

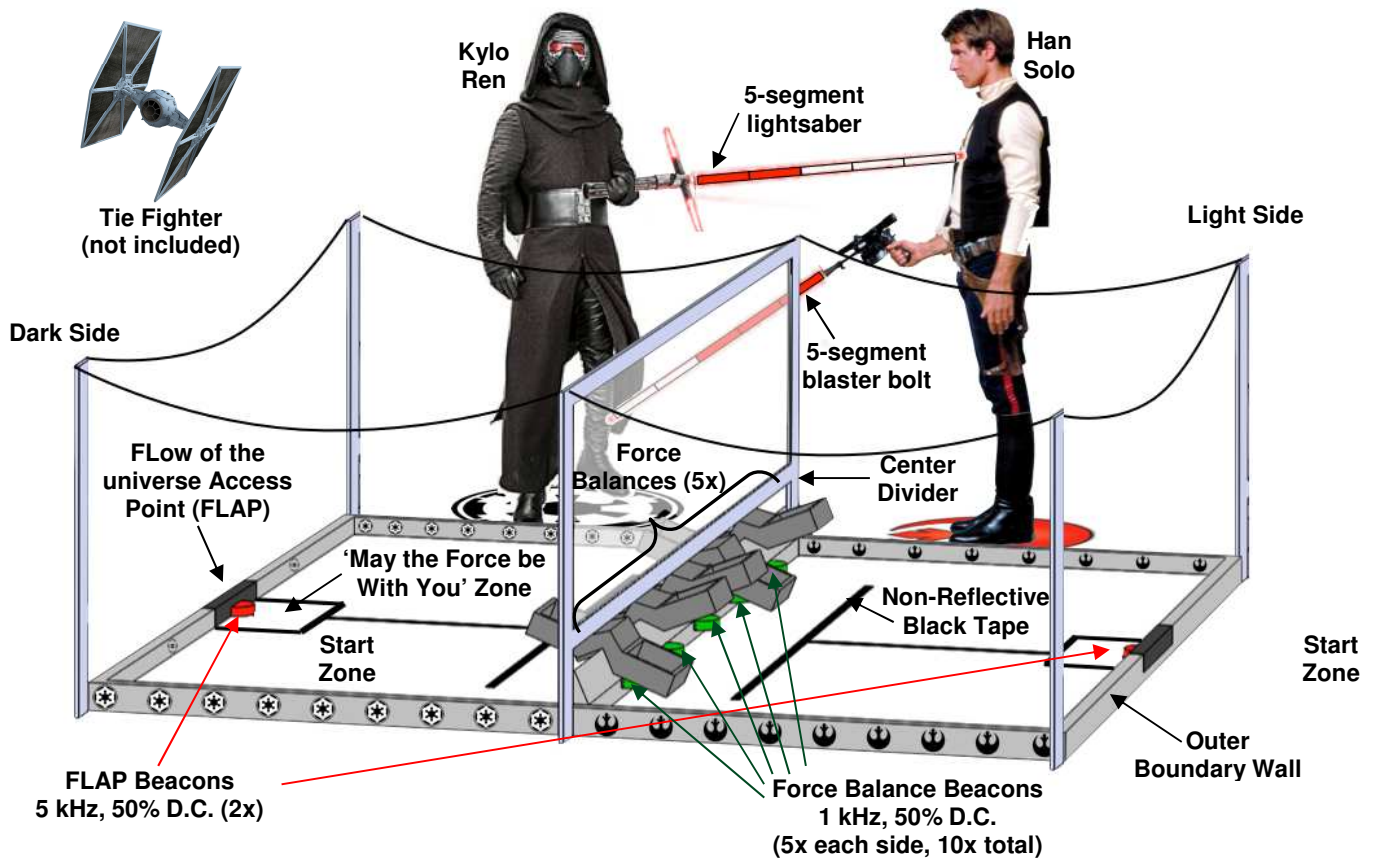


ME210 Project Specifications
Winter, 2016



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 tip the balance of the force to the Dark Side or the Light to help Kylo Ren decide whether or not he should stick it to his old man.



