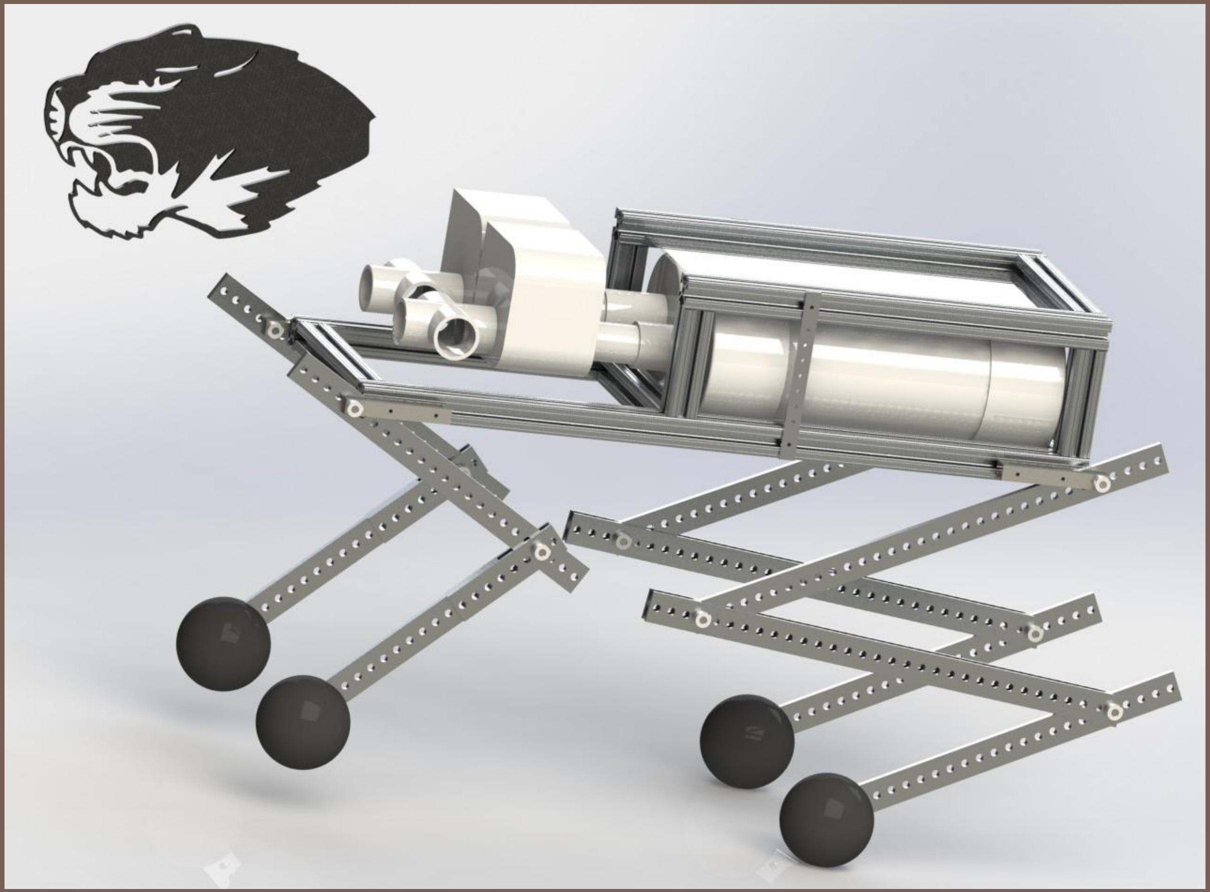


PROJECT REVIEW

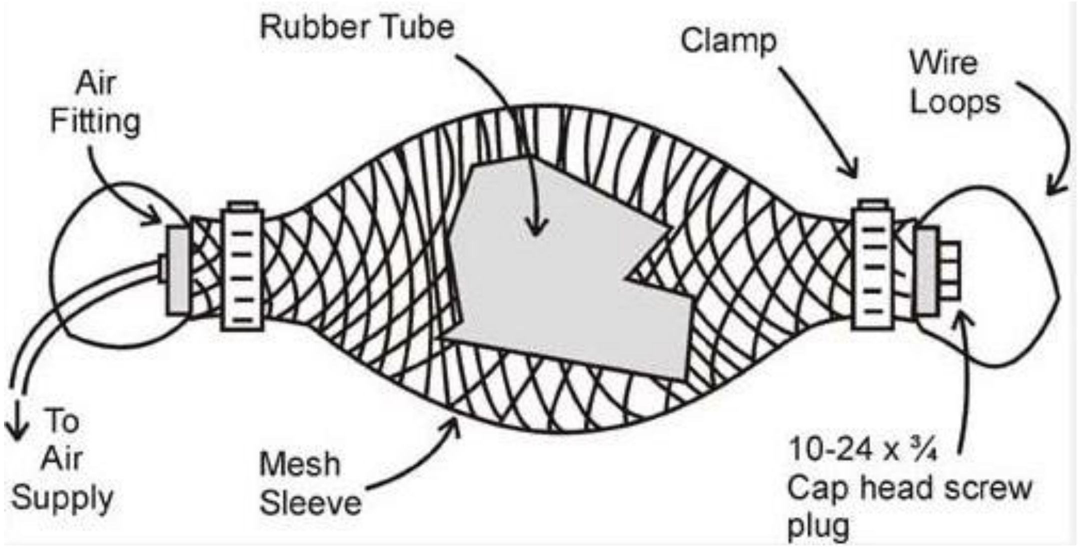
Robot Tiger

Agenda

- Project Recap
  - Customer Needs
  - Specs
  - Proposed Design
- Schedule
- Test Plan

Air Muscles

- Rubber tube inside of a braided mesh sleeve
- Pressurized tube inflates causing the mesh to contract in length
- Closely mimics biological muscles



Customer Needs

Customer Need	Importance (1 = high)	Description
CN1	1	Can jump forward a distance equal to at least the length of its body (only 1 jump required per tank fill)
CN2	1	Use air muscles to provide jumping force
CN3	1	Lands safely without damage
CN4	2	Is ready to jump again after landing, without user adjustment of robot body or legs
CN5	2	Self-contained (on board power sources)
CN6	2	Portable (small enough for one person to carry)
CN7	2	Reasonable battery life; battery charging takes hours
CN8	3	Resemble a tiger
CN9	3	Controls do not yield a noticeable delay

