MSD II Phase IV Project Progress Review Agenda

Date: April 16, 2015
Location: BAD lab

Overview of meeting	[2 min]	(8:00-8:02)
Action Items from phase 3	[8 min]	(8:02-8:10)
Completed test (Green)	[40 min]	(8:10-8:50)

- Circuit Board: Revision 2
- CAIR Capacity Test 2
- Lower Component Housing (LCH)
- Temperature added to the leg
- Pressure to the leg
- Nazareth Pedometer testing
- Distance Sensing

Tests in Progress (Yellow)	[20 min]	(8:50-9:10)

- Terrain sensing
- IRB
- UCH
- Strength Testing

Demo	[10 min]	(9:10-9:20)
Administration	[10 min]	(9:20-9:30)

- Risk List
- Problem Tracking
- Phase IV Vision
- Review Action Items

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rqmt. #	Importance	Source	Function	Engr. Requirement (metric)	Unit of Measure	Ideal Value	Marginal Value	Current Value	Direction of improvement	Comments/Status	Test (how are you going to verify satisfaction)	Owner	Test #
ER1	9	S1,CF1,CF2	Mechanical	Pressure to leg of AFO	mmHg	20	40	18	▼	0.39 and 0.77psi	pressure sensor	JG	(T1), T11
ER2	3	S1,CF4		Design failure factor of safety	FOS	1.3-1.8	1.3-4		X	Test whole muscle. Failure can be deflection	stress test	TL	(T1), T15, (T8)
ER3	2	S1,CF4		Average skin temperature increase from use	°F	1	3	1.42	▼	compared to other comprssion socks/rigid orthotic	thermocouple	JG	T11
ER4	9	FT1,FT3,ST5		Torque to lift foot by Mckibben air muscle	Ft-lbs	3.7	2.2	3.4	▲		mechanics test	NS	T1, T12, (T15)
ER5	3	FT2,FT3		Dorsiflexion mobility with Mckibben air muscle	degrees	50	30	15	▲	We may not meet this	Tracker software	GG	(T12), T11
ER6	3	P1		Number of muscle flexes untethered	#	1500	1000	2028	▲		tank life test	NS	T6, (T14), T15
ER7	9	S2,D2	Electrical	Battery in water repellant case	IP Code	54	54		X	5-solid object, 4-water	Ingress protection code (IP)	AP	T5
ER8	9	S1,S2,D2		Sensors water repellant	IP Code	54	54	54	X	5-solid object, 4-water	Ingress protection code (IP)	AP	T5
ER9	9	S1		Immediate max current	mA	200	400	94	▼	should be itterated	multimeter	ME	T2
ER10	3	P1		Time between charges	hours	8	6	7.3	▲	should be itterated	batteries used	ME	T2
ER11	3	ST3		Response time of Terrain Sensor	ms	100	200		▼		timer in microcontroller	ME	(T9), T10
ER12	9	ST1,ST2,ST4		Percentage of time object detected by sensors	percentage	90	80		▲		ruler	JG	T9
ER13	3	C3	Wearability	Average Time to put on AFO	min	3	5	2	▼		timer	GG	T3, (T11)
ER14	9	FT4		Weight of AFO on leg	lbs	1	2	0.62502	▼		scale	AP	T11
ER15	9	FT4		Weight of total AFO	lbs	8	13	6.6682	X	Still need bag and UCH	scale	AP	T11
ER16	9	CF1,CF5		Difference in knee flex	degrees	0	0	0	X	fabric bunching back of knee	protractor	AP	T11
ER17	1	CF1,CF6		Aesthetically pleasing	Better/Same/Worse	Better	Same		▲	Comapred to old project	survey	GG	T4
ER18	9	CF1,CF7		Total running noise	dB	<50	<80	85	X	Measured without UCH	db sensor	TL	T7
ER19	9	C1		Added foot width	inches	0.19685	0.295	0.12	▼		measure	GG	T11, (T13)
ER20	1	FT5		Audible Low Battery Alert	dB	70	50	53	X		db sensor	AP	T7
ER21	1	C4		Easy to interface system	1-5 scale	1	3	2.6	X	Done in Survey	survey	GG	T4

