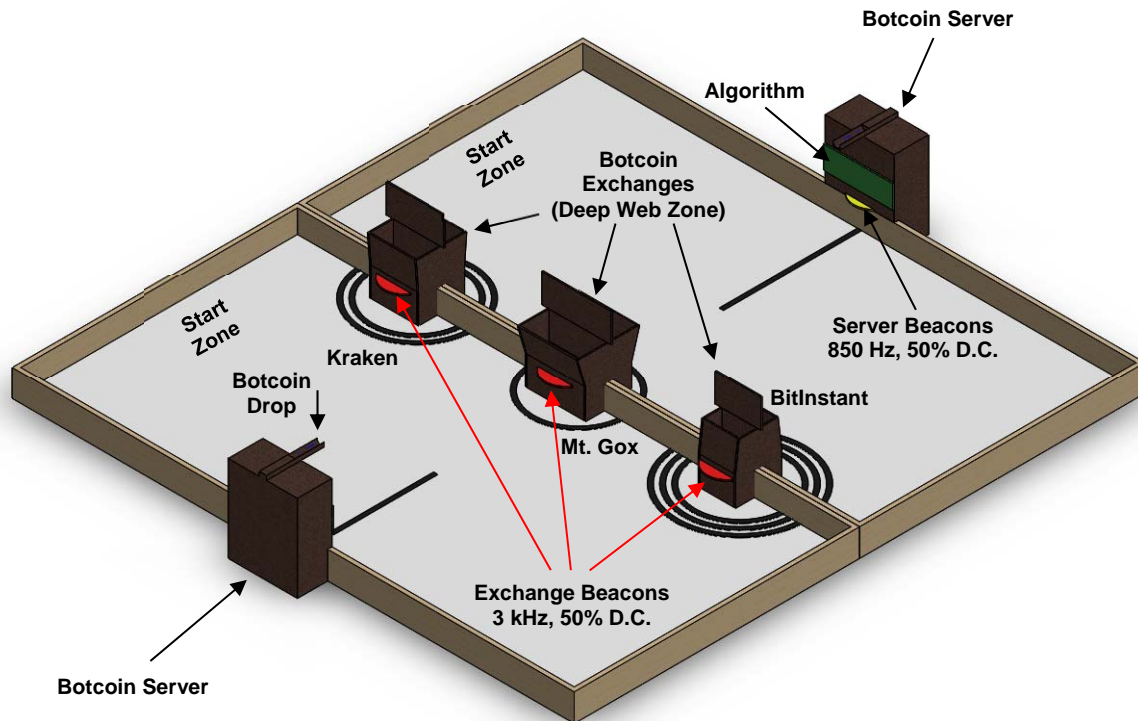# Botcoin Bonanza
ME210 Project Specifications
Winter, 2014

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 Bitcoin "investing".

The ME210 Botcoin Bonanza Trading Floor

Motivation:

"Greed is good!" – at least according to Gordon Gecko, Michael Douglas's character in Oliver Stone's 1987 cinematic masterpiece *Wall Street*. This may have been a bit before the average ME210 student's time, but 27 years later, you have to admit that this philosophy is holding up well. People have sacrificed all manner of things at the altar of Greed: time, balance, relationships, health. Will we be taking a step away from this in ME210? On the contrary, we will be taking greed to new levels of obsession, and adding automation and mechanization to the mix!

Greed recently found a new medium of expression with the introduction and growing popularity of Bitcoin. Bitcoin was introduced January 3, 2009 by the mysterious Satoshi Nakamoto, during a quaint era when it was still possible to do things anonymously on the internet. For the first few years of its existence, Bitcoin was a curiosity, an experiment – a sleepy backwater frequented mostly by the Technorati, money launderers, and purveyors of illicit goods and services.