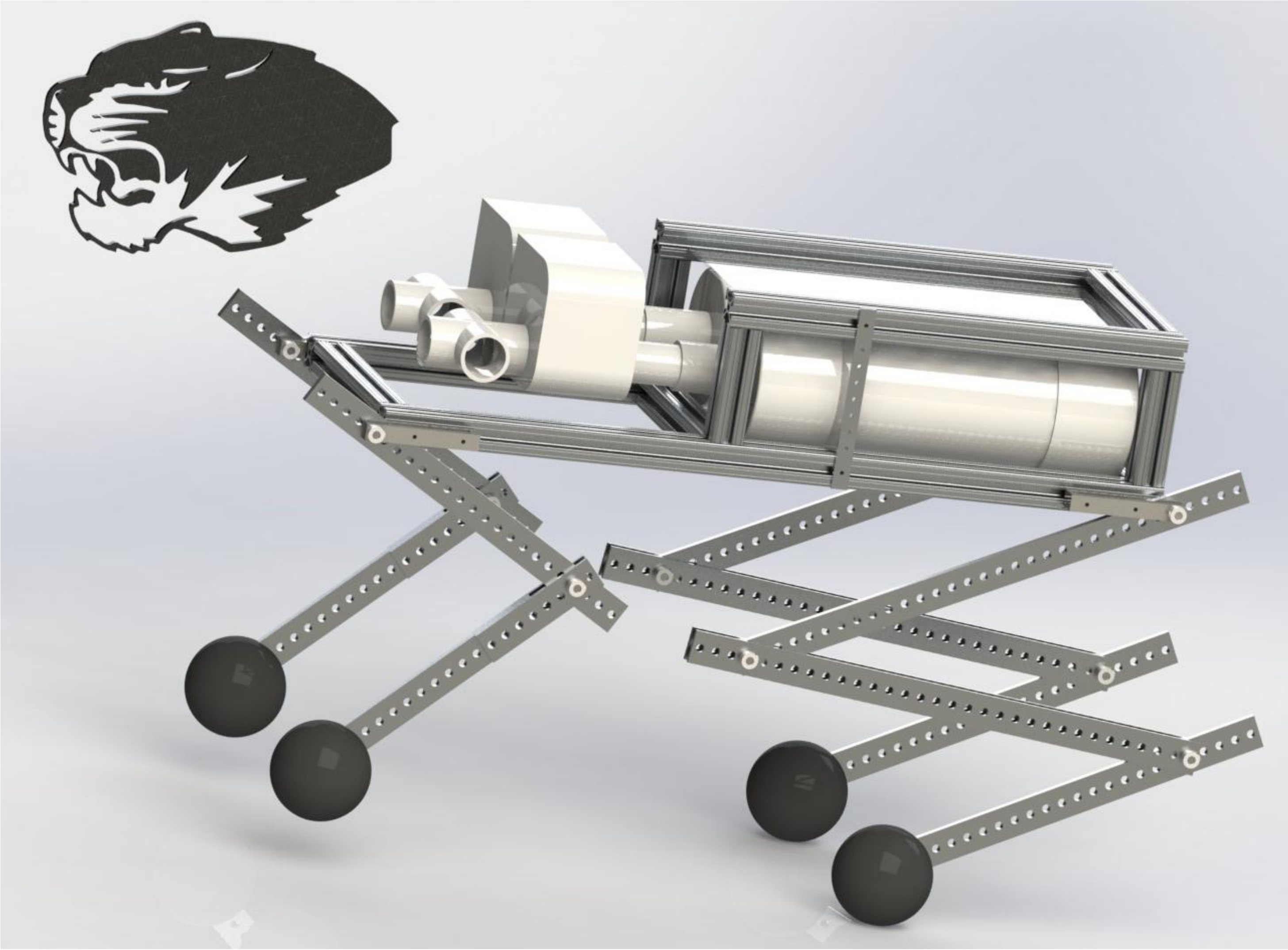
Specifications

Spec	Source	Metric	Unit of Measure	Marginal Value	Ideal Value	Preferred Direction
S1	CN1	Horizontal Jump Distance	Feet	1*body length	1.5*body length	Up
S2	CN1,2	Uses Air Muscles	Binary		Yes	
S3	CN3	Sliding Distance After Landing	Inches	3	2	Down
S4	CN4,5	Self-Contained	Binary		Yes	
S5	CN3,6	Overall Weight	Lbs	50	25	Down
S6	CN3,5,6	Overall Length	Feet	4	2	Down
S7	CN3,5,6	Overall Height	Feet	2	1	Down
S8	CN3,5,6	Overall Width	Feet	1		Down
S9	CN8	Resemble a Tiger	Percent	80	100	Up
S10	CN2	Muscle Air Pressure	psi	60	60	Down
S12	CN9	Total Response Time to Jump Command	s	0.3	0.15	Down
S13	CN2,9	Solenoid Response Time	ms	50	25	Down
S14	CN2,9	Muscle Fill Time	s	.5	.25	Down
S15	CN2,7	Battery Life	# of Jumps	1	100	Up
S16	CN2,8	Two Actuated Legs	Binary		Yes	
S17	CN4,5	Tank can be filled in less than 5 minutes	Binary		Yes	Down

Proposed Design

- Completely self contained robotic tiger
  - On board air supply, power supply, controls, & muscles
- Utilizes McKibben Air Muscles to create jumping motion
- Patterned attachment holes in legs to allow for air muscle testing and adjustability
- Air release controlled using an Arduino Board and sprinkler valves
- Rechargeable power & refillable (Aluminum?) pressure chamber

