Final Design

RASC-AL RoboOps Competition

Team 11: SpaceHex

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Competition Guidelines Summary

- 45 kg weight limit
- Max. stowed dimensions: 1m x 1m x 0.5m
- Sample acquisition system performance
- On-board video feed for navigation and control
- Communications between rover and operator(s) over commercial wireless broadband network
- Proposal due December 9, 2012
  - Drafted and distributed for review

Design Solutions from Guidelines

- Use of lightweight materials
- Rover scaled using XRL dimensions
- Minimize SEM mobility
- Implement IP cameras for site surveying and precise sample acquisition
- Utilize 3G/4G router to network on-board systems

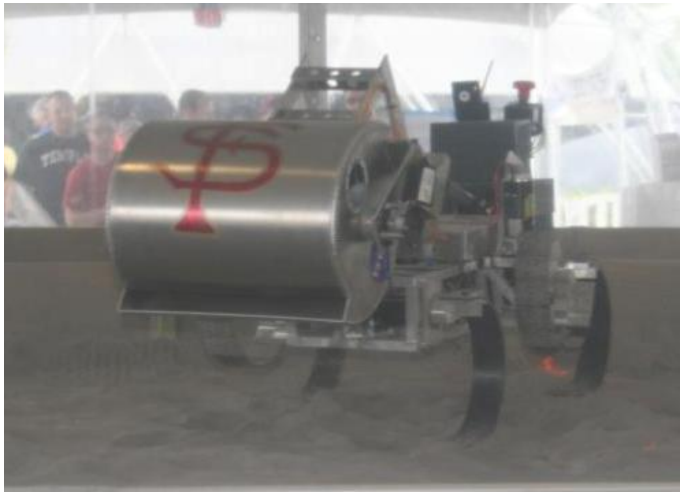
Spring Semester Planning

If Selected:

- Rover Development
- 6 Deliverables required for competition
- Required web and physical E/PO

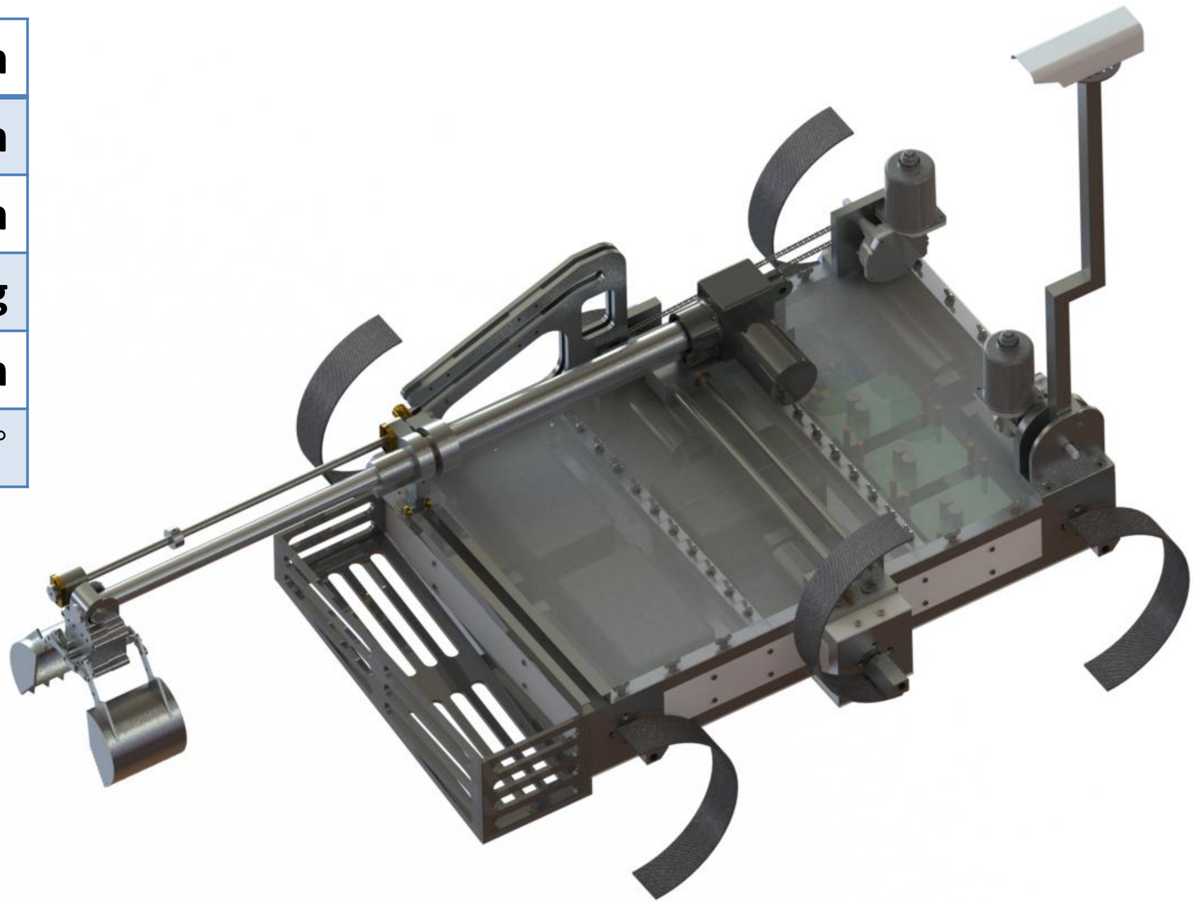
Contingency Plan:

- Hexcavator



CAD Model

Stowed Length	86.9 cm
Stowed Width	70.8 cm
Stowed Height	46 cm
Weight	40 kg
Ground Clearance	15 cm
Tipping Angle	43.2°



Motor Selection

	Continuous Torque	Stall Torque	Nominal Rotational Speed
XRL	2.3 Nm	30.52 Nm	187 rpm
Desired	17.1 Nm	226.74 Nm	120 rpm
Selected	17.4 Nm	383.56 Nm	132 rpm

Mass	
XRL (m_1)	10kg
Competition Max (m_2)	45kg

Dynamic Scaling:

$$\tau_2 = \tau_1 \left(\frac{m_2}{m_1} \right)^{4/3}$$

Motor Selection

maxon motor

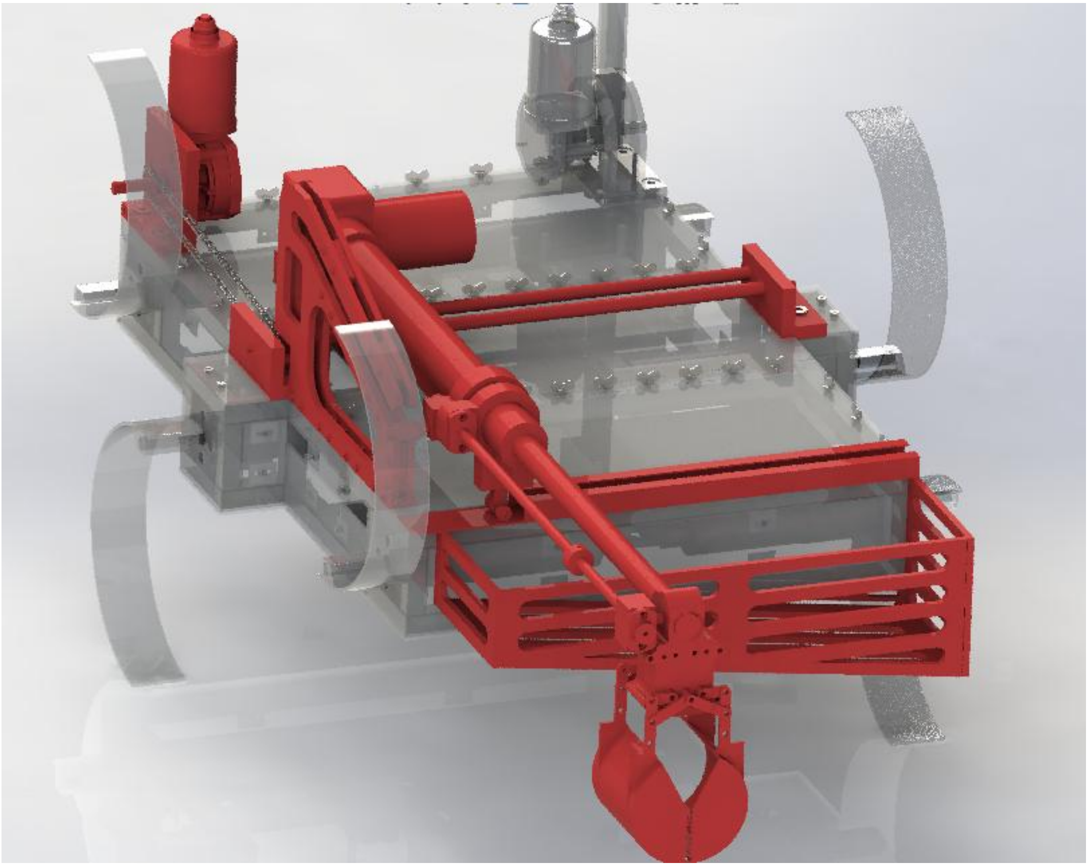
driven by precision

- RE50 Motor
- GP 52 Gearbox
- HEDL 5540 Encoder

Supply Voltage	24 V
Power	200 W
Weight	1.9Kg
Encoder Counts/Revolution	108,500
Overall Length	207mm
Discounted Price (each)	$867.75

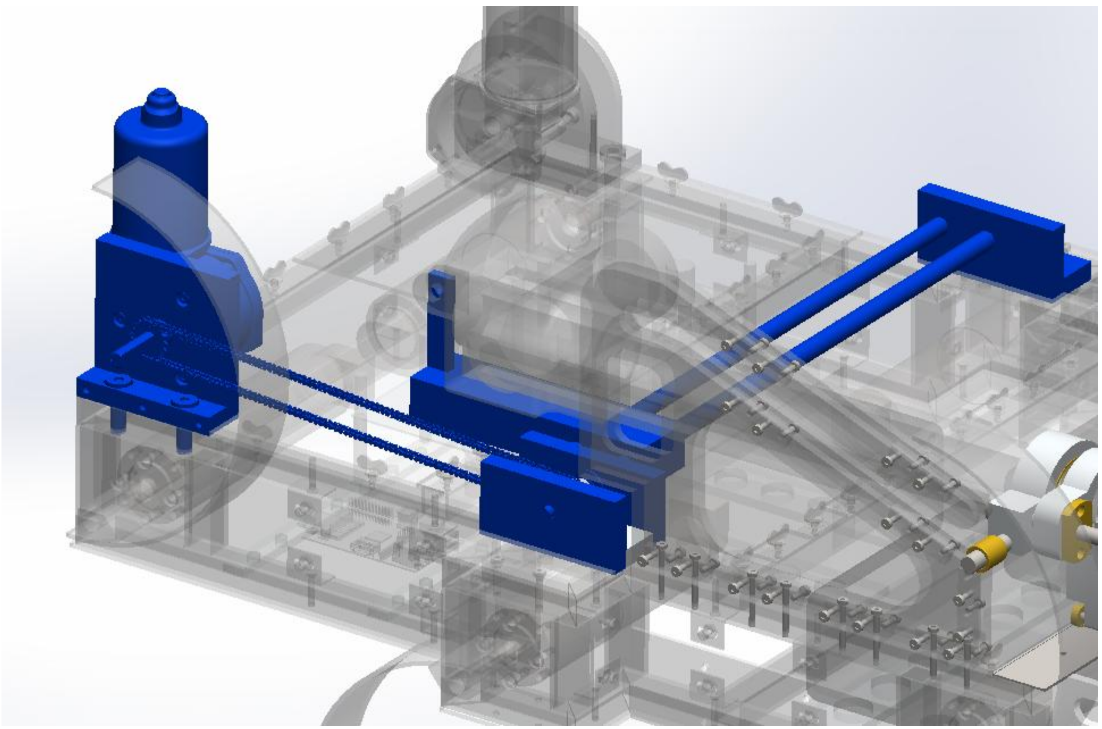
Sample Extraction Module (SEM)

- SEM design takes advantage of non-planar nature of robot
- Legs used for vertical movement
- Fast extraction times
- Low algorithmic complexity



