KGCOE MSD I Subsystem Review Agenda

Meeting Purpose:

To review the progress that the P15001 team has made to demonstrate their Critical Subsystem Feasibility

Materials to be Reviewed:

Updates to Phase 1 Documentation:
Engineering Requirements, Use Scenario

Updates to Phase 2 Documentation:
Feasibility Testing Reports, Risk Table, PostPrototype Test Plan, System Concept, System Architecture

Phase 3 Shared Vision
Phase 3 Prioritized Tasks
Phase 3 Testing

End State Deliverables

Meeting Date:

October 23, 2014

Meeting Location:

Senior Design Center

Meeting time:

12:00 (noon) – 1:00pm

Agenda

Summary Overview (10 minutes)

- Updates to Phase 1 Documentation (see summary table)
- Updates to Phase 2 Documentation (see summary table)
- Deliverable Completion Plan
    - Discuss current status and next phases
- Explore Shared Vision for this phase
    - Discuss how each of these system relate to our testing

Key Technical Prioritized Tasks (40 minutes)

- Initial BOM
- Schematic
- Pseudocode
- Solenoid Control
- Force Sensor Prototype
- Step Detection
- Input Filtering
- Low Battery Alert
- Power Down Mode
- Muscle Optimization- stage 1
- Lower Foot Attachment
- Upper Foot Attachment
- Muscle Deflection
- Tank Regulation & Capacity
- Pressure Alert Research
- Risk Table

Week 12 Project Plan (10 minutes)

- Reviewed Shared Vision
- Review Task List

Summary Tables

P15001: Active Ankle Foot Orthotic - Updated on October 21, 2014

Changes to Phase 1 Documentation		
	Needed Change	**Actions taken**
Engineering Requirements	Change “FOS” instead of multiplier	Updated document
	Use a constant system of units	Changed to English Unit system
	Change the temperature to heat	Updated document
Use Scenario	Change the Use Scenario to Switch before sitting down	Updated document
	Create Use Scenario for low battery and low air	Create new part and updated to Edge

Changes to Phase 2 Documentation		
	Needed Change	**Actions taken**
Changes to Feasibility Testing	Look at the battery power per weight	Added to table and report
	Look at the flow rate in an out of the muscle	Created more defined testing for this an next phase
	Create Weight Budget	weight budget for AFO and backpack
	Refine foot-lift model	Incorporated and tested during this phase
	Look into Flow Alert	Found air pressure sensor, will order one to test
Risks	Consider more technical risks	Updated document
	Added more causes of risks	Updated document
PostPrototype Test Plan	Add corrosion test to long term plan	Added and created new MSD II testing plan
Things to Consider	Consider not using quick connect	Found some issues with quick connects during testing
	Consider Permanent Elastic in front	Will be part of next phase testing
System Concept	muscle attachment	Gained a better understanding of connection point
	using the muscle to attach to foot	Looking into area between muscle and foot
	Look into the sensors to be used	Confirmed sensors to be used
	looking the placement of the distance sensors to see terrain	picked the location of the distance sensor
System Architecture	Refine how the electronics are connected together	Created Schematic

Summary Tables

Deliverable Completion Plan					
	Week 7	Week 9	Week 12	Week 15 (End of MSDI)	What made us choose week 9 percentage?
CAD	0%	10%	60%	100%	As of today, team has not stared CAD modeling and does not feel it is critical for phase 3
BOM	10%	60%	80%	100%	The following items have already been choosen: 1.) pressure sensor 2.) distance sensor 3.) micro-controller
Schematics	20%	50%	80%	100%	We already have a schematic for the distance sensor
Software Code	20%	40%	60%	70%	We already have the code for the distance sensor
Build/Assy/ Debug Plan	0%	30%	60%	100%	For this, really need to focus on the safety and how we are going to handle safety issues that could go wrong.
Test Plan	10%	20%	40%	100%	This needs to done while we move forward on the testing. How are we proving functionality now and should we do that again later. We have an outline right now
Risk List	40%	60%	80%	100%	We have a really good start on this. We will find more risks as we move forward with the project
Project Plan	0%	10%	40%	100%	We do not have much of a start on this. This will be defined more as we move forward with testing.
Enter ASME Contest	0%	0%	0%	20%	We will not be required to enter the contest until the Spring Semester. The 20% completion indicated in week 15 shows that we will have done our research about how and what we want to submit

Phase 3 Shared Vision

Our vision for this phase is to demonstrate Critical Subsystems feasibility. Our current critical subsystems are defined as:

1. Distance and heel strike sensor
2. Electrical control of air muscles
3. Secure foot – Lower
4. Secure foot – Upper (Air muscle attachment)
5. Air muscle lift / operating pressure
6. Air Tank for a full day

Key related technical questions include:

1. What is the best location to place the sensors? Can we control the distance of object detection? Is the new pressure sensor an improvement from the foam used on past projects?
2. Can we control the air using electrical components? Can we do that using just an Arduino? Will we need level shifters?
3. How and where to apply torque? What possible materials to use? Does the brace remain comfortable when a force is applied?
4. How and where to attach muscle? How much force can it support? Is it safe?
5. How much force can we produce? What is the operating pressure range?
6. How much air do we actually need? Can we meet the operating pressure?