The value of a Bitcoin languished below $15 for several years. That era ended in April of 2013, when the price spiked briefly above $200. After that, it stabilized for a few months at about $100 (that's a long time when you're talking about Bitcoin). Then, just to make sure we were paying attention, this was followed by a startling and greed-inflaming race above $1,200 in the last quarter of 2013. There have been many heart-stopping swings since, but at that point, pretty much everyone started thinking about jumping in.
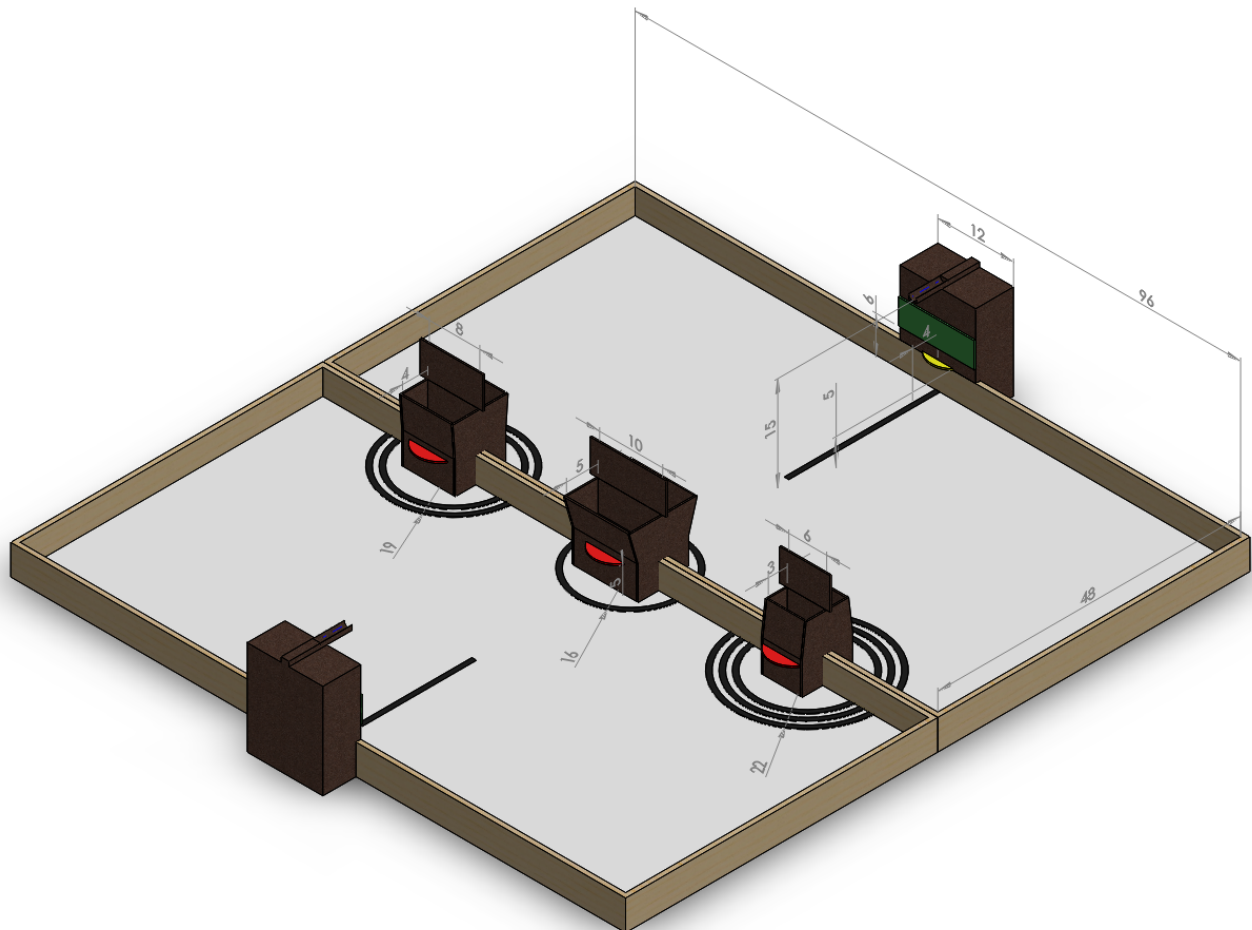
What is it about human nature that makes us *all* think that surely we would have gotten in at the low and sold at the peak? We in ME210 are no different from anyone else. We've asked ourselves this question, over and over, late into the night. But rather than dwell on the past, we got to work, cooking up a scheme that leverages mechatronics to make some serious Bitcoin. Finally, it came to us: we could create robots that compete for Bitcoins! If greed is good, then surely automated, mechanized, competitive greed must be even better!

