted selection chart
 - Show how you combine elements of different **Modules** to create “best overall **Modules**”
- Start development of the Most Critical (risky) **Module**
 - Perform Bench Level Experiments to help start developing the Most Critical **Module**
- Rohrbach evaluation of each other’s **Concepts** and Most Critical (risky) **Module**

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Week 6: Milestone **Six** (10 pts)

Developing the Most Critical **Module** (MCM)

Deliverables:

- FINALIZE & LOCK IN Most Critical **Module** from Milestone **Five**:
 - Present the final description of the most critical **Module** in a FRDPARRC Sheet
 - Be VERY CAREFUL to analyze risks and countermeasures
- Proceed with detailed engineering of **Components** for the Most Critical **Module**
 - FRDPARRC Sheets
 - Appropriate analysis (silicon is cheaper than metal!)
 - Bench Level Experimentation (if analysis too tough for you or teacher, run an experiment!)
 - REMEMBER, part of development is creating BLEs (get in the lab and build and experiment and try stuff!)
 - Sketch the idea and identify sensitive design parameters (e.g., dimensions)
 - Solid Modeling of **Components** for the Most Critical **Module** so you can make its parts
 - Manufacturing drawings and process plans (know what you need to do before you step up to the machine!)
 - Solid Modeling of **Components**
- Rohrbach evaluation of each other's **Modules**

Your intention should be to build & test the Most Critical **Module** first, so you have a good idea of will your concept work well before spring break

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Week 7: Milestone **Seven** (15 pts)

Test & Evolve Most Critical **Module** (MCM)

Deliverables:

- Finish building and testing your most critical **Module**
- Determine what works and what doesn't, and evolve your **MCM** accordingly
 - If the MCM is a total unsalvageable failure, this will not affect your grade, IF you can show how you plan to fall back to a less risky **concept** (or **strategy**)
 - Now is the time to change, or forever hold your peace
 - You only have SIX weeks left, and soon it will be warm and sunny outside!
- FINALIZE & LOCK-IN the remaining **Modules**:
 - Present the final description of these **Modules** in FRDPARRC Sheets
- Rohrbach evaluations of each other's most critical **Modules**

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Week 8: Milestone **EIGHT**

Spring Break: Relax!

Deliverable:

- Come back Relaxed!

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Strategy & Concept				Detailed Engineering & Development						Integration & Test				!!!	WWW



Week 9: Milestone **NINE** (15 pts) Most Critical **Module** Complete

Deliverables:

- Finish building and testing most critical **Module**
 - It should now be a working module, ready to integrate into the rest of your machine!
- Complete manufacturing drawings and process plans for what you will build next week
- Develop a manufacturing, assembly, and test schedule for rest of the course
- Proceed with detailed engineering of **Components** for the remaining **Modules**:
 - FRDPARRC Sheets
 - Use what you learned in building the MCM to carefully do the risk and countermeasures analysis!
 - Appropriate analysis (silicon is cheaper than metal!)
 - Bench Level Experimentation (if analysis too tough for you or teacher, run an experiment!)
 - Sketch the idea and identify sensitive design parameters (e.g., dimensions)
 - Solid Modeling of **Components** (you need drawings to machine parts!)
 - Manufacturing drawings and process plans (know what you need to do before you step up to the machine!)
- Rohrbach evaluation of each other's drawings and process plans
- Revise schedule for next week

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Strategy & Concept				Detailed Engineering & Development						Integration & Test			!!!	WWW



Week 10: Milestone **TEN** (10 pts) Design, Build, Test

Deliverables:

- Manufacture **Components** from drawings made last week
- Test **Modules** from **Components** made
- Evaluate what did and did not work, and take appropriate action (fix it!)
- Proceed with detailed engineering of **Components** for the remaining **Modules**:
 - FRDPARRC Sheets
 - Use what you learned in building the MCM to carefully do the risk and countermeasures analysis!
 - Appropriate analysis (silicon is cheaper than metal!)
 - Bench Level Experimentation (if analysis too tough for you or teacher, run an experiment!)
 - Sketch the idea and identify sensitive design parameters (e.g., dimensions)
 - Solid Modeling of **Components** (you need drawings to machine parts!)
 - Manufacturing drawings and process plans (know what you need to do before you step up to the machine!)
- Rohrbach evaluation of each other's drawings and process plans

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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Week 11: Milestone **ELEVEN** (10 pts)

Design, Build, Test, & Begin Integration

Deliverables:

- Manufacture **Components** from drawings made last week
- Test **Modules** from **Components** made
- Begin Intergation of **Modules**
- Evaluate what did and did not work, and take appropriate action (fix it!)
- Proceed with detailed engineering of **Components** for the remaining **Modules**:
 - FRDPARRC Sheets
 - Use what you learned in building the MCM to carefully do the risk and countermeasures analysis!
 - Appropriate analysis (silicon is cheaper than metal!)
 - Bench Level Experimentation (if analysis too tough for you or teacher, run an experiment!)
 - Sketch the idea and identify sensitive design parameters (e.g., dimensions)
 - Solid Modeling of **Components** (you need drawings to machine parts!)
 - Manufacturing drawings and process plans (know what you need to do before you step up to the machine!)
- Rohrbach evaluation of each other's drawings and process plans
- Revise schedule for next week

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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Week 12: Milestone **TWELVE** (20 pts) Demonstrate Working Machine

Deliverables:

- Manufacture **Components** from drawings made last week
- Test **Modules** from **Components** made
- Evaluate what did and did not work, and take appropriate action (fix it!)
- Assemble and demonstrate working machine (at least to some degree)
- Evaluate what did and did not work
- Complete manufacturing drawings and process plans for all **Components** that need to be **finished!**
- Revise schedule for next week

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
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Week 13: Milestone **THIRTEEN** (10 pts) In-Class Contest & “Ship” Machine

Deliverables:

- Clean up your machine and test, test, test!
- Have a working machine ready to compete in the in-class contest
 - Your score will determine your seeding in the final contest
 - High score machines will be matched against low score machines
- Evaluate what did and did not work
- “Ship” your machine:
 - Machine is judged for size and weight:
 - **Green dot means you can compete and win**
 - **Red dot means you can compete in first round, but cannot win**
 - Machine is boxed in FREM container and put into locked locker
- Recycle unused materials and components
- Clean up your 2.007 web site (if you have one!)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
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Week 14: Milestone **FOURTEEN** (80 pts) Final Contest (Celebration!)

Deliverables:

- Check the website for details
- Pick up your machine (and FREM box) from the Lab before 5 PM on the first contest day and take it to the Contest Arena
 - Place your machine in your designated section area
 - Make sure your batteries are charged and you bring your charger
- You **MUST** (please) wear your 2.007 T-Shirt and **safety glasses** to the contest
- Have FUN!

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
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Week 15: Milestone **FIFTEEN** (20 pts)

Document the Design

Deliverables:

- Website (if you chose to do one) containing at least:
 - What you did for each milestone:
 - Either this is already done (you did it each week), OR:
 - A clear description of how you evolved your machine
 - FRDPARRC Sheets for final **Strategy, Concept, Modules**
 - One page summary from each earlier milestone
 - Post-contest analysis:
 - What worked and what didn't?
 - What would you have changed if you could do it all over again?
 - How well did you follow the schedule
 - What do you think your grade should be, based on the fact that your grade is based 100% on how well you met weekly milestones?