Some additional plans for this phase for our group are as follows:

- Review of functional decomposition and system architecture by adding up key subsystems to critical system requirements (verify flow-down to subsystems).
- Create subsystems' functional decomposition. Show feasibility for these subsystems.
- Update postprototype test plan, make sure that requirements can be tested.
- Update and iterate the Risk table
- Update Actions items from last review

Summary Tables

P15001: Active Ankle Foot Orthotic - Updated on October 22, 2014

Importance	Tasks	Next Steps	Action Owner(s)	Due Date: Stage 1	Why are we doing this?	Expected Outcomes	What will be completed in weeks 9-12 (stage 2)?
1	Initial BOM	1.) Follow up with each task action owner 2.) create a BOM with finanical information	Geni	October 15th	To create a project BOM	To have all AFO components listed on the BOM but do not include specific component specifications yet	Continue to add to the BOM, specifically focusing on adding specs to each component. Our goal is to have the BOM completed by
2	Muscle Optimization- stage 1	1.) Tyler to follow up with Dr. Lamkin Kennard 2.) Create test plan	Tyler/Noah	October 15th	To be able to create appropriate McKibben air muscles. This will feed into our CAD drawing	At least one original muscle will be made and tested for force & deflection. Benchmarking of previous air muscles will be done to prepare for	Stage II, optimize the design based on iteriative results from benchmarking and all other tests
3	Lower Foot Attachment	1.) Obtain ankle/foot brace 2.) Create test plan 3.) Perform test	Geni	October 17th	To determine where we will attach our McKibben muscles on the AFO foot base	To obtain a quantitative analysis of muscle attachment and a qualitative analysis of comfort	Complete test again after final muscle design is completed
4	Upper Foot Attachment	1.) Perform test	Tyler	October 15th	To determine where we will attach our McKibben muscles	Determine the type of attachment that will be needed to secure the orthotic to the lower leg to counteract the reaction force from the McKibbon	Complete test again after final muscle design is completed
5	Solenoid Control	1.) Get a solenoid 2.) Run it from Arduino	Adam	October 15th	Will be POC and also inform out BOM	Obtain a solenoid value and test it with a muscle in the lab.	Connect the solenoid to the Arduino and order project specific solenoid.
6	Force Sensor Prototype	1.) Find Force Sensor 2.) Run From Arduino 3.) Order Better part	Megan	October 15th	Will be POC and also inform out BOM	Have a working Prototype for the pressure sensor. Have a class function for the code	Make final selection on resistor size and sensor type
B: Good Work Level							
7	Tank Regulation & Capacity	1.) Go to paintball shop	Noah	October 15th	To determine the maximum tank capacity	Confirm basic functionality of the tank, identify operating pressure, tank life, gain knoweledge from experts	Test tank life and simultaineously measure force and displacement if
8	Pressure Alert Research	1.) Research If it is possible	Megan	October 15th	Will test feasablity	Decide feasibliy of cost and implimentation Order a part if we are moving forward	Develop working prototype
9	Step Detection	1.) Detect Object 2.) Create test Plan	Jarad	October 15th	Will be POC and also inform out BOM	Decide on sensor position for detecting terrain straight ahead	Develop working prototype
10	Input Filtering	1.) Find the best way to look at the information from sensors	Megan/Jared	October 15th	Will inform our coding diagrams	Look into filtering for hardware and software See noticable improvement	decide finial method of filtering
A: Outstanding Work Level							
11	Low Battery Alert	1.) Alert when low battery 2.) Research/ order audio part	Megan/Jared	October 15th	Will be POC and also inform out BOM	Have at least one working Prototype.	Decide on final method of monitoring
12	Power Down Mode	1.) Set values in EEPROM 2.) Set default state of	Megan	October 15th	Will inform our coding diagrams	Have working EEPROM read/write and class	Default state of solenoid
13	Muscle Deflection Testing	1) Complete test plan 2) Perform test	Tyler	October 21st	To determine how much our McKibbon muscle must deflect to raise the foot	Find how much the muscle must deflect	These results will pair with force results to feed into muscle design

Phase 4 Shared Vision

Our vision for this phase is to finalize critical subsystems and test non-critical subsystems. Our current subsystems are defined as:

1. Distance and heel strike sensor
2. Electrical control of air muscles
3. Secure foot – Lower
4. Secure foot – Upper (air muscle attachment)
5. Lower and Upper base attachment
6. Air muscle lift / operating pressure
7. Air Tank for a full day
8. Low battery alert
9. Air tank sensor
10. Air tank tubing

Key related technical questions include:

1. Distance and heel strike sensor
   a.) How do we integrate distance and heel strike sensing?
   b.) How do we receive real time response based on heal strike and distance?