Key: Importance:(9=must have, 3=nice to have, 1=preference only) Color: (Green = Completed and Value Hit, Yellow = Started or Has a Problem, Red = Missed Value)

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Problem Tracking

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	Identifying & Selecting Problem PSP 1	Analyzing Problem PSP 2	Generating Potential Solutions PSP 3	Selecting & Planning Solution PSP 4	Implementing Solution PSP 5	Evaluating Solution PSP 6	Owner
Rating	R1	R2	R3	Y4	Y5	G6	
CRITICAL	Upper brace absorbes valuable strain during foot-lift	The root cause is that there is too much elasticity between the upper base and the upper strap.	Re-sew upper brace strap to support muscle. Sew inelastic material from top of brace to muscle base. Keep brace sewing, add belt loop for muscle support.	The chosen solution is to re-sew the base and add inelastic material from the top of brace to muscle base.	sewed inelastic material to the top of the brace	found no improvement from the change	Noah
		the upper base moves with the muscle	Apply brace over pants, increase strap friction (add sticky material), sew strap supports, sew top of strap tighter	Chose to apply brace over pant leg for simplicty	Tested with pant leg in phase 3 foot-lift tests 3, 4, & 5	Results indicated reduced muscle base deflection but no real ankle angle improvement except when strap is over lower brace	
				Design a longer muscle	Preform capacity testing, build muscle, and test muscle		
MAJOR	Tank leaks when cap screw is tightened, loose cap screw could lead to premature tank exhaustion.	Leak could be due to a lack of grease or something wrong with the internal parts. Regulator cap cannot be secured at a stable pressure without leaks.	Use thread tape to lock the regulator cap at 60psi with minimal leaks. Return to Performance Paintball and ask the experts.	Returned to Performance Paintball to see experts.			Noah
	Heelstrike does not always work with different shoes	the threshold for heelstrike is different for different shoe types	Set the threshold lower and see if the there is any noise that would cause it to trigger.				Megan
	Properly timing the articulation of the muscle.	We are currently using two presure sensors for stair identification, these could be used to identify location in the gait.	Adapting gait monitoring system to response on heelstrike and toe strike and not a precentage of the gait				Megan
ORDINARY	Full Day's Use	Air tank does not provide enough air to last for a full day's use	Reduce muscle size Purchase larger air tank	Selecting a larger tank that is composed of carbon fiber	Perform calculations that would verify that the larger tank would last for an entire day's use based on physical test with current tank		Noah
	PCB board cavity holes are printed with flaws	One of the 4 holes that seal the PCB board cavity on the lower component housing was not printed correctly and failed when the threaded insert was added to the assembly. This was due to the infill percentage of the 3D printer	The section of the component housing that the hole was located in was not a solid filled section. Plastic epoxy can be used to either fill the hole, fill the cavity, or epoxy the threaded insert into the part	The entire section that the hole was located in will be filled with plastic epoxy, creating a solid cavity. A new hole will then be drilled to be able to add the threaded insert.	Plastic epoxy will be purchased and inserted into the LCH using a syringe. After letting it settle twice and refilling to the top each time, a hole will be drilled so the threaded insert can be added.		Noah
ADDRESSED	Ribbion wire connections may fail if snagged	The ribbion wire attachment in the lower component hoousing (LCH) is not robust mechanically	Ensure that the air hose length is less than the ribbion wire length, use a quick connector inside the LCH, redesign the LCH to secure the wires via O-ring pressure	the chosen solution is to re-sew the base and add inelastic material from the top of brace to muscle base.	The LCH was redesigned to the wire connections to the PCB leave the housing at a downward angle, ensuring the will not become disconnected. Also, the wires leave the housing through channels that seal with the lid connection, applying pressure so the wires won't snag	LCH was assembled and it was determined there is enough pressure provided by the lid and the angle of the ribbon so if the connections were snogged they would not be pulled out and the electronics would not be damaged.	Tyler
	Correct terrain identification across users.	Consistancy is not seen aross user because the sensor is at a different location	This could be corrected during fitting by adjusting the threshold level in the code	Spoke with customer and terrain recording not adoptation is used	IR Sensor is poled and recorded every 30 ms	Code was tested on test subject and it was good	Megan
	Software Stops after extended time	the cause may be that the SD card is writing to a large file	A fix might be to restart to code or start a new file. But this is a fix but not the root of the problem	Restart the code to refresh the code	Changing the code to make the restart seamless.	Tested code on individual and software restart was not apparent	Geni
	Comfort of the AFO	Discomfort, near base of big toe bone, is felt by user when force is applied to lower part of AFO	Implement soft material as cusion Change the angle at which strap is attached at	Change the angle at which strap is attached at. Strap is currently sewn at 0 degrees of attachment point. Calculate an	Sewed strap at 45 degrees of attachment point.	Three of the six team members have worn the device and completed the comfrot survey. The average comfort rating was at 1 out of a 0-10 pain scale	Jared
	Placement of Lower Attachment Strap	Strap interferes with adjustment of Velcro strap and makes it more difficult for users to put on and take off	Replace fishing line attachment with a strap Adjust length and orientation of attachment strap	Our plan is to implement an A-shaped strap that allow users to apply the AFO easier.	An A-shaped strap fixture has been implemented in lui of the fishing line attachment method.	The strap works well with the current system. Need to test with other users	Adam
	Power Source	Source runs low too early or not enough current is drawn	look at the current consumption of the battery	looking at the idle and active states of the system use	calculate the battery use based off the current draw	the battery used looks to be enough. This should be retested at the end of the system.	Noah