X-Axis

- Lead screw linear drive for movement
- Chain driven for spatial reasons



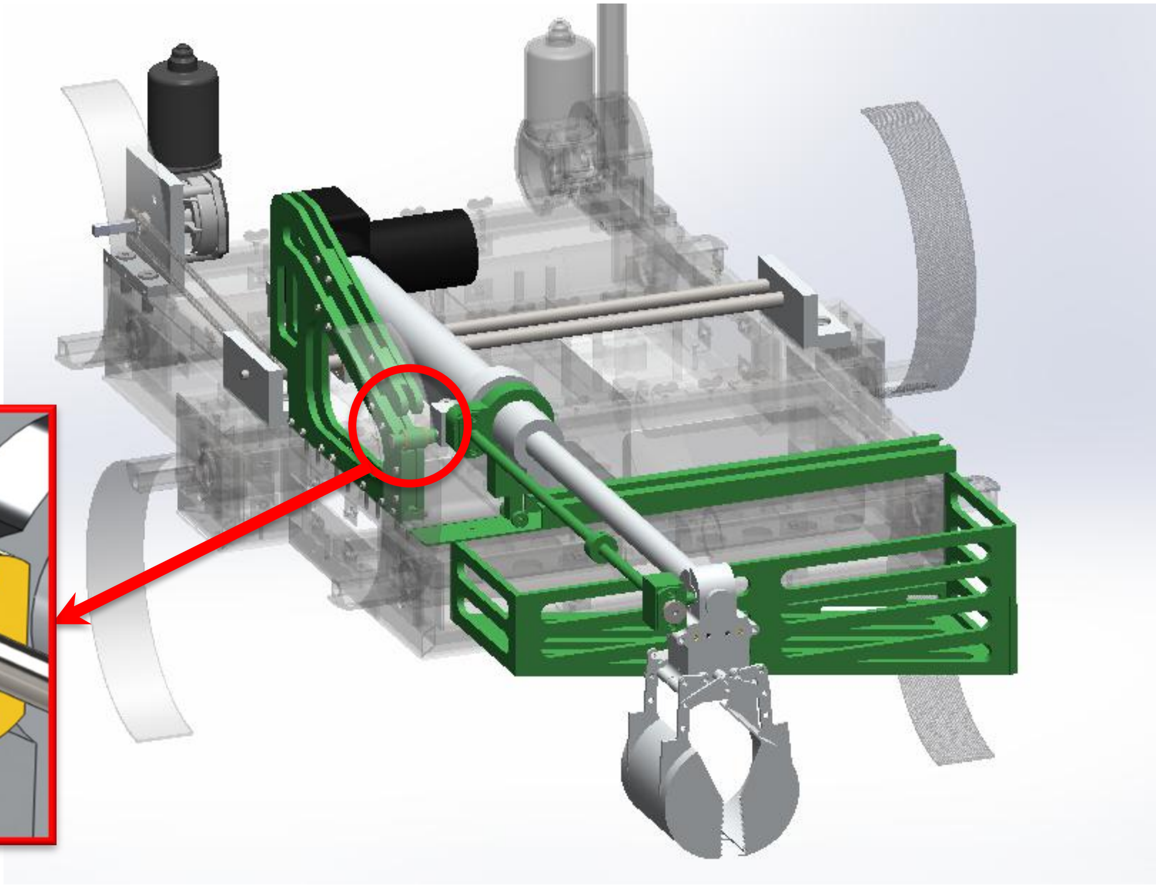
- High torque (27 Nm)
- 512 count encoder on lead screw for precision
- 12” traverse
- 1.5 in/s max speed

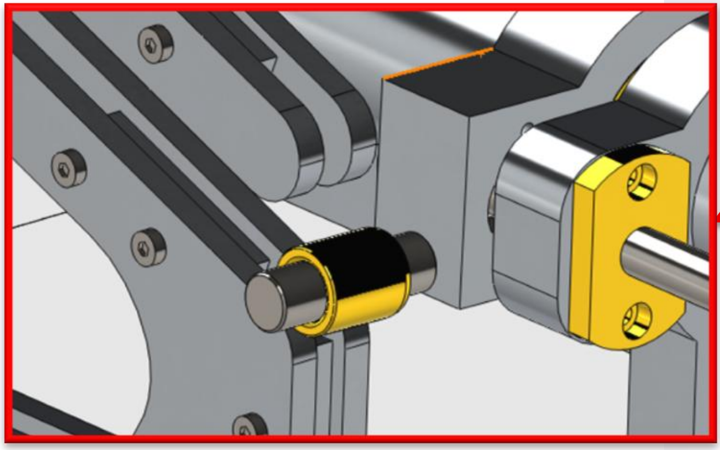
Z-Axis

- High- force linear actuator for movement (200 lbf)
- 12” useable extension
- Maximum extension speed of 1.5 in/s