Overall Design of Robotic Tiger



Schedule

MSD2	Week 1							Week 2							Week 3							Week 4							Week 5							Week 6							Week 7							Week 8							Week 9							Week 10						
	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S	Su	M	T	W	R	F	S
Orifice Size Testing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																																																	
Wall Thickness Testing								X	X	X	X	X	X	X																																																								
Decision on Prototype Muscle																X	X	X	X	X	X																																																	
Test Spring Return and Landing								X	X	X	X	X	X	X	X	X	X	X	X	X	X																																																	
Finish Simulations	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																																																	
Incorporate Test Data								X	X	X	X	X	X	X	X	X	X	X	X	X	X																																																	
Final Evaluation															X	X	X	X	X	X	X																																																	
Order Parts for Prototype	X	X	X	X	X	X	X																																																															
Machine Parts								X	X	X	X	X	X	X																																																								
Assemble Prototype								X	X	X	X	X	X	X	X	X	X	X	X	X	X																																																	
Theoretical Based Testing																						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																					
Purely Experimental Testing																						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																					
Final Adjustments																																																		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Basic Program for Testing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																																										
Program for Final Product																																				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
Precise Solenoid Timing																																				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
Poster																																																									X	X	X	X	X	X	X	X	X	X	X	X	X	X
Technical Paper																																																									X	X	X	X	X	X	X	X	X	X	X	X	X	X
Imagine RIT																																																															X							
Final Presentation																																																																						X

Schedule

ID #	Tasks	Days	Start	Finish	Start Week	Finish Week	Assignments
1	**Muslce Testing and Development**	**20**	**4-Mar-2013**	**24-Mar-2013**	**1**	**3**	
1.1	Orifice Size Testing	7	4-Mar-2013	10-Mar-2013	1	1	Andrew Pace
1.2	Wall Thickness Testing	7	11-Mar-2013	17-Mar-2013	2	2	Andrew Pace
1.3	Decision on Prototype Muscle	7	18-Mar-2013	24-Mar-2013	3	3	Group
1.4	Testing Spring Return/Landing	7	11-Mar-2013	24-Mar-2013	2	3	
2	**Theoretical Analysis (MatLab)**	**20**	**4-Mar-2013**	**24-Mar-2013**	**1**	**3**	
2.1	Finish Simulations	14	4-Mar-2013	24-Mar-2013	1	3	Jeff Manicone, Sean Mosier
2.2	Incorporate Test Data	14	11-Mar-2013	24-Mar-2013	2	3	Jeff Manicone, Sean Mosier, Andrew Pace, Trevor Crandell
2.3	Final Evaluation	7	18-Mar-2013	24-Mar-2013	3	3	Group
3	**Prototype Build**	**20**	**4-Mar-2013**	**24-Mar-2013**	**1**	**3**	
3.1	Order Parts for Prototype	7	4-Mar-2013	10-Mar-2013	1	1	Trevor Crandell, Andrew Pace
3.2	Machine Parts	7	11-Mar-2013	17-Mar-2013	2	2	Trevor Crandell, Andrew Pace
3.3	Assemble Prototype	7	11-Mar-2013	24-Mar-2013	2	3	Trevor Crandell, Andrew Pace
4	**Prototype Testing**	**48**	**25-Mar-2013**	**12-May-2013**	**4**	**10**	
4.1	Theoretical Based Testing	21	25-Mar-2013	21-Apr-2013	4	7	Group
4.2	Purely Experimental Testing	21	25-Mar-2013	21-Apr-2013	4	7	Group
4.3	Final Adjustments	14	22-Apr-2013	12-May-2013	8	10	Group
5	**Arduino Testing**	**69**	**4-Mar-2013**	**12-May-2013**	**1**	**10**	
5.1	Basic Program for Testing	28	4-Mar-2013	31-Mar-2013	1	4	Phil Brown
5.2	Program for Final Product	21	8-Apr-2013	5-May-2013	6	9	Phil Brown
5.3	Precise Solenoid Timing	21	8-Apr-2013	5-May-2013	6	9	Group

Test Plan

- 1. Muscle Testing and Development
  - 1.1 Orifice Size Testing
  - 1.2 Wall Thickness Testing
  - 1.3 Decision on Prototype Muscle
  - 1.4 Spring Return and Landing
- 2. Theoretical Analysis
  - 2.1 Finish Simulations
  - 2.2 Incorporate Test Data
  - 2.3 Final Evaluation