Motivation:

In the cavernous interior of Starkiller Base's Thermal Oscillator, Kylo Ren faces Han Solo, his father, and must make a choice. Should he continue down the path of evil, obey the commands of the sinister

Supreme Leader Snoke, and secure his place as the biggest Darth Vader fanboy of all time by stabbing his dad through the chest? Or should he hesitate long enough to allow Han to Shoot First, taking Kylo out of action and giving young master Ren a chance at redemption and return to his old life as Ben Solo?

Luckily for Kylo, in the Star Wars universe, big decisions (and game-winning shots) need never be made alone. The Force (an energy field created by all life and accessible to those trained in the Jedi arts) has woken up (why it was sleeping we don't know) and it is trying to influence this crucial moment in the galactic struggle. But the Force has a Light Side and a Dark Side, and while the Light Side of the Force is beckoning Kylo down a path of forgiveness and reconciliation, the Dark Side of the Force can't wait to make a Han Solo Shish Kabob (in passing we note that the nice thing about a lightsaber Kabob is that it simultaneously holds and grills your meat).

Now, when I was growing up, the Force would try and influence people by sending dead Jedi back as fuzzy blue Force Ghosts or by whispering quietly in the unseen passages of the soul. But it's 2016 now, and the Force knows there's got to be an App for that – or more accurately, a mechatronic solution of dazzling, superhuman (and superghostly) speed, precision, and reliability. And that's where you come in!

The Dark Side and the Light Side want to influence Kylo Ren in making the most important decision of our young Sith Lord's promising adolescent career. To do so, they have to move the weight of their influence into bins which shift Kylo's real-time allegiance. The Force has contracted you to design an autonomous robotic Force Ambassador which can take Force Tokens from the Flow of the Universe and deposit them into the balancing bins of Kylo Ren's soul.

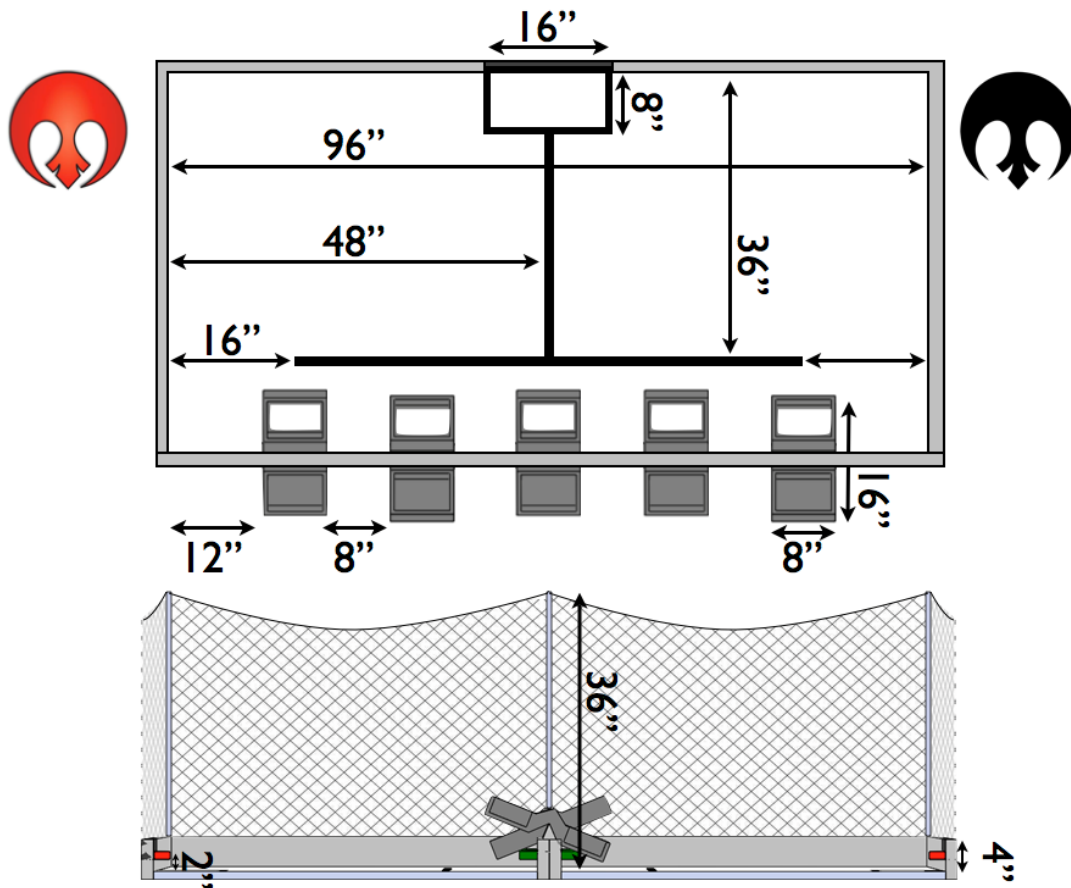
Your Force Ambassador (whose services you can sell to either the Dark Side or the Light) will access Dark Side or Light Side tokens and deposit them into five Force Balances, each of which represents 20% of Kylo's current Force affiliation. You will compete against an opposing Force Ambassador to tip Force Balances over in the brief two-minute period Kylo takes to make his final decision. To indicate the results of the contest as it progresses, Kylo's lightsaber has been divided into five segments, with the last segment firmly lodged in Han Solo's breastbone. Han's blaster bolt has also been divided into five segments, with the last segment inserted non-fatally into Kylo. If a Force Balance is tipped in favor of the Light Side, a segment of the blaster bolt will light up. If a Force Balance is tipped in favor of the Dark Side, a segment of the lightsaber will ignite. If at any point during the two minutes all five bins are tipped in favor of a single side, the decision is made, victory is declared and the round is over. Otherwise, the side with the most Force Balances tipped in its favor at the end of two minutes will win Kylo's heart. Each two-minute round is also referred to as a Forced Decision.