Sample Storage

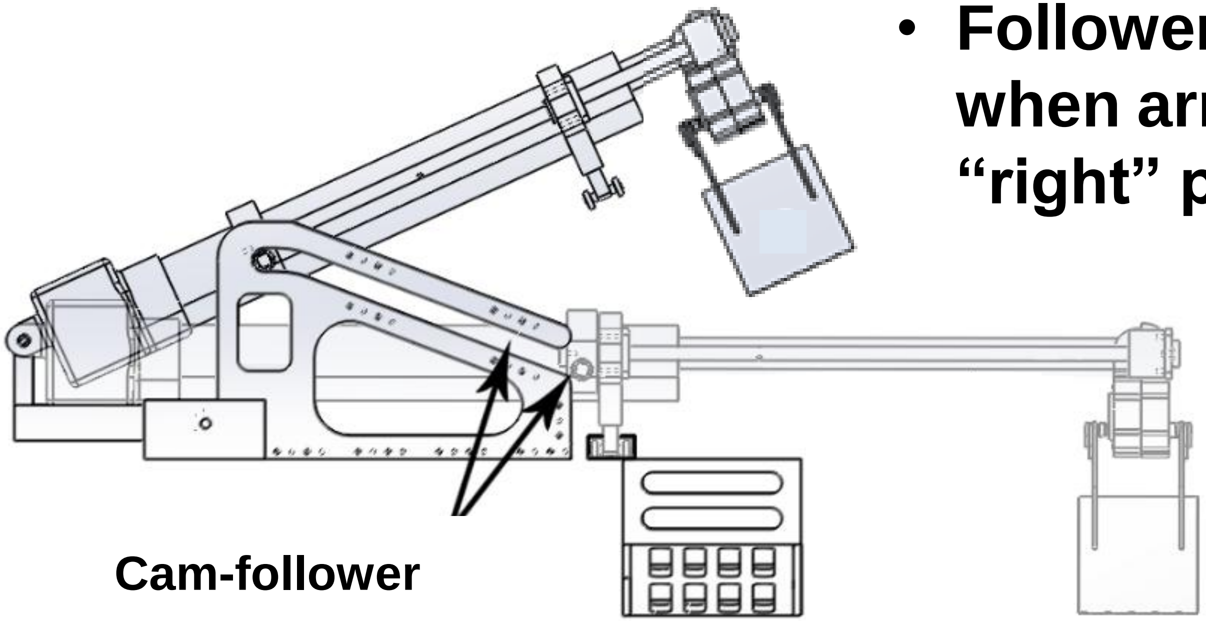
- Box must be accessible to end effector while still constraining cargo
- Passive DOF added





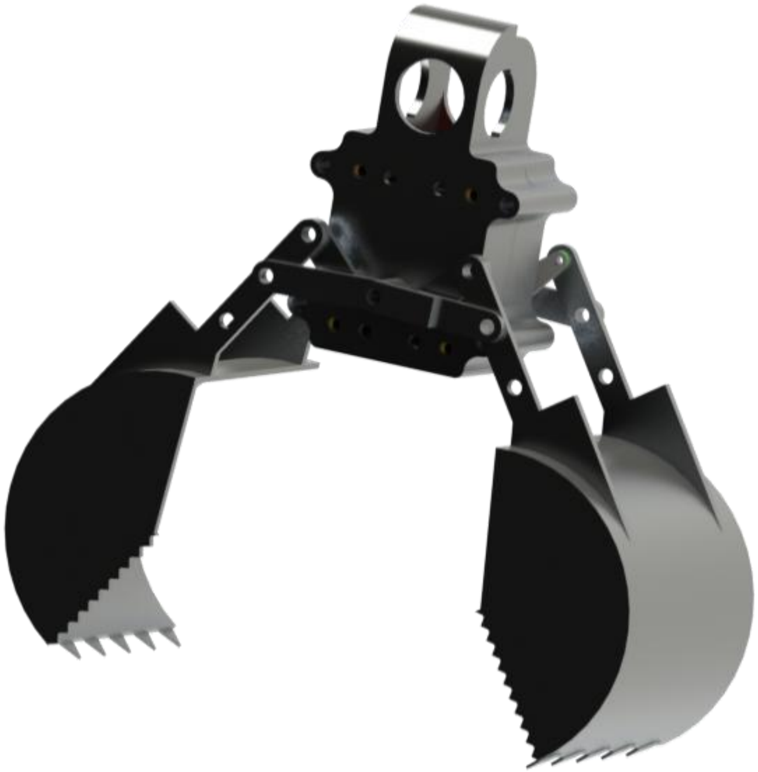
Storage Procedure

- Arm retraction coupled to pitching about base using cam-follower
- Follower only accessible when arm is in extreme "right" position