Test Plan

- 3. Prototype Build
  - 3.1 Order Parts for Prototype
  - 3.2 Machine Parts
  - 3.3 Assemble Prototype
- 4. Prototype Testing
  - 4.1 Theoretical Based Testing
  - 4.2 Purely Experimental Testing
  - 4.3 Final Adjustments

Test Plan

- 5. Arduino Testing
  - 5.1 Basic Program for Testing
  - 5.2 Program Final Product
  - 5.3 Precise Solenoid Timing

Risk Assessment

Risk	Effect	Cause	Chance of Occurring	Severity	Importance	Action to Mitigate	Owner
Inadequate Muscle Motion (Force, Impulse)	Lack of or sub-par jumping ability.	Limited time for muscle material data collection.	4	5	20	Rescope project to reduce weight (tether).	Andrew
Muscles cannot overcome the weight of the pressure vessle	Lack of or sub-par jumping ability.	Customer desires untethered robot with $400 budget.	4	5	20	Rescope project to allow tether or increase budget to purchase a strong lightweight tank.	Phil
Matlab simulation does not yield results	Wasted time, unable to quickly predict system response.	Not enough time, modeling discrepancies .	4	4	16	Rely on trial and error testing of prototype.	Jeff, Sean
Inadequate Muscle Displacement	Lack of or sub-par jumping ability.	Limited time for muscle material data collection.	3	5	15	Rescope project to reduce weight (tether).	Andrew
Inadequate Air Flow	Lack of or sub-par jumping ability.	Bottle-knecking at fittings.	3	5	15	Keep all fitting/hose diameters >=muscle inner diameter.	Phil
Dynamics Design	Proper jump motion is not achieved.	Poor leg design	3	5	15	Check with Matlab simulation to confirm link lengths and initial angles.	Jeff, Sean
Long Lead Time	Unable to complete robot construction due to lack of certain ordered parts.	Natural for some unique parts. Poor group planning	2	4	8	Make sure to plan on ordering specialized parts promptly. Include shipping times in planning.	Group
Mismanaged Budget	Could result in changes in development.	Poor group planning and limited funds.	2	4	8	Discuss and track all purchases as a group.	Jeff
Mismanagement of Time	Unable to complete some aspects of project.	Poor group planning. Lack of time management.	2	4	8	Plan out all aspects of development and testing properly for allotted time.	Jeff

Risk Assessment

Risk	Effect	Cause	Chance of Occurring	Severity	Importance	Action to Mitigate	Owner
Air Muscle Performance Failure	Muscle tears or expands in an unexpected manner leading to poor dynamics and function	Poor construction protocol. Non-uniform construction quality of muscles.	2	4	8	Take great care when constructing each air muscle. Test to determine wall thickness.	Andrew
Electrical Communication Failure	Failure of all solenoids to release air to muscles.	Extreme movement of this robot could loosen wires. Landing may also cause strong enough impulses to disconnect electrical circuits.	4	2	8	Make sure electrical connections are secure.	Phil
Poor Documentation	Dissatisfied customer. Follow up projects would be hindered	Poor documentation throughout design and testing process.	2	3	6	Continually update website and svn folder.	Group
On Board Power Supply	Failure of electronics to operate.	Not enough power supplied from on board.	2	3	6	Test power supply with sprinker valves.	Phil
Dimension Related Muscle Interference	Muscles cannot expand fully causing less than full utilization of muscle potential	Poor layout planning. Inadequate attention paid to design around muscles.	2	3	6	Trail and error with prototype to account for muscle fill related size changes.	Trevor
Malfunction of Air Muscle Cables	Binding or stretching of cables. Improper transmission of muscle force.	Improper cable material selection. Poor design/placement of cable paths.	2	2	4	Carefully design cable pathways and be aware of binding possibility during testing.	Trevor
Material Failure	Material yielding leading to failed operation.	Poor material selection/design.	2	2	4	Consider landing stresses. Implement shock absoring landing equipment.	Andrew
Over Weight Robot (excluding tank)	Unable to use current muslces to lift off the ground.	Various heavy parts on the robot including it's frame.	2	2	4	Machine excess material off of all parts.	Trevor
Group Dysfunction	Divergent design ideas.	Poor communication and decision protocol.	1	2	2	Build a decisions making system.	Group