The Force has constructed a simulation of this critical moment to select the strongest possible champions for both the Dark Side and the Light. All robots will compete, and the winning robot from each round will be invited to continue onward in a single elimination tournament. The final two robots will play for keeps, as the Force converts the crude matter of the simulation into the luminous real-life moment and the audience watches in breathless anticipation to see the fate of the Galaxy unfold before their very eyes!

Also, Chewbacca is watching. Keep an eye on your droid's arms.



Project Specifications:













The object of an ME210 Forced Decision is simply for a Force Ambassador to secure more votes than its opponent in the time available, and to have fun doing it. Force Ambassadors achieve this by allocating their resources (i.e., poker chips covered with stickers of Darth Vader’s helmet or BB-8, referred to as “Force Tokens”) to influence the five Force Balances representing the state of Kylo Ren’s decision. Each Force Balance is represented by a literal force balance – a seesaw – and is Upset or Restored as a Force Ambassador deposits more Tokens into the seesaw so that it is more heavily weighted and tilts down on the side closest to the Force Ambassador. The Force Ambassador with the most Force Balances tipped in its favor at the end of a 2-minute round wins and advances to the next round. If, at any time before the 2-minute limit, a Force Ambassador is able to cause all five Force Balances to tilt in its favor, that Force Ambassador “Forces the Issue”, automatically winning the round and advancing to the next round.




Dimensioned Top and Cutaway Views of Starkiller Base's Force Geography

Starkiller Base:



	Starkiller Base will be constructed from particle board, the playing surface of which will be uniformly covered with white laminate. Starkiller Base will be evenly divided into 2 separate regions, one side for each Force Ambassador.
	Each half of Starkiller Base will have dimensions of 8' x 4'.