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	Weight of the AFO	Systems have not been optomized for weight saving, especially power.	Optomizing sub systems like power to achieve oue engineering requirements and reduce weight.	All items were weighed. We will meet our requirement for weight on the leg but it will be close for the ideal total weight, we will definitley meet the marginal total weight.	When selecting a back pack and UCH we will have to be concious about the weight. We currently have 1.3 pounds until we exceed the ideal value	When the orthotic is put together enitrely it will be weighed again.	Megan
	Muscle strain will not provide required displacement	The root cause is that the required strain may be more than our optimized tank and muscle can deliver. Our AFO may also be a source of more strain than expected.	Perform additional testing to determine actual strain requirments. Brainstormed ideas inclue using a wider muscle, different sleeving, pulleys.	Our plan is to perform strain testing in MSD II phase I & II to find true strain requirments. We also plan to develop a Working Model kinematic simulation. If necessary we will build a wider muscle as advised by our customer.	A slow motion deflection video was made to find the required strain during the gait cycle Working model simulation was started. Preliminary integrated testing was performed to determine other sources of strain.	Slow motion deflection video found the required strain to be approx. 1 inch. Working model has the capacity to make similar calculations but has a steep learning curve. Preliminary integrated testing resulted in foot lift, but upper brace strain was noticed.	Adam
	SD Card Functionality	The specific problem that would cause the SD card to not work is not yet known. Conectivity, levels, cold joints, and the program has been tested. Timing and SD card formating still remain to be tested.	By an externally fabricated SD card breakout board. Conect this to the current board.	Look at the SD card under the Xray	Found a body of solder that would for a short when pressure is applied.	The SD card is working without problem. Some improvement on the board layout were identified and will be implimented.	Tyler
	Muscle hold state will be inadequate to provide passive support	Muscle experiences small leaks	Redesign passive support method Implement Loctite	Further testing was completed and a regulator was discovred to be the source of leaking.	The regulator will not be in the final design and was removed. Once removed there was no noticable leaking.	Once removed there was no noticable leaking. The pressure could not be monitored with a regulator but the muscle was placed along side a ruler and there was no noticable loss of compresssion	Adam
	The lower PCB board is not properly sealed off from the environment	The lower PCB board component housing cavity, which contains the PCB, is not propoerly sealed off from the enviroment at all connection locations, which may impact the ingress protection requirement	Ensure O-Rings present wherever possible, ensure lids fit as closely as possible, use heat shrink on all wire connections	Our plan is to redesign the LCH in such a way that all connection locations and possible locations that debris could impact the board will be sealed off, in conjuction with the ribbon wire redesign	The LCH was redesigned with a additional second lid to cover the cavity that holds the IR sensor. Both the IR sensor and PCB lids have O-Rings present. The channels with the wires leaving the housing will be sealed off from the O-Ring	A waterproof test was performed to test our lower component housing to see if it agrees with our ingress protection code. Test results showed that both cavities are fully sealed off from the environment and the LCH meets our ingress protection requirements	Tyler

