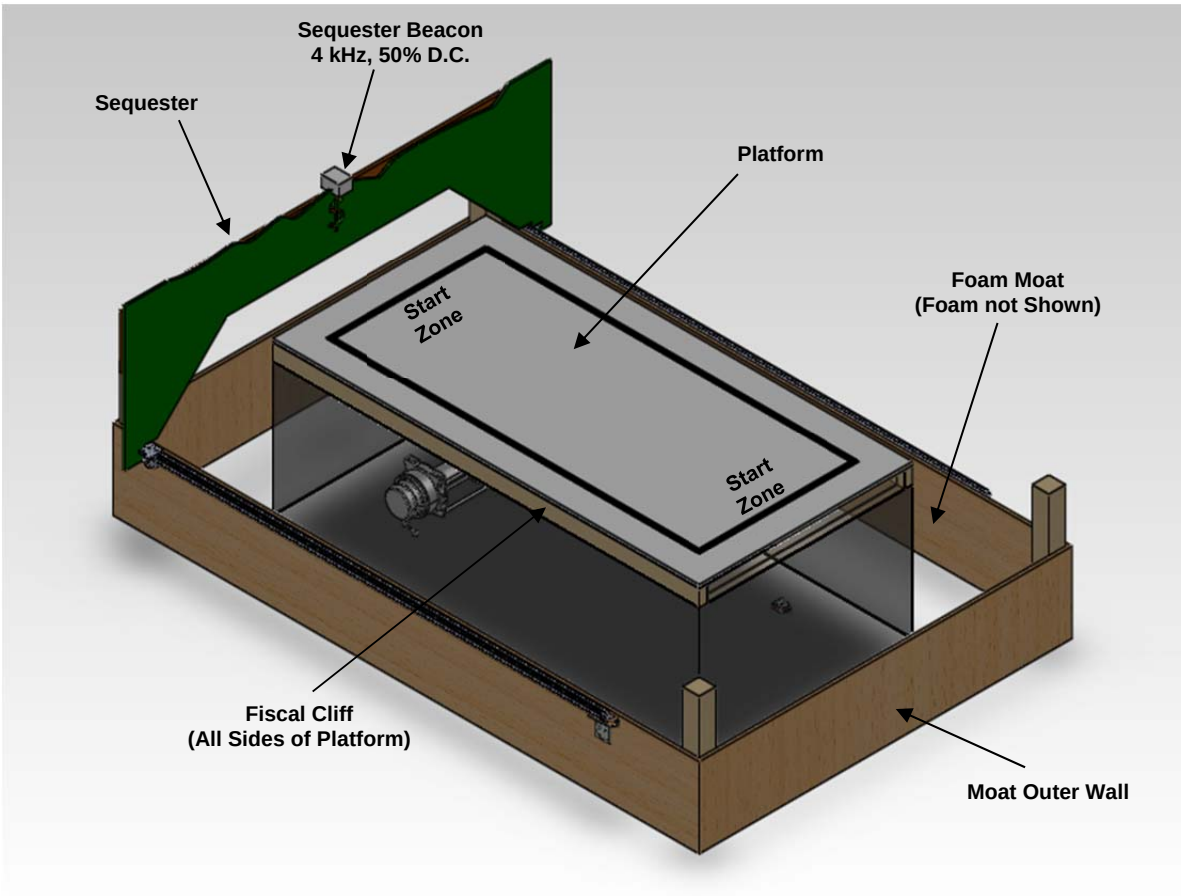
Fiscal Cliff Face-Off

ME210 Project Specifications
Winter, 2013

Purpose:

The purpose of this project is to provide an opportunity to apply all that you have learned so far in ME210 to solve an open-ended mechatronics design problem. The task is to design an autonomous machine that will defeat an opponent in a mechatronic version of congressional debate over how best to resolve the financial crisis.



The Fiscal Cliff Face-Off Sumo Wrestling Arena

Motivation:

Americans have undergone a "crash course" in economics in recent years. Before 2008, few had ever pondered the subtleties of collateralized debt obligations, credit-default swaps, or LIBOR – but thanks to the mortgage crisis and the ensuing Great Recession, we've all expanded our knowledge base of these and many other delightful topics. And just when we were at risk of becoming complacent as these crises recede and the economy slowly recovers, our legislative and executive branch leadership has created a steady stream of new crises certain to keep us engaged.