End Effector

- **Pincer/Scoop Hybrid Claw**
  - Combines speed and precision
  - Servos for simple control
  - Features to enhance effectiveness
    - Viewing window
    - Teeth



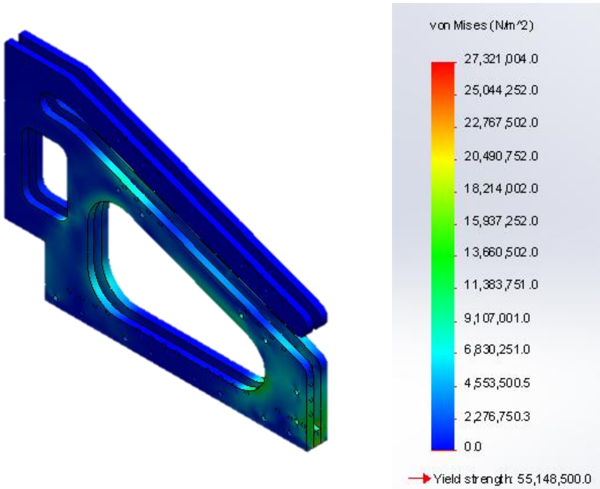
Camera Boom

- Single motor to raise boom
- Backstop to limit rotation
- Worm gear in motor negates need for locking mechanism

Finite Element Analysis

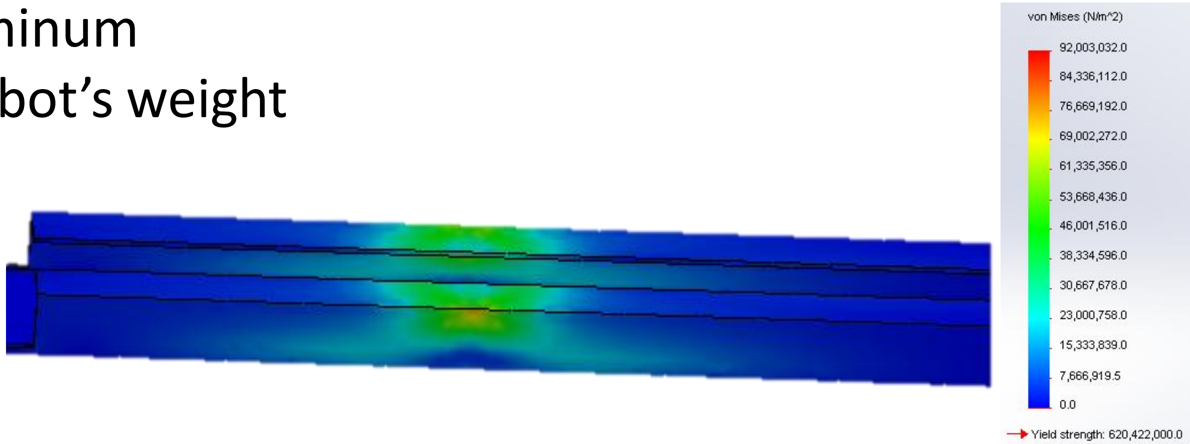
Follower Slot:

- Minimized material
- Ensured that it could withstand maximum force from linear actuator (200 lbs)