	A protective shield will be installed around the perimeter of each half of Starkiller Base. This will serve to clearly demarcate the boundaries of the Hall, and to ensure that Force Ambassadors are not able to navigate off the edges of the Hall to their doom (as long as they stay below light speed). The borders will be constructed of $\frac{3}{4}$ "-wide boards and be 4" tall relative to the surface. Above this protective shield, a 3' net will be hung to make sure Force Tokens do not leave the playing field and "influence" unsuspecting passerby.
	The two halves of Starkiller Base are physically identical, and will be placed side-by-side for elections to enable head-to-head competition between two Force Ambassadors (described below) running simultaneously. The dimensions of the fully assembled Starkiller Base will be 8' 1½" long by 8' wide.
	A center divider will separate the two sides of Starkiller Base, and will extend above the playing field to prevent Light Side tokens from landing on the Dark Side, and vice versa.
	Each side of Starkiller Base will house a FLOW of the universe Access Point (a FLAP), which will supply the Force Ambassador placed on that side. FLAPs will be located at the halfway point on the outer boundary of Starkiller Base.
	A 16" by 8" box centered on each FLAP will be designated as the "May the Force Be With You" Zone. Force Ambassadors who successfully enter this region of the border may receive as many Tokens as they may legally hold. Tokens will be loaded by members of the Force Ambassador's design team.
	Tokens are round, flat, disc-shaped objects that are approximately 40 mm in diameter and 3 mm thick, with an approximate mass of 15 g.
	Five Force Balances will be mounted along the center divider of the Hall. The Force Balances are seesaws that are evenly spaced in 16" increments along the length of the divide.
	Each Force Balance seesaw will be a total of 16 in. long, and 8 in. wide. Each seesaw's central pivot will be 5½ in. above the Base's surface.
	Two beacons will be located at the base of each Force Balance seesaw, one on each side of the divider at the center of Starkiller Base. Beacons will be centrally located below the pivot of each seesaw, at a height of 2 in. above the surface of the Base. When a Force Balance seesaw is tilted up on one side of Starkiller Base (that is, when the Force Ambassador is losing in that Balance), the beacon at its base on that side will modulate infrared light at a frequency of 1 kHz with a 50% duty cycle. When a Force Balance seesaw tilts down on a side of Starkiller Base (the Force Ambassador is winning in that Balance), the beacon at its base will be disabled. Enabling/disabling will be managed automatically via circuitry built into the Force Balance seesaws.
	The locations of the FLAPs will be indicated with beacons that modulate infrared light at a frequency of 5 kHz and a duty cycle of 50%. These beacons will be located at a height of 2" above the surface of Starkiller Base, in the center of the May the Force be with You Zone. FLAP beacons will be enabled for the entire duration of each Forced Decision.
	Force Ambassadors will have clear line-of-sight to all beacons everywhere on their side of Starkiller Base. Reasonable precautions will be taken to insure that the beacons on the other half of the Base are not visible to Force Ambassadors.
	A 3 ft. length of 1 in.-wide non-reflective black tape will span the shorter central axis of each half of Starkiller Base. One end of the tape will terminate at the center of the May the Force be with You Zone in front of the FLAP and the other end will terminate 12 in. from the central divider on the side of the Base where the Force Balances are located.

	An additional 5 ft. 4 in. length of tape will be placed parallel to and spaced 12 in. away from the center divider. This length of tape terminates on either end even with the outermost States.
	The Start Zones are the regions where Force Ambassadors are placed at the beginning of each 2-minute Forced Decision. Start Zones are located in symmetric outside corners of Starkiller Base, and are 18 in. square.

The Force Ambassadors:





	Each student team will be responsible for designing, building, and demonstrating a Force Ambassador. This is an autonomous robot that will influence Kylo Ren's Forced Decision according to the specifications and rules defined in this document.
	Each Force Ambassador 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 Force Ambassador. 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 Force Ambassador must operate completely un-tethered during grading and competition.
	Force Ambassadors may carry a maximum of 12 Tokens at any given point in time.
	The Force Ambassador'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 Force Ambassador has been activated at the start of a game, the operator may not touch it again until the entire Forced Decision is complete, with the exception of loading Tokens in the May the Force be with You Zone in front of the FLAPs.
	Force Ambassadors must automatically cease all motion 2 minutes after the start command is issued.
	Each Force Ambassador 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 Force Ambassador fits entirely within the specified maximum volume (just like carry-on baggage at the airport).
	A Force Ambassador is allowed to launch Tokens towards the bins, but only when it is outside the "May the Force be with You" Zone. Tokens must leave the Force Ambassador at an above-horizontal trajectory and travel no higher than three feet off the ground and no farther than eight feet away before hitting the ground. If, during the competition, a Token escapes the three-foot containment net around the field, the Force Threshold is breached, the Forced Decision is aborted, and the other side of the Force automatically wins! Do not shoot Tokens that escape the net! The teaching team reserves the right to eliminate a projectile strategy that seems in any way perilous.
	Each Force Ambassador will incorporate an easily accessible toggle switch on the top of the robot that will serve as an emergency 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 Force Ambassador 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 Starkiller Base in any way.
	Each Force Ambassador 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.