The most notable and urgent of these looming crises is the dreaded *Fiscal Cliff*. The Fiscal Cliff is an intoxicating mix: the urgent need to raise the debt ceiling in order to avoid defaulting on our sovereign debt, and the intriguingly and ominously named "sequester" – a provision in the Budget Control Act of 2011 that requires a cool 1 trillion

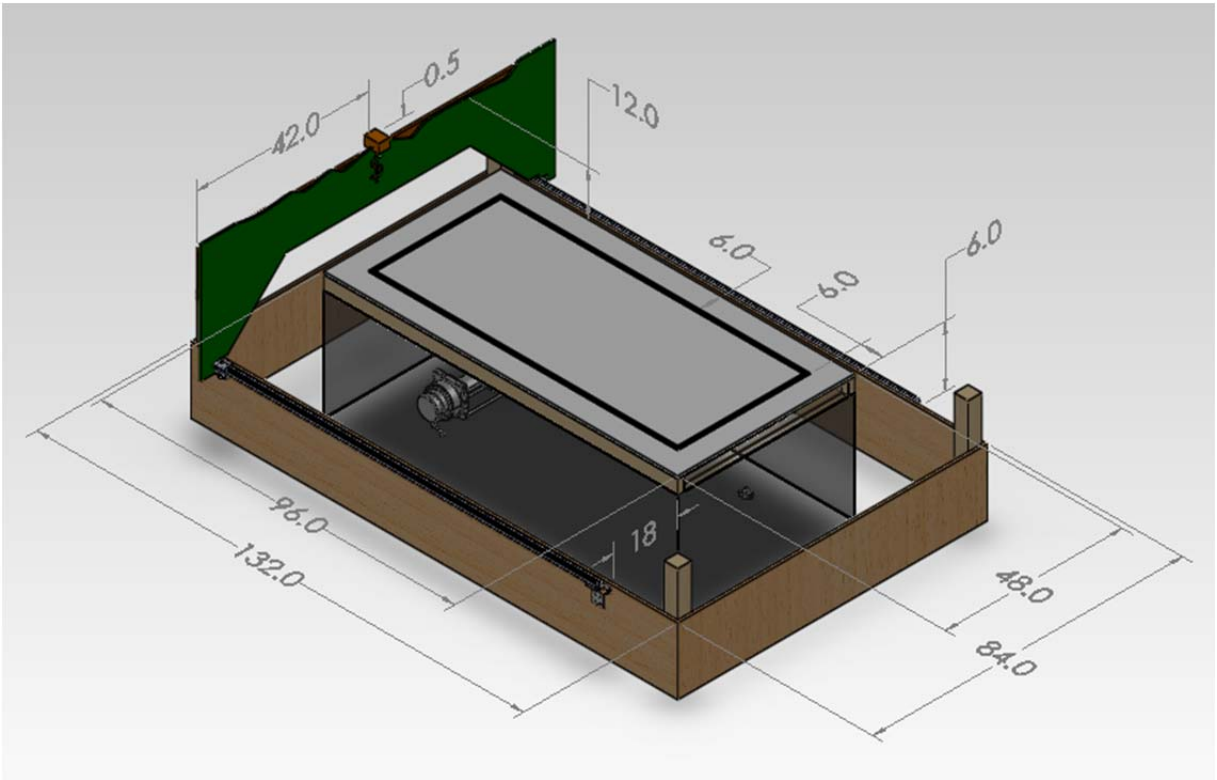
dollars (more easily grasped by engineers when written as $1e12) in across-the-board spending cuts over the next 10 years. The current deadline for resolving the budget and dodging the Sequester is March 1.

This timing couldn't be better for ME210. We believe there's a sensible way to settle these disputes that's an alternative to the customary bickering, name-calling, gridlock, filibustering, and general skullduggery, we propose a good, old-fashioned robotic contest of strength, agility, and guile. Democrats and Republicans will each nominate robotic champions who will sumo wrestle, and the winner of the wrestling tournament will have the honor of deciding how to resolve the Fiscal Cliff crisis.

Because the crisis at hand was cleverly named and is now generally known as "The Fiscal Cliff", and because many members of the public and practically all members of congress are easily confused, the rules of the game have been defined to symbolize the issue as literally as possible. Sumo wrestling matches will take place on an elevated platform, several feet above the floor of the Fiscal Cliff Face-Off Sumo Arena. Robotic sumo wrestlers have up to two minutes to win their match by pushing their opponent over the edge of The Fiscal Cliff to their doom. This, by itself, would probably have been dramatic enough, but The Sequester adds another exciting element: The Sequester is a wall that slowly moves from one end of the platform to the other during each two minute match. The Sequester sweeps everything before it over The Cliff. Robotic sumo wrestlers have two minutes to defeat their opponent by pushing them over The Cliff, or they will be swept off the Fiscal Cliff themselves by The Sequester. The last sumo robot on the platform wins the match. No filibustering this time, senators…it's go time in ME210!