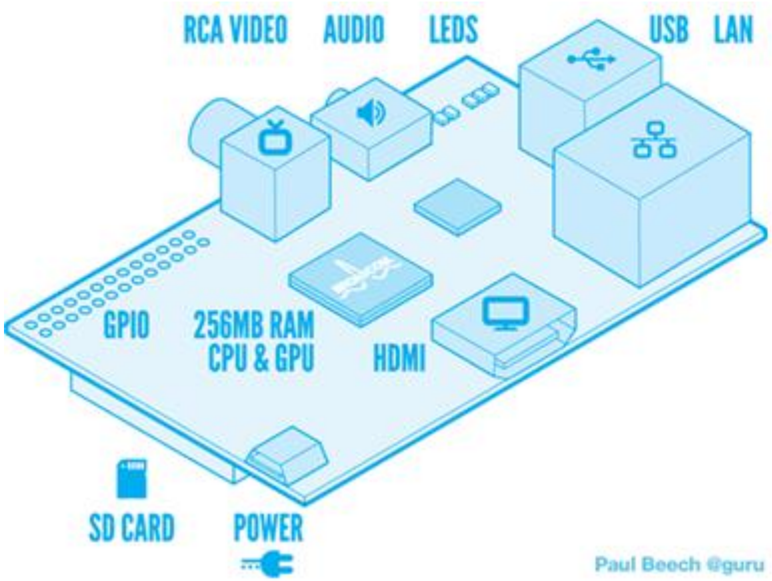
Guide Rail:

- Chose steel over aluminum
- Tested with half of robot's weight



Raspberry Pi

- Dedicated Serial Peripheral Interface (SPI)pins
- 3.5 W Power Rating
- 2 Universal Serial Bus (USB) Ports
- Ethernet Port
- Open Source Libraries
  - wiringPi
  - wiringPiS



XuLA2-LX25

- Xilinx Spartan 6 FPGA
  - 24,051 Logic Cells
  - 4 Digital Clock Managers
  - 2 Phase Lock Loops
- 33 Input/Output Pins
- 9 grams
- Uses Flash memory
  - Non-volatile
- 51mm x 25mm

Pantech UML290

- USB Modem for Verizon
- Technology Bands:
  - 4G LTE,CDMA,GSM
- 51 grams
- Requires 150 MHz Processor
- Requires 64 MB RAM
- Backwards Compatible with 3G