In ME210, we will actually build robots that mine "Botcoins" from "Botcoin Servers", and exchange them for "Samoleans" (a slang term for money dating from the gangster era). Except for a few minor details, this is pretty much the same thing as Bitcoins and dollars. In our version of cryptocurrency mania, two robots (or "BitBots") compete head-to-head to mine as many Botcoins as possible from their Botcoin Server in a Botcoin Trade-Off. It's up to each BitBot to decide when to mine Botcoins, and when to convert those Botcoins into a harder currency (the aforementioned Samoleans), which is done by depositing them into one of three Botcoin Exchanges, each with different exchange rates. When a BitBot places the requisite number of Botcoins into a Botcoin Exchange, it will pay out a Samolean (an indisputably valuable prize) to reward the BitBot, and a Consolation Prize (an indisputably undesirable item) to the other BitBot. A BitBot wins a Trade-Off when it obtains more Samoleans than its opponent, or if it has successfully deposited more Botcoins than its opponent into active Exchanges. We don't recommend a "buy-and-hold" strategy in this class – this market is going to be volatile, and the action will be HOT!

Project Specifications:

The objective of a round of ME210 Botcoin Trade-Off is to make money, fast. Preferably without doing any work. To achieve this, your BitBot must out-arbitrage its opponent by obtaining as many Botcoins as possible the hard way (by mining them), and cash them in at one of the three Exchanges located in the Deep Web Zone of the Trading Floor. Opposing BitBots start each Trade-Off on their side of the Trading Floor, and when the opening bell rings, each BitBot attempts to acquire and convert more Botcoins than its opponent. Converting Botcoins to objects of less dubious and more stable value requires that Botcoins be deposited in an Exchange. When an Exchange has received a sufficient number of Botcoins from a BitBot (the number varies by Exchange), it will reward the successful BitBot by bestowing upon it one Golden Samolean. It will simultaneously punish the unsuccessful BitBot with a Consolation Prize (an object of lesser (or perhaps even negative) value)). The Exchange will then shut down for the remainder of the Trade-Off.

At the conclusion of each Trade-Off, one BitBot will be declared the winner. In order to be named as the winner, a BitBot must 1) obtain all of the Golden Samoleans from the Exchanges, 2) obtain more Golden Samoleans than its opponent, 3) have deposited more Botcoins into Exchanges than its opponent within the 2 minute time limit, if time expires and no Golden Samoleans have been awarded to either BitBot, or 4) have deposited more Botcoins into the remaining active Exchange than its opponent within the 2 minute time limit, if time expires and one Golden Samolean has been awarded to each BitBot.

Dimensioned diagram of the ME210 Botcoin Bonanza Trading Floor

The Trading Floor:

	The Trading Floor will be constructed from particle board, the playing surface of which will be uniformly covered with white laminate. The Trading Floor will be evenly divided into 2 separate regions, one side for each BitBot.
	Each half of the Trading Floor will have nominal dimensions of 8' x 4'.
	A protective border will be installed around the perimeter of each half of the Trading Floor. This will serve to clearly demarcate the boundaries of the Floor, and to ensure that BitBots are not able to navigate off the edges of the Floor to their doom. The borders will be constructed of ¾"-wide boards and be 4" tall relative to the surface.
	The two halves of the Trading Floor are physically identical (though mirrored), and will be placed side-by-side for Trade-Off matches to enable head-to-head competition between two BitBots (these are described below) running simultaneously. The nominal dimensions of the fully assembled competition Trading Floor will be 8' 1½" long by 8' wide.
	A center divider will separate the two sides of the Trading Floor, and will be comprised of the protective borders from each half placed adjacent to each other. The total thickness of the center divider will be 1½".
	The outer side of the Trading Floor will house a Botcoin Server, where BitBots may "mine" raw Botcoins. Botcoin Servers will be located at the halfway point on the outer boundary of the Trading Floor.
	Botcoin Servers incorporate an Algorithm on the side that faces the Trading. BitBots may "seed the Algorithm" – that is, BitBots press the Algorithm (basically, a large button) to request that a Botcoin Server deliver a Botcoin. The Algorithm is a rigid panel that measures 4" x 12" (h x w). The lower edge of the Algorithm is at a height of 6" above the surface of the Trading Floor.
	BitBots may request that a Botcoin be delivered to them by a Botcoin Server by pressing the Server's Algorithm with sufficient force to be detected. The first Botcoin will be dispensed when the Algorithm is pressed (and detected) 1 time. After the first Botcoin has been delivered, another Botcoin may be requested by pressing the Algorithm 2 times. Generalizing this: after the Nth Botcoin is delivered, the next Botcoin will be delivered when the Algorithm has been pressed (and detected) N+1 times.
	Botcoins are released straight down from a height of 15" above the surface of the Trading Floor, 4" away from the border in front of the Botcoin Server, at the midpoint of the Botcoin Algorithm.
	The locations of the Botcoin Servers will be indicated with beacons that modulate infrared light at a frequency of 850 Hz and a duty cycle of 50%. The base of the beacons will be located at a height of 4" above the surface of the Trading Floor, at the center of the Server. Botcoin Server beacons will be enabled for the entire duration of each Trade-Off.
	Botcoins are round, flat, disc-shaped objects that are approximately 40 mm in diameter and 3 mm thick, with an approximate mass of 15 g.
	The center divider of the Trading Floor is within the Deep Web Zone. This Zone contains three Botcoin Exchanges where Botcoins may be deposited. The Exchanges are evenly spaced in 24" increments along the length of the divide, with the center Exchange located at the midpoint of the divide.
	Each Exchange incorporates a Depository, which is a receptacle located at the top of the Exchange. The top of the Depository is 10" above the surface of the Trading Floor. Each Depository is bisected by a backboard along the dividing line separating the two halves of the Trading Floor. The backboards are rectangular, are 5" taller than the top of the Depository, and extend 1" on either side.
	BitBots may deposit Botcoins into an Exchange's Depository at any time during a Trade-Off. Once the number of Botcoins required by an Exchange has been deposited, the Exchange will eject a Golden Samolean on the side of the Trading Floor corresponding to the BitBot that deposited enough coins. It will eject a Consolation Prize on the other side. A count of Botcoins deposited is maintained for each BitBot and displayed for the audience: either BitBot may deposit the required number of coins, and the count from the opposing BitBot does not affect the count of your BitBot. The first BitBot that deposits enough BotCoins in a Server is awarded that Server's Golden Samolean.

	Each Exchange's Depository requires a unique number of Botcoins to pay out, and has a unique size. Exchanges with bigger Depositories are easier to find and deposit Botcoins into, and they require more Botcoins before they pay out. Exchanges with smaller Depositories are harder to find, and require fewer Botcoins. The Exchanges are as follows:

Exchange	Location	Botcoins Required	Depository Dimensions
Mt. Gox	Center	8	10" x 5" (w x d)
Kraken	End #1	5	8" x 4" (w x d)
BitInstant	End #2	3	6" x 3" (w x d)