Project Specifications:

The objective of an ME210 Fiscal Cliff Face-Off Sumo Wrestling Match is simply for your SumoSenator to remain on the sumo wrestling platform longer than the SumoSenator from the opposing party. SumoSenators with divergent viewpoints start each match – symbolically – on opposite sides of the platform, and as soon as the referee gives the start signal, the SumoSenators attempt to push each other off The Fiscal Cliff. During the match, The Sequester slowly and inexorably advances across the platform, stopping only if one SumoSenator is successful in pushing the other over The Fiscal Cliff. If The Sequester isn't stopped, it continues to advance, reducing the SumoSenators' space to maneuver and ultimately pushing at least one over the Fiscal Cliff. The last SumoSenator remaining on the platform wins the match.



Dimensioned diagram of the Fiscal Cliff Face-Off Arena

The Fiscal Cliff Platform:

	The Fiscal Cliff platform is constructed of particle board, the playing surface of which is uniformly covered with white laminate. The platform has dimensions of 4' x 8' (W x L).
	The boundaries of the Fiscal Cliff platform are smooth, and offer no impediment to a SumoSenator traveling over the edge. The vertical space below the edge of the Fiscal Cliff platform will be free of any foreign bodies or obstructions (with the exception of the foam in the moat, described below).
	The Fiscal Cliff platform is surrounded by a moat filled with soft foam pieces that cushion the impact of SumoSenators that are pushed or fall off the platform. The distance between the surface of the Fiscal Cliff platform and the top of the foam pieces is at least 6" and at most 12". SumoSenators will fall no farther than 12". SumoSenators should be designed and constructed to repeatedly survive traveling over The Cliff (consider the number of times your SumoSenator will be tested during development), and you should include a reasonable margin of safety.
	The outer wall of the moat is constructed of wood, which is spaced 18" away from the edges of the Fiscal Cliff platform.
	1 in.-wide strips of non-reflective black tape will run along the edges of all sides of The Fiscal Cliff platform. The centerline of the tape will be spaced 6.5" from the edge of The Cliff.

	The Start Zones are the regions where SumoSenators will be placed at the beginning of each 2-minute Fiscal Cliff Face-Off Sumo Wrestling Match. The Start Zones are 18" square, and are centered along the longer central axis of the Fiscal Cliff platform. The inner edge of the non-reflective black tape along the short sides of the Fiscal Cliff platform constitutes the outermost boundary of the Start Zone.

The Sequester:

	The front face of The Sequester is flat, and constructed from particle wood. The Sequester spans the entire width of the Fiscal Cliff Face-Off Arena. The height of The Sequester is 12", measured from the top surface of the platform.
	The Sequester is supported on rails attached to the outer walls that enclose the moat. The bottom of The Sequester does not touch the platform: there is a gap of approximately 0.5".
	A large winch, powerful enough to pull Jeeps out of mud bogs and stumps cleanly out of the ground, powers The Sequester. The Sequester is capable of pushing practically any and all objects on the platform over The Cliff. Resistance is futile.
	At the beginning of each match, The Sequester will be positioned at one end of the Arena, in contact with the outer wall of the moat. The Sequester will remain in this position for the first 30 seconds of each match.
	30 seconds after the start of a match, The Sequester will begin moving from its initial position at one end of the Arena toward the opposite end of the Arena. The Sequester will reach the opposite end of the platform approximately 90 seconds later. In this way, the total length of a match is guaranteed to be at most 2 minutes.
	An infrared beacon is located at the midpoint of The Sequester, at a height of 12.5" from the surface of the platform. The Sequester beacon modulates infrared light at a frequency of 4 kHz with a 50% duty cycle. The beacon is continuously active during each match.

The SumoSenator:

	Each student team will be responsible for designing, building, and demonstrating a SumoSenator. This is an autonomous robot that will compete in the Fiscal Cliff Face-Off according to the specifications and rules defined in this document.
	Each SumoSenator must be a stand-alone entity, capable of meeting all project specifications.
	Power must be supplied by batteries, which are to be carried on board each SumoSenator. Each team will be provided with two 7.2V NiMH rechargeable battery packs. Additional batteries may be used if desired, and may either be purchased by each team or provided by the teaching staff (depending on availability).
	Each SumoSenator must operate completely un-tethered during grading and competition.
	Once your SumoSenator has been activated at the start of a game, the operator may not touch it again until the entire match is complete.
	Each SumoSenator must incorporate a horizontal mounting platform for an infrared beacon. The beacon mount must be located on top of the robot at a height of 11" from the surface of the Arena platform, and must be located at the centroid of the robot's projected footprint. The beacon mount must be at least 3" in diameter (if circular – if not circular, it must be large enough that a circle of at least 3" diameter may be drawn on it). Strips of adhesive-backed Velcro will be provided to all teams so that beacons can be quickly and securely attached and removed from SumoSenators. The infrared beacons will modulate their infrared light at a frequency of 850 Hz, and will be powered by their own battery packs. Beacon-battery assemblies will be provided in the lab.
	SumoSenators must incorporate a class-standard foam bumper that encompasses the perimeter of the robot. The midpoint of the foam bumper must be at a height of 3" above the surface of the Arena platform. The bumper is required to be the point of contact between robots. It need not be a single continuous piece of foam (that is, it can be comprised of sections of the foam material), but it must not be possible to make contact with another robot at a point that is not protected by the bumper. No part of a SumoSenator may extend beyond its bumper in any direction. Bumper material will be provided in the lab.

	Each SumoSenator is required to occupy a volume not to exceed 11" x 11" in horizontal dimensions (including its bumper) and 11" in height when initiated. An official ME210 Dimension Verification Box will be used to insure that each SumoSenator fits entirely within the specified maximum volume (just like carry-on baggage at the airport).
	SumoSenators may not weigh more than 15 lbs.
	SumoSenators must automatically cease all motion 2 minutes after the start command is issued.
	Each SumoSenator will incorporate an easily accessible toggle switch on the top of the robot that will serve as an E-stop. The purpose of the switch is to cut power to the machine in the event of a software or hardware malfunction.
	No element or action of a SumoSenator may interfere with or block the light emitted by any beacon (including their own), or alter any aspect of the Arena in any way. This, of course, prohibits any damage to the Arena. SumoSenators may not intentionally impede the motion of The Sequester.
	SumoSenators may not reach or extend any element past the edge of The Cliff or under the platform.
	SumoSenators need to be rugged and robust to survive. The best-case scenario is that your robot gets repeatedly bashed and pushed around. The worst-case scenario is that the best-case scenario is followed by your robot plunging over the Cliff. Design your robots to withstand these conditions, and consider that they will be subjected to this during testing as well as grading and competition.
	Each SumoSenator robot must be constructed as part of ME210. It may not be based on a commercial or otherwise pre-existing platform.
	Each team is limited to an expenditure of $200 for the materials and parts used in the construction of the project.

The Rules of Fiscal Cliff Face-Off:

	Before the start of each match, each SumoSenator will be placed in a random orientation somewhere within the in the Start Zone on a randomly selected side of the platform. Initial placement will be specified by a member of the teaching staff.
	A verbal start command will be issued by a member of the teaching staff, at which time teams will initiate the actions of their SumoSenator. This is the last human interaction allowed with the robot.
	SumoSenators are to attempt to push their adversary over the edge of the Cliff. The SumoSenator that remains on the platform the longest is the winner of the match.
	Fiscal Cliff Face-Off Sumo Wrestling Matches last for 2 minutes. After 30 seconds, the Sequestor begins to advance. The Sequester will move completely across the platform after approximately 2 minutes. A match is over when The Sequester reaches the far end of the platform.
	SumoSenators may move anywhere on the platform that is in front of The Sequester. The front of the Sequester is defined as the leading face as it advances over the platform.
	SumoSenators are only allowed to interact with their opponents by bumping into and pushing against them. No other interactions are allowed. Intentionally damaging an opponent will result in immediate and permanent disqualification.

Performance Requirements:

	For the purposes of grading, the minimum requirement for each SumoSenator is to "Beat the Brick" (the standard inanimate ME210 check-off opponent). Specifically, each SumoSenator must be able to win a sumo wrestling match when competing against – literally – a brick. The brick will conform to the size requirements for SumoSenators, will weigh no more than 10 lbs., and will carry a SumoSenator beacon at the standard height and location.
	Failing to meet the minimum requirements during the first official attempt will result in having to meet the requirements 2 times in a row in the next official attempt. Failure to meet the requirements 2 times in a row will increase the number to 3 times, which must also be consecutive. Subsequent failures do not increase the number beyond 3.
	The Fiscal Cliff Face-Off Sumo Wrestling single-elimination tournament will be held in the Bldg. 550 Atrium on the evening of Monday, March 11 to determine which SumoSenator will be granted the honor of resolving the Fiscal Cliff crisis in whatever way it desires. The public is invited to

	attend this event. You may want to prepare a manifesto in advance, in case your SumoSenator is victorious.
	The results of the Fiscal Cliff Face-Off Sumo Wrestling Tournament at the public presentation will not affect grading – this is purely an opportunity for you to enjoy the devices you've created.