2. Electrical control of air muscles
   a.) How to control the solenoid from the Arduino?
   b.) How to supply different voltage levels?
   c.) Specify the right solenoid

3. Secure foot – Lower
   a.) How to apply torque?
   b.) What possible materials to use?
   c.) Does the brace remain comfortable when force is applied?

4. Secure foot – Upper
   a.) How will the muscle be attached to the brace?
   b.) Does the brace remain comfortable when force is applied?
   c.) Are additional components needed for support?

5. Lower and Upper base attachment
   a.) What possible materials to use? permanent elastic?
   b.) Is it abrasion safe?
   c.) Is it user friendly?
6. Air muscle lift / operating pressure
   a.) What are the muscle dimensions?

7. Air Tank for a full day
   a.) How much air does the muscle need?
   b.) Do we need a bigger tank?

8. Low battery alert
   a.) Is a hardware approach better than a software approach?
   b.) Is an audio alert or visual alert better?

9. Air tank sensor
   a.) Is using an air tank sensor feasible?
   b.) Can it be connected to Arduino?

10. Air tank tubing
    a.) How will it feed to the air tank?
    b.) What is an appropriate dimension range?

Some additional plans for this phase for our group are as follows:

- Identify vendors and review budget
- Develop an assembly build and test plan
- Review MSDII plan
- Review Risks
- Update post prototype test plan; make sure that requirements can be tested.
- Update and iterate the Risk Table
- Update action items from last review
- Review and update project timeline

Summary Tables

P15001: Active Ankle Foot Orthotic - Updated on October 22, 2014

Importance	Tasks	Next Steps	Action Owner(s)	Why are we doing this?	Expected Outcomes	What will be completed in weeks 12-15?
1	Update BOM	1.) Communicate with team members about components that have 'TBD' listed on BOM and make any necessary updates 2.) Populate BOM with specifications	Geni	To maintain BOM and have a better understanding of the materials we have and materials that we need to purchase	Updated BOM with component specifications. BOM will be atleast 80% complete by the end of this phase.	Continue to add to the BOM, specifically focusing on adding specs to each component. Our goal is to have the BOM completed by
2	Muscle Optimization- stage 2	1.) Identify needs from other tests 2.) Design optimized muscle 3.) Construct and test stage II muscle	Tyler/Noah	To be able to create optimal McKibben air muscles and reduce risks.	Muscle dimensions will be clarified, muscle BOM will be near completion, tank size will be determined, requirments for stage 3 iteration will be identified	Stage II, optimize the design based on iteriative results from benchmarking and all other tests
3	Lower Foot Attachment- stage 2	1.) Create test plan 2.) Conduct test 3.) Create test report	Geni	To determine how we will attach our McKibben muscles on the AFO ankle/foot base	1.) Obtain force values 2.) Gain a better understanding of the most ideal and practical way to attach McKibben muscles (e.g. number of attachment points, material of muscle tether, etc)	TBD
4	Upper Foot Attachment- stage 2	1) Iterate test once final muscle design is chosen 2) Begin to consider comfort of additional strap at top of brace (if needed)	Tyler	To determine how we will attach our McKibben muscles	1) Determine if velcro straps will be sufficient 2) Determine if non-elastic strap at top of brace will be needed to prevent slippage during use	Complete test again after final muscle design is completed
5	Solenoid Control	1.) Look into hold or Locked state 2.) Call SMC to discuss project specific solenoid 3.) Order solenoid	Adam	To control air going into the muscle using the Arduino	1.) A project specific solenoid will be chosen and orderd.	Connect the solenoid to the Arduino, make test rig for air muscle with solenoid in lab, design hold state and order project specific solenoid.
6	Heel Strike and Distance Sensing	1.) Connect heelstrke to working system 2.) Create class for Distance 3.) Record heelstrike on SD card	Megan/Jared	To have a working tterrain sensing system and accurately record gait timing	Make final selection on resistor size and sensor type Determine Terrain at time of heelstrke	Tell the system how to react when a terrain is sensed
B: Good Work Level						
7	Lower and Upper Base Attachment	1.) Identify potential attachment materials and methods	Geni/Tyler	To understand where and how the lower and the upper base will be connect	Potential materials and methods to connect lower and upper base have been determined	TBD
8	Pressure Alert Prototype	1.) order part 2.) read pressure from tank	Megan	To demostrate proof of concept of air pressure monitoring	Working prototpe	determination of if this will fit in the system
9	Decision on Input Filtering	1.) Do trials with different software filtering 2.) Do trials with different hardware filtering	Jared	To inform our schematic and coding procedures	decide finial method of filtering	Use this in final schematic and code
A: Outstanding Work Level						
10	Low Battery Alert- stage 2	1.) Get audio alert working 2.) Side by side comparison of response time.	Megan/Jared	Need to test higher voltage batteries	Test system functionality and the feasiblity of added an audio alert	Decide on final method of monitoring
11	High Limit Force Sensing Prototype	1.) order part 2.) see working prototype	Megan	Need to confirm that high limit force sensor works	Confirm expected behavior	Make final decision on sensor type