	On the Trading Floor, concentric rings of black adhesive vinyl are adhered around the center point of each Exchange. Each ring has a width (Δr) of 0.75". The Mt. Gox Exchange has a single ring, located at a radius of 8", as measured from the center point of the Exchange to the centerline of the vinyl ring. The Kraken Exchange has 2 concentric rings, the innermost ring located at a radius of 8", and the outermost ring located at a radius of 9.5", as measured from the center point of the Exchange to the centerlines of the vinyl rings. The BitInstant Exchange has 3 concentric rings, the innermost ring located at a radius of 8", and the center ring located at a radius of 9.5", and the outermost ring located at a radius of 11", as measured from the center point of the Exchange to the centerlines of the vinyl rings.
	During a Trade-Off, each Exchange will indicate the number of Botcoins that have been deposited by each BitBot, and how close it is to awarding prizes.
	Beacons will be located at the base of each Exchange, one on each side of the divider at the center of the Trading Floor. Beacons will be centrally located below the Depositories, with their base located at a height of 4" above the surface of the Trading Floor. When an Exchange is active (that is, it has not yet awarded prizes), the beacons at its base will modulate infrared light at a frequency of 3 kHz with a 50% duty cycle. When an Exchange awards its prizes, its beacons will be disabled. Enabling/disabling will be managed automatically via circuitry built into the Exchanges.
	BitBots will have clear line-of-sight to all active beacons everywhere on their side of the Trading Floor. Reasonable precautions will be taken to insure that the beacons on the other half of the Trading Floor are not visible to BitBots.
	A 24 in. length of 0.75 in.-wide black adhesive vinyl will extend from front the central point of each Botcoin Server, and will be perpendicular to the border along the outer walls of the Trading Floor. One end of the tape will terminate at the border and the other end will terminate 24 in. inward, toward the center of the Trading Floor.
	The Start Zones are the regions where BitBots are placed at the beginning of each 2-minute Trade-Off. Start Zones are approximately 18" square, and are located at the same end of the Trading Floor, adjacent to the midpoint of the side borders.

The BitBots:

	Each student team will be responsible for designing, building, and demonstrating a BitBot. This is an autonomous robot that will run in the ME210 Botcoin Tradeathon according to the specifications and rules defined in this document.
	Each BitBot must be a stand-alone entity, and meet all project specifications.
	Power must be supplied by batteries, which are to be carried on board each BitBot. Each team will be provided with two 7.2V NiCad 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 BitBot must operate completely un-tethered during grading and competition.
	There is no limit to the number of Botcoins a BitBot may carry at any point in time.
	The BitBot's control software must execute from the flash memory of the Arduino. Workstations will not be available in the room where the competition takes place (though the ME210 lab is nearby and teams may use their own computers).

₿	Once your BitBot has been activated at the start of a game, the operator may not touch it again until the entire Trade-Off is complete.
₿	BitBots must automatically cease all motion 2 minutes after the starting bell sounds.
₿	Each BitBot is required to occupy a volume not to exceed 11" x 11" in horizontal dimensions and 12" in height when initiated. An official ME210 Dimension Verification Box will be used to insure that each BitBot fits entirely within the specified maximum volume (just like carry-on baggage at the airport).
₿	Each BitBot 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 BitBot may interfere with the light emitted by any beacon, make contact with or otherwise impede the operation of an opponent, or alter any aspect of the Trading Floor in any way. The Trading Floor must remain unaltered at all times during testing and competition rounds.
₿	Each BitBot 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.

Trade-Off Competition Rules:

₿	Before the start of each Trade-Off, each BitBot will be placed in a random orientation somewhere within the in the Start Zone on a randomly selected side of the Trading Floor. Initial placement will be specified by a member of the teaching staff, and BitBots will be placed in a location that allows them to spin in place without touching a border.
₿	A start command will be issued by a member of the teaching staff, at which time teams will initiate the actions of their BitBots. This is the last human interaction allowed with the BitBots until the Trade-Off ends.
₿	BitBots are to deposit their Botcoins into the Exchanges, with the objective of depositing the requisite number of coins for the Exchanges to be awarded Golden Samoleans.
₿	The Trade-Offs last for 2 minutes. The BitBot with the most Golden Samoleans wins the round. A winner may be called prior to the expiration of 2 minutes if a BitBot is able to obtain all 3 Golden Samoleans. If each BitBot has 1 Samolean at the end of a round, the BitBot that deposited the most Botcoins into the Exchanges wins.
₿	At any time, BitBots may request Botcoins from its Botcoin Server. Requests are made by "seeding the Algorithm" (pressing against the Server's Algorithm with sufficient force to trigger it). The first Botcoin is dispensed when the Algorithm is seeded (pressed) 1 time. Thereafter, the Algorithm must be seeded 1 additional time for each subsequent Botcoin. For example, to get the 5th Botcoin, the Algorithm must be pressed 5 times, and to get the 20th, the Algorithm must be pressed 20 times. The maximum rate at which the Algorithm will recognize requests is 2 Hz (1 press every 0.5 seconds). Requests may not be recognized if the Algorithm is pressed excessively rapidly, with too little or too much force, or for an insufficient duration.
₿	During a Trade-Off, BitBots are required to stay within the boundaries of their side of the Trading Floor.
₿	Botcoins are the only objects allowed to be deposited into an Exchange.
₿	Each Botcoin may be used only once during a Trade-Off.
₿	BitBots may not interact in any way with their opposition. Cryptocurrency fraud is a serious offense, and BitBots found to be gaming the system will be disqualified. Determination of fraud is at the sole discretion of the teaching staff.

Performance Requirements:

Ƀ	For the purposes of grading, the minimum requirement for each BitBot is to "Beat the Brick" (the standard inanimate ME210 check-off opponent). Specifically, each BitBot must be able to deposit at least 2 Botcoins into an Exchange within 2 minutes, when competing against – literally – a brick.
Ƀ	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.
Ƀ	The results of the ME210 Botcoin Tradeathon at the public presentation will not affect grading – this is purely an opportunity for you to enjoy the devices you've created.
Ƀ	The ME210 Botcoin Tradeathon single-elimination tournament will be held in the Bldg. 550 Atrium on the evening of Monday, March 10. The public is invited to attend this event.

Documentation Requirements:

Ƀ	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.
Ƀ	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.

Projectiles other than Botcoins are not allowed to be used during any match. Excessively high-velocity Botcoin flinging is prohibited. The teaching staff reserves the right to require you to reduce the operating speed of your BitBot or the velocity of Botcoins for the safety of the other BitBots, the Trading Floor and associated infrastructure, 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 the Spirit of the Rules, you must consult with a member of the teaching staff. Interpretations and rulings are the sole domain of the teaching staff, and all decisions are final.

Tolerances on the dimensions of the Trading Floor 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, 3/7. The public presentation will be on the evening of the following Monday, 3/10. 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 (20%)** This will be based on the technical merit of the design and programming of 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 (20%)** This will be based on the BitBot 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. **Milestones (20%)** Based on the four project milestone reviews (see below), and feedback from your project coach.
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 DVD disc ready for publication on the web. Reports may be prepared on 3rd party website design platforms, as long as the source code is provided (preferred) or a link to the hosted site is provided (less preferred).

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 and construction. 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 2/18/14 Presented in class using Power Point (8 min.). 12-15 teams will be randomly selected to present.	At least 3 design concepts, with sketches Time schedules, project plan Personnel assignments
Second Review 2/21/14 Turn in preliminary design documentation (Bldg. 550, room 103)	Calculations System block diagrams Preliminary test results Design sketches, solid models
Third Review 2/26/14 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 3/4/14 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, 3/7/14	Demonstrate minimum functionality on the Trading Floor set up in the lab or Atrium
Final Presentations Held on 3/10/14 Bldg. 550 Atrium, 7:00 pm	Finished, operational, presentable, greedy machines
Final Report On or before 5:00 pm, 3/14/14	HTML format Suitable for posting on ME210/SPDL website