Sponsors

STRIDE LABORATORY
SCANSORIAL AND TERRESTRIAL ROBOTICS AND INTEGRATED DESIGN

CISCOR
CENTER FOR INTELLIGENT SYSTEMS, CONTROL, AND ROBOTICS

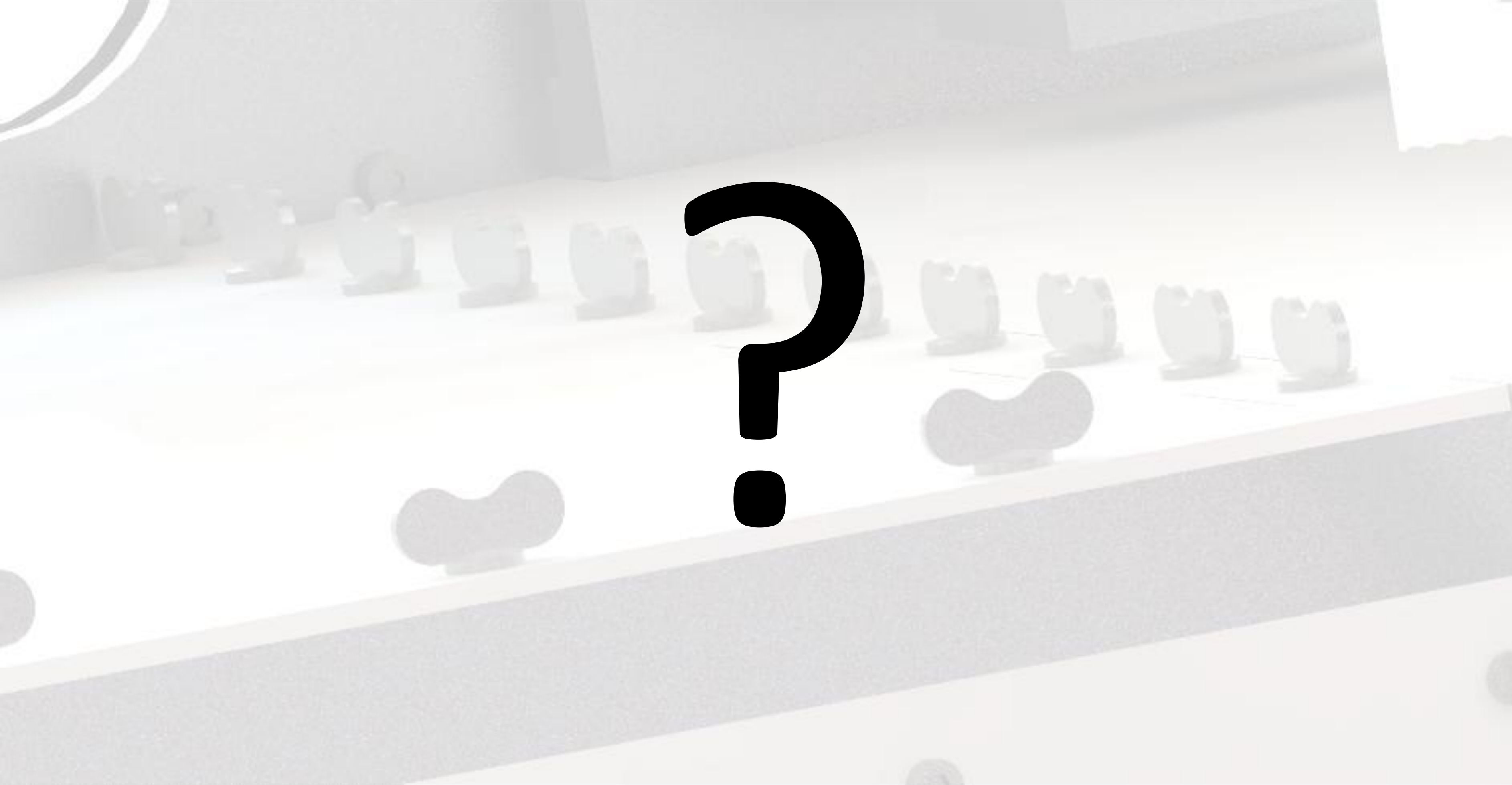
NASA
FLORIDA SPACE GRANT CONSORTIUM

MISUMI
Empowering Engineers with Configurable Components

PROGRESSIVE AUTOMATIONS
LINEAR ACTUATORS
Lowest Prices in North America

maxon motor
driven by precision

Questions



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Spring Semester Planning

Task Name	Duration	Start	Finish
Design Refinement	7 days	Wed 12/19/12	Thu 12/27/
Purchasing	**27 days**	**Fri 12/28/12**	**Mon 2/4/1**
Critical Components	3 days	Fri 12/28/12	Tue 1/1/
Final Components	2 days	Fri 2/1/13	Mon 2/4/
Manufacturing	**35 days**	**Wed 1/2/13**	**Tue 2/19/1**
Frame Fabrication	25 days	Wed 1/2/13	Tue 2/5/
Machining	20 days	Wed 1/2/13	Tue 1/29/
Leg Manufacturing	15 days	Wed 1/2/13	Tue 1/22/
S.E.M Mounting	5 days	Wed 2/6/13	Tue 2/12/
Camera Boom Mounting	5 days	Wed 2/6/13	Tue 2/12/
Electrical Component Mounting	5 days	Wed 2/6/13	Tue 2/12/
Final Assembly	5 days	Wed 2/13/13	Tue 2/19/
Component Testing	**50 days**	**Wed 1/2/13**	**Tue 3/12/1**
S.E.M. Testing	10 days	Wed 2/20/13	Tue 3/5/
Locomotion Control Development on Existing Platform	20 days	Wed 1/9/13	Tue 2/5/
Locomotion Testing on Competition Platform	15 days	Wed 2/20/13	Tue 3/12/
Wireless Control Testing	20 days	Mon 1/21/13	Fri 2/15/
Video Testing and Refinement	20 days	Wed 1/2/13	Tue 1/29/
System Testing	**50 days**	**Wed 3/13/13**	**Tue 5/21/1**
Sample Pickup Testing	15 days	Wed 3/13/13	Tue 4/2/
Obstacle and Terrain Testing	15 days	Wed 4/3/13	Tue 4/23/
Simulated Time-delay Testing and Practice	10 days	Wed 4/24/13	Tue 5/7/
Competition Dry Runs	10 days	Wed 5/8/13	Tue 5/21/
Control Algorithm Refinement	30 days	Wed 4/10/13	Tue 5/21/
Automation	30 days	Wed 3/13/13	Tue 4/23/
GUI Development	25 days	Wed 3/13/13	Tue 4/16/
E/PO Events	90 days	Mon 1/14/13	Fri 5/17/