Orbital Test Stand

Project Proposal

Mary Begay, Brett Booen, Calvin Boothe,
James Ellis, and Nicholas Garcia

December 2, 2014

NORTHERN ARIZONA UNIVERSITY
College of Engineering, Forestry & Natural Sciences

Orbital
Innovation You Can Count On®

Overview

- Fall 2014 Timeline
- Orbital Test Stand
- Problem Definition → PHASE I
- Concept Generation
- Concept Selection → PHASE II
- Winches vs. Wheels
- Final Design Selection → PHASE III
    - Components
- Cost Analysis
- Spring 2015 Timeline
- Conclusion

Brett Booen

Fall 2014 Timeline

2014

August | September | October | November | December

September 3, 2014:
"I am Nick Garcia and we are on the same capstone team."

September 26, 2014:
First Orbital trip; Full understanding of problem; 3-hour brainstorming session

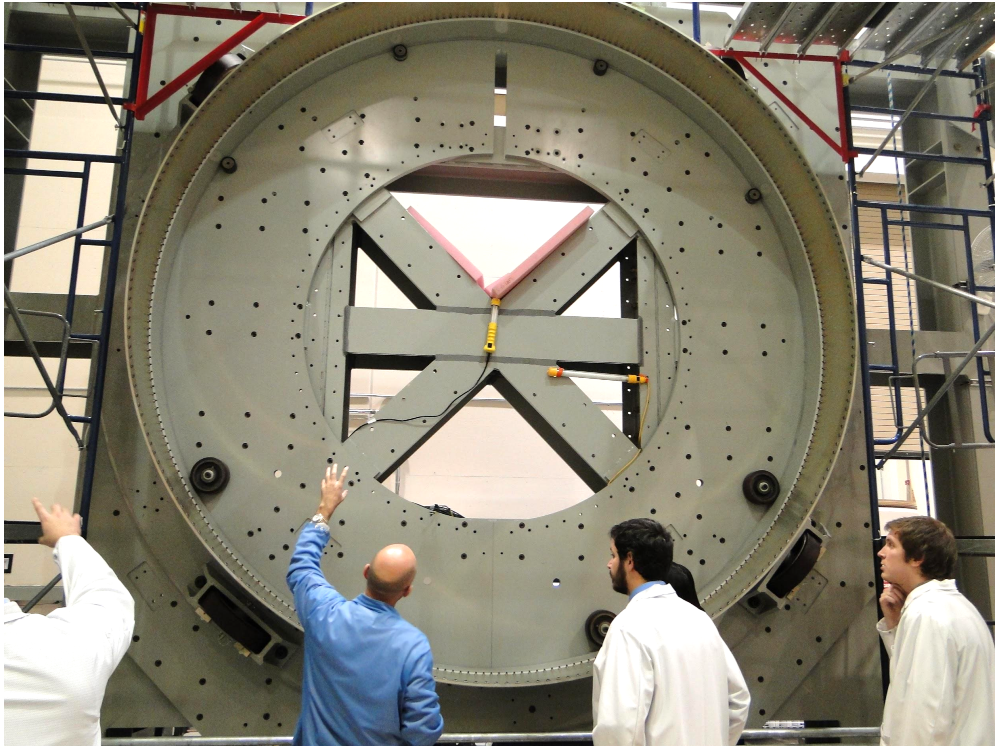
October 1-14, 2014:
"Ok, but seriously, how are we going to do this?"

November 21, 2014:
Second Orbital trip; Design presentation; 3-hour wheels versus winches debate

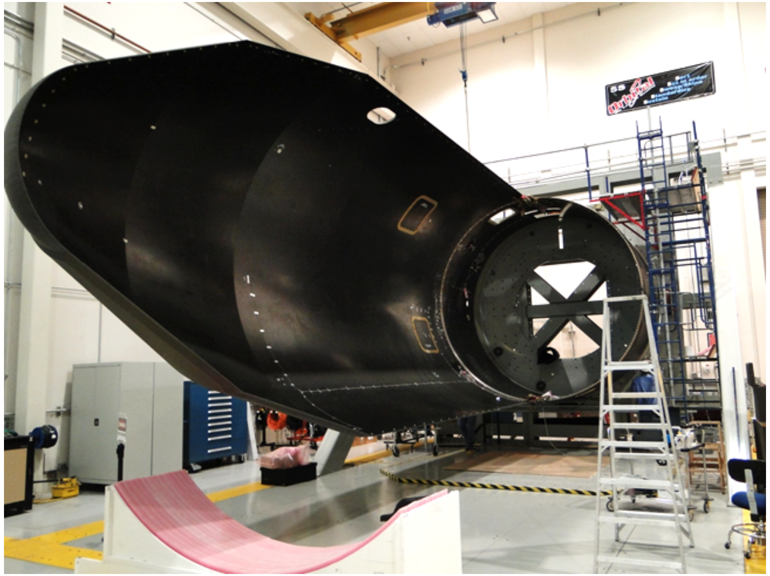
December 1, 2014:
Final design; Need winter break; Ready for spring though