Documentation Requirements:

	An HTML-based report describing the technical details of your machine is required. The report should include sufficient detail that a person skilled at the level of ME210 could understand, reproduce and modify the design. You must turn in the actual HTML source code for your report, rather than building a site on a 3rd party host and linking to it. These reports will be posted on the public ME210 website in the future, so please make sure the content is appropriate and do not disclose information that you do not wish to made public.
	Each design team will maintain a logbook (which may be in electronic format, e.g., a wiki). At a minimum, this logbook will contain up-to-date mechanical, electrical, and software documentation. This is expect to include such things as task lists, schedules, sketches, notes from brainstorm meetings, solid models, schematics, code listings, notes about software versions, etc.

Other General Guidelines & Safety:

The machines must be safe to the user, the lab and the spectators.

No projectiles are allowed to be used during any match. The teaching staff reserves the right to require you to reduce the operating speed of your SumoSenator for the safety of the other SumoSenators, the Fiscal Cliff Face-Off Sumo Wrestling Arena, the teaching staff, and innocent bystanders. Pyrotechnics of any kind are forbidden.

All projects must respect the spirit of the rules as established in this specification, and the culture of ME210. If your team is considering something that may violate these, you must consult with a member of the teaching staff. Interpretations and rulings are the sole domain of the teaching staff.

Tolerances on the dimensions of the Arena are ± 1in. unless otherwise specified.

Evaluation:

Performance testing procedures:
All machines will be operated by one of the team members. There will be one round for grading purposes, and one round for entertainment purposes.

Level 1: Grading evaluation. Each machine will be graded based on its performance during the check-off period, the last day of which is Friday, 3/8. The public presentation will be on the evening of the following Monday, 3/11. During the grading session, each machine will have up to 2 minutes to meet the minimum project requirements. Grading is not based on the score achieved during the evaluation, only on the ability to meet the requirements.
Level 2: Public evaluation/performance. After a warm-up period, teams and machines will be entered into a head-to-head, single-elimination tournament. The winner of each game will advance to the next round. The brackets for the single-elimination tournament will be seeded based on the order that teams successfully meet the grading criteria during the grading session.

Grading Criteria:
1. **Concept (25%)** This will be based on the technical merit of the design and programming for the machine. Included in this grade will be evaluation of the appropriateness of the solution, as well as innovative hardware and software and use of physical principles in the solution.
2. **Implementation (25%)** This will be based on the SumoSenator displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the machine and the quality of construction. We will not presume to judge aesthetics, but will evaluate craftsmanship and finished appearance.

3. **Performance (25%)** Based on the results of the performance during the evaluation session.
4. **Coach Evaluations (10%)** Based on the four project milestone reviews (see below).
5. **Report (15%)** This will be based on an evaluation of the final report. It will be judged on clarity of explanations, completeness and appropriateness of the documentation. This report should be prepared in HTML format, and submitted on a CD-ROM or DVR disc ready for publication on the web.

Note: This is a *mechatronics* project design activity. While we have emphasized electronics and software aspects of this subject in class this quarter, it is important to realize that any mechatronic project also requires substantial mechanical design. Grading in this class is based on complete system design and function. Therefore, a "beautiful" electronics system is not a successful project if the mechanical part of the machine fails. Be sure to allocate resources (energy, time and people) to all aspects (including mechanical) of this project.

Project Milestones:

Event	Deliverables
First Review 2/19/13 Presented in class using Power Point (5 min.)	At least 3 design concepts, with sketches Time schedules, project plan Personnel assignments
Second Review 2/22/13 Turn in documentation (Bldg. 550, room 103)	Calculations System block diagram Preliminary test results
Third Review 2/27/13 Presented to coach Check-off by teaching staff	Demonstration of all functional subsystems per block diagram: beacon sensing, tape sensing, mobile platform, etc.
Fourth Review 3/5/13 Check-off by teaching staff	Integration of subsystems Working software to test all systems Working versions of all systems
Grading Session On or before 5:00 pm, 3/8/13	Demonstrate minimum functionality on the Convention Hall set up in the lab or Atrium
Final Presentations Fiscal Cliff Face-Off Tournament: 3/11/13 Bldg. 550 Atrium, 7:00 pm	Finished, operational, presentable machines
Final Report On or before 5:00 pm, 3/15/13	HTML format Suitable for posting on ME210/SPDL website