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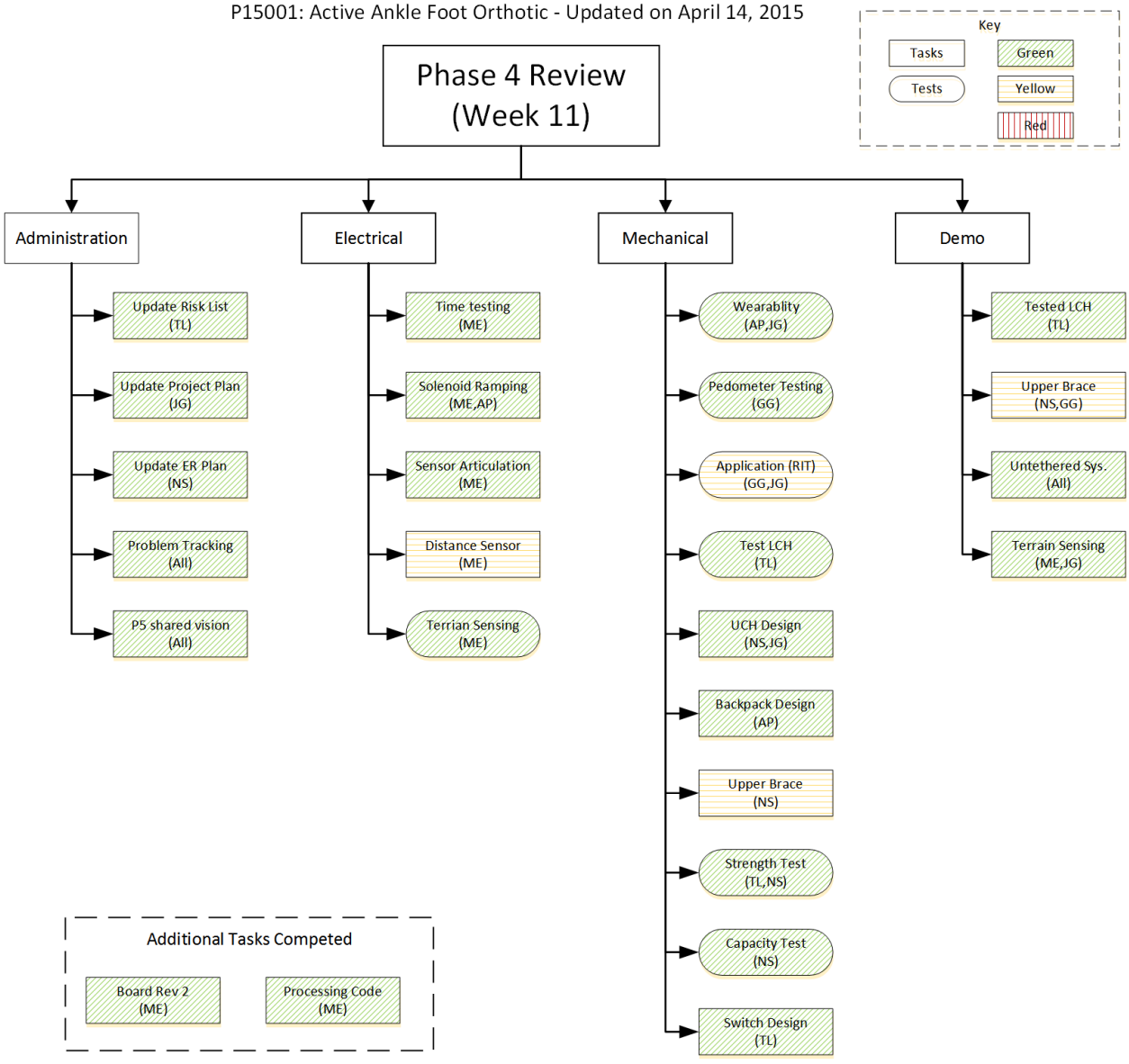

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