Brett Booen

Orbital Test Stand



Orbital Test Stand with idea of scale



Test Stand with one 570-pound fairing loaded

Brett Booen

Problem Definition

★ CUSTOMER NEEDS:

- The procedure for rotating launch vehicles on the test stand is inefficient and unsafe.
- Rotating launch vehicles on the test stand places Orbital engineers in a dangerous position.
- The setup time for testing is exhausted by the need to manually rotate the launch vehicles.

Brett Booen

Problem Definition

★ **PROJECT GOALS:**

- Easy to **operate**
- Easy to **implement**
- Easy to **maintain**
- Easy to **inspect**
- **Meet customer requirements**

Problem Definition

★ **OBJECTIVES:**

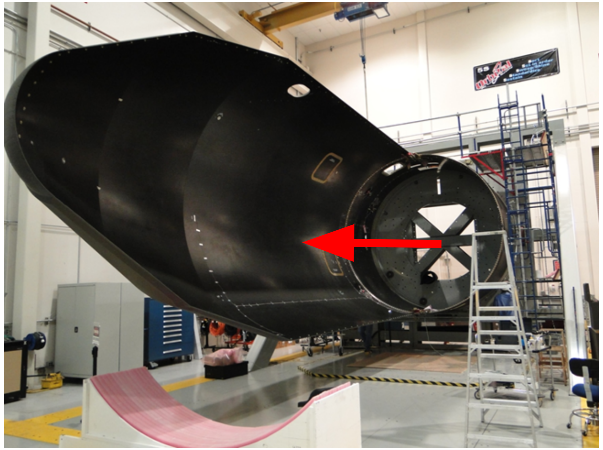
Objective	Measurement Basis	Units
Minimize time it takes to load launch vehicle onto test stand	Time to load launch vehicle with new mechanism in place compared to current procedure	minutes
Minimize costs associated with new design concept	New design cost compared to maintaining current procedure and other designs	dollars
Limit new modifications made to test stand	Cost of material for modifications	dollars
Handle the off-center loads of Antares payload fairings when loaded on stand	Strength	psi
Minimize space requirements	Square footage required by new mechanism	ft^2