Forced Decision Rules:

	Before the start of each Forced Decision, each Force Ambassador will be placed in a random orientation somewhere within the in the Start Zone on a randomly selected side of Starkiller Base. Initial placement will be specified by a member of the teaching staff, and Force Ambassadors will be placed in a location that allows them to spin in place without touching a border.
	Each Force Ambassador may optionally begin a Forced Decision pre-loaded with up to 7 Tokens. These Force Tokens represent the Gift Of The Force.
	A verbal start command will be issued by a member of the teaching staff, at which time teams will initiate the actions of their Force Ambassador. This is the last human interaction allowed with the Force Ambassadors, with the exception of Force Token loading.
	Force Ambassadors are to distribute their Tokens among the Force Balances with the objective of tilting as many seesaws in their favor as possible. When a Balance tilts toward the floor on one side of Starkiller Base, the Force Ambassador on that side leads the Balance of the Force there.
	The Forced Decisions last for 2 minutes. The Force Ambassador with the most Force Balance seesaws tilted in its favor (that is, tilted down on its side of Starkiller Base) wins the round. A winner may be called prior to the expiration of 2 minutes if a Force Ambassador is able to tilt all 5 Force Balances to its side.
	At any time, Force Ambassadors may contact the “May the Force be With You” Zone, which is the 16 in.-wide region in front of the Super PAC on their side of Starkiller Base. When a Force Ambassador contacts the “May the Force be With You” Zone, it must remain there nonchalantly while up to 12 Tokens are loaded into the Force Ambassador by a member of the Force Ambassador’s design team.
	The design team member loading the Force Ambassador with tokens may not interact with it in any way other than the loading of tokens. This includes, but is not limited to, pressing buttons, flipping switches, changing batteries, etc.
	During a Forced Decision, Force Ambassadors are required to stay within the boundaries of Starkiller Base.
	Tokens are the only objects permitted to be used to tilt the Force Balances.
	Each Token may be used only once during a Forced Decision. Recycling Tokens between Force Balances, for any reason, is not permitted.
	Force Ambassadors may not interact in any way with their opposition. Robotic tampering with the Force that surrounds us is a serious offense, and Force Ambassadors found to be cheating will be disqualified. Determination of cheating is at the sole discretion of the teaching staff.

Performance Requirements:

	For the purposes of grading, the minimum requirement for each Force Ambassador is to “Beat the Brick” (the standard inanimate ME210 check-off opponent). Specifically, each Force Ambassador must be able to tip at least 3 Force Balances to its side of the force within 2 minutes, when competing against – literally – a brick.
	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 results of the Forced Decisions at the public presentation will not affect grading – this is purely an opportunity for you to enjoy the devices you’ve created.
	The Star Wars: The Force Decides single-elimination tournament will be held in the Bldg. 550 Atrium on the evening of Sunday, March 6 to determine the fate of Kylo Ren’s soul and Han Solo’s torso. The public is invited to attend this event.

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 3 rd 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 expected 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.

For this project, excessively high-velocity Token discharge will be discouraged. The teaching staff reserves the right to require you to reduce the speed that your Force Ambassador delivers Tokens for the safety of the other Force Ambassadors, Starkiller Base, the Force Balance seesaws, 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 Starkiller Base are ± 1 in. 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, March 4. The public presentation will be on the evening of the following Monday, March 6. 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. Each machine will receive points based on the scoring scheme outlined above, and 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 Force Ambassador 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 to Coursework Drop Box in the form of a ZIP file.

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 2016-02-16 Turn in computer presentation (3-5 slides; Coursework Drop Box), with potential presentation in class	At least 5 design concepts, with sketches Time schedules, project plan Personnel assignments
Second Review 2016-02-19 Turn in documentation (Coursework Drop Box)	Calculations System block diagram Preliminary test results
Third Review 2016-02-24 Presented to coach Check-off by teaching staff	Demonstration of all functional subsystems per block diagram: Token delivery, beacon sensing, tape sensing, mobile platform, shooting platform, etc.
Fourth Review 2016-03-01 Check-off by teaching staff	Integration of subsystems Working software to test all systems Working versions of all systems
Grading Session On or before 16:00, 2016-03-04	Demonstrate minimum functionality on Starkiller Base set up in the lab or Atrium
Final Presentations Forced Decision: 2016-03-06 Bldg. 550 Atrium, 19:00	Finished, operational, presentable machines
Final Report On or before 23:59, 2016-03-11	HTML format Suitable for posting on ME210/SPDL website