Brett Booen

Problem Definition

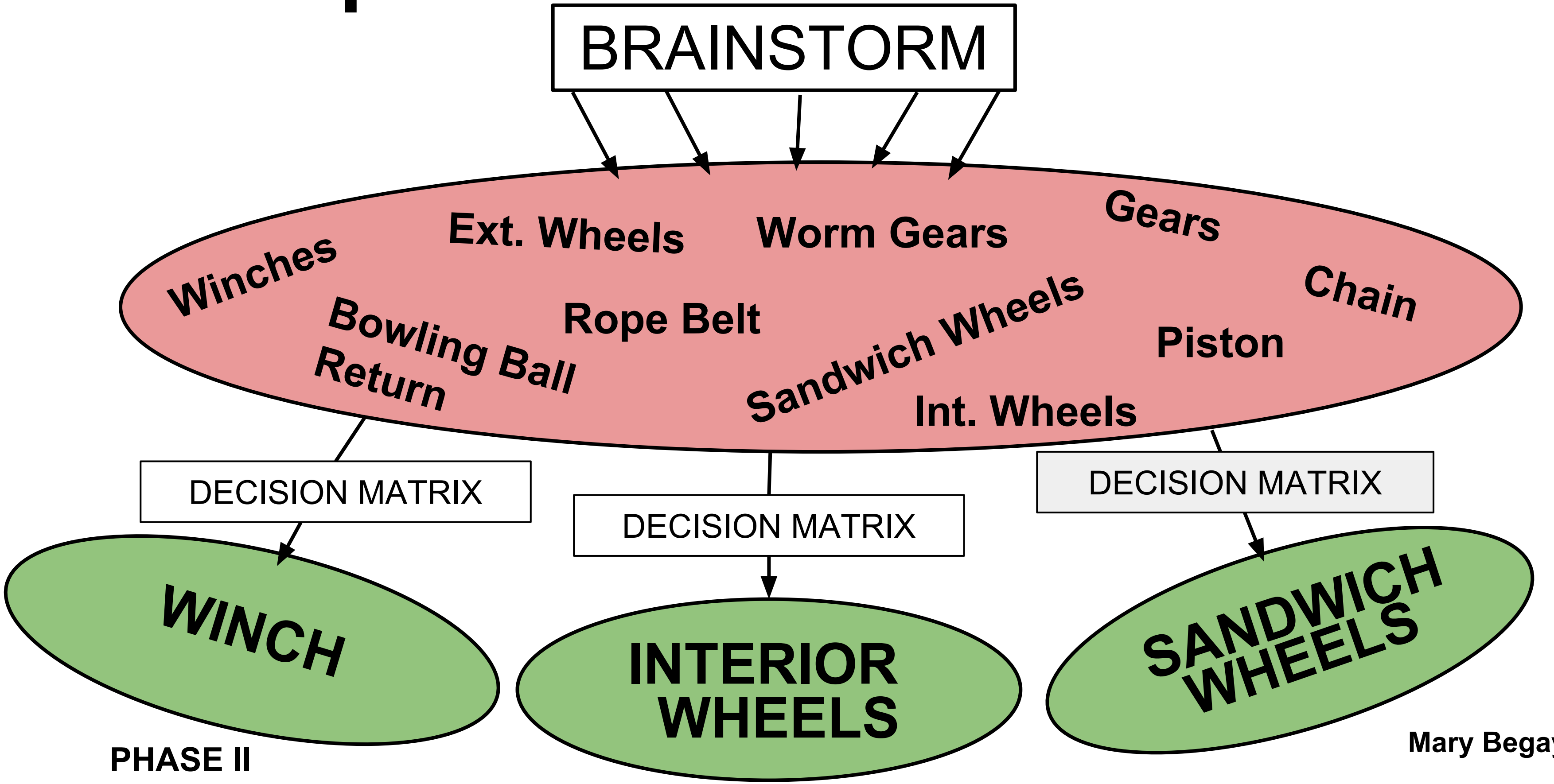
★ **CONSTRAINTS:**

- Continuous rotation for +/- 360 degrees
- Rotational speed not exceeding 1 RPM
- Counteract off-centered load of 570 lb at 153 in
- Minimal modifications



Brett Booen

Concept Generation



PHASE II

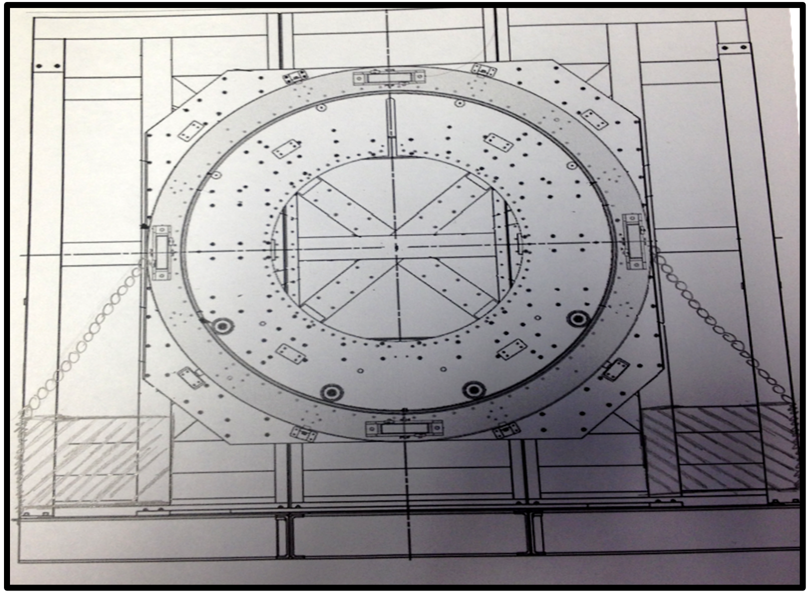
Mary Begay

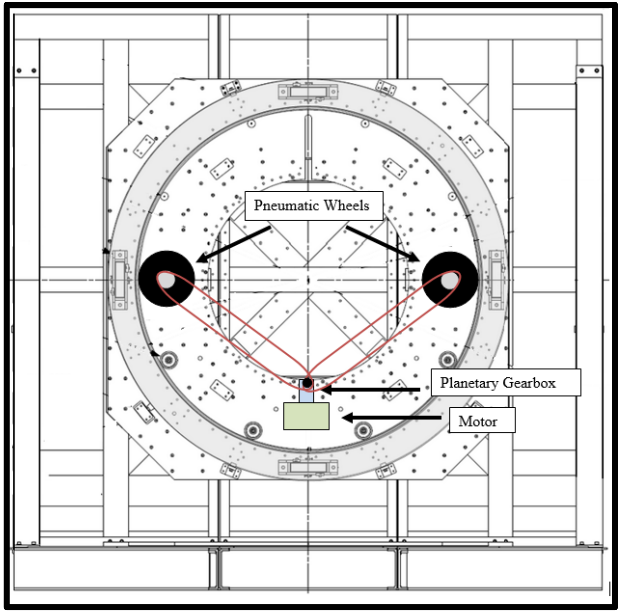
INPUT FROM ORBITAL

Concept Selection - 2 Finalists

WINCH

INTERIOR WHEELS





PHASE II

Mary Begay

Pros and Cons

Winch Design

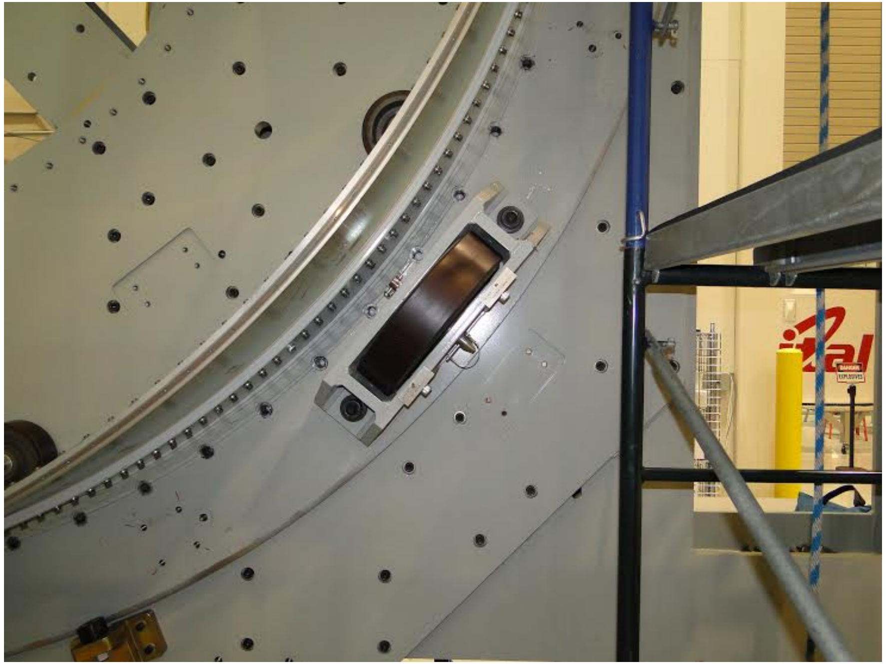
- Pros
  - Low Maintenance
  - Easy To Operate
  - Low Installation Costs
  - Easy To Transport
  - No Braking Mechanism
- Cons
  - Expensive Winch
  - Similar To Current Design
  - Safety Concerns
  - Aesthetics

Interior Wheels Design

- Pros
  - Aesthetics
  - Easy To Operate
  - Modular
  - High Fatigue Life
  - Low-Cost Components
- Cons
  - High Technician Costs
  - High Maintenance
  - Safety Concerns for Belt
  - Braking Mechanism

Calvin Boothe

Winch Implementation Problems



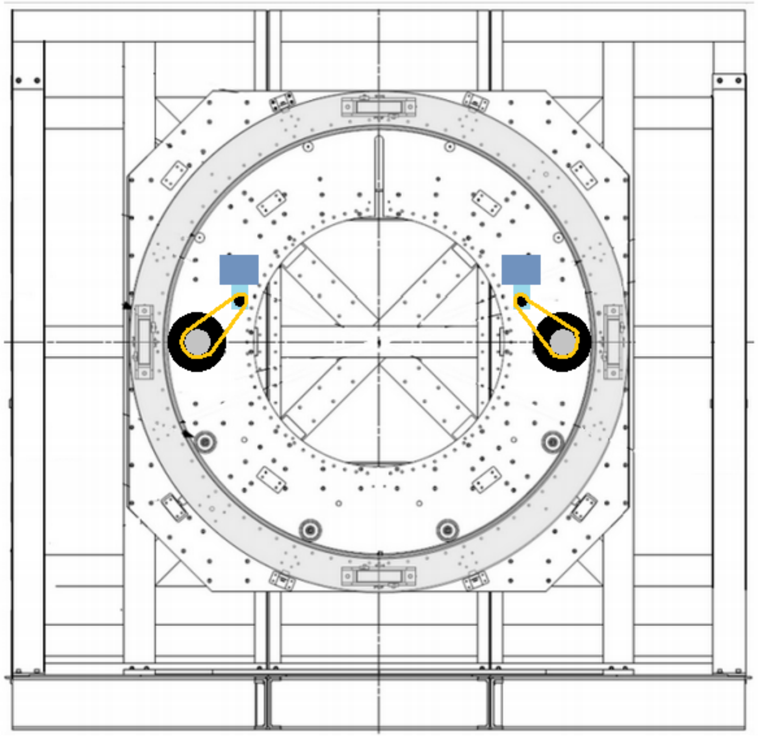
- Interference With Chain
- Mounting To Structure
- Additional Coil Space

Final Selection - Interior Wheels

- Orbital's Decision
  - Aesthetics
  - Cost
  - Maintenance
  - Ease of Use
  - Elegant

Calvin Boothe

Wheels Design - Overview

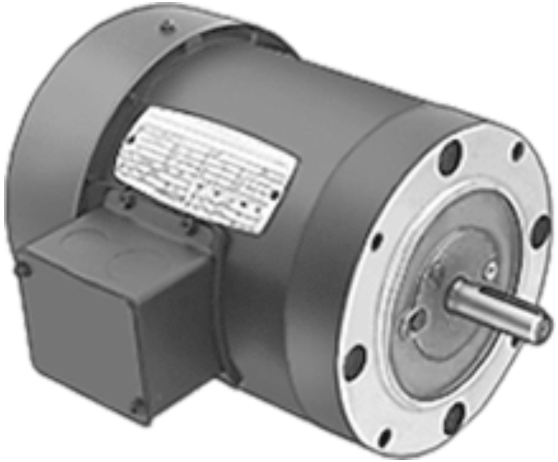


PHASE III

Nick Garcia

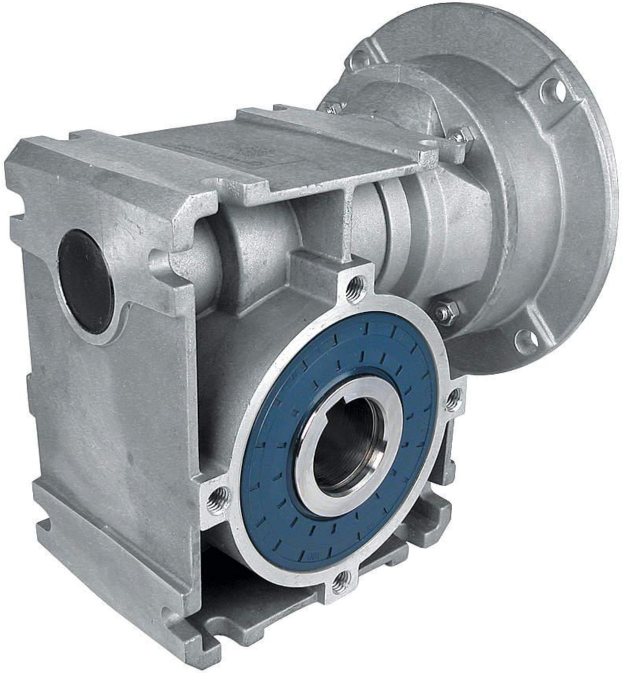
Motor

- McMaster-Carr
- 1 Hp
- 1725 RPM
- Steel Housing
- Motor can directly be mounted to equipment
- Heavy duty applications with high starting torque



Speed Reducer

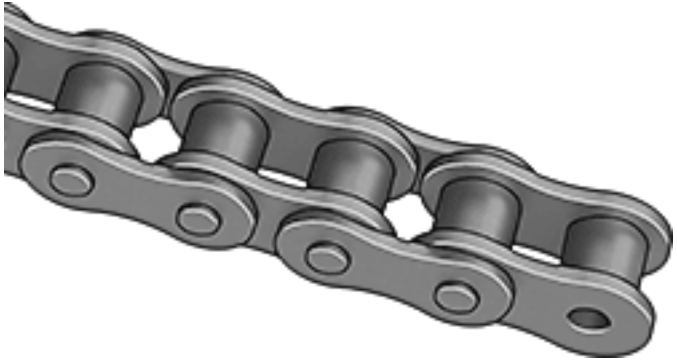
- Grainger
- 1 Stage - Reversible
- Nominal Output RPM - 18
- Max Torque - 1655 in-lb
- Aluminum housing
- Bronze alloy worm gear
- Hardened alloy steel worm pinion gear



Nick Garcia

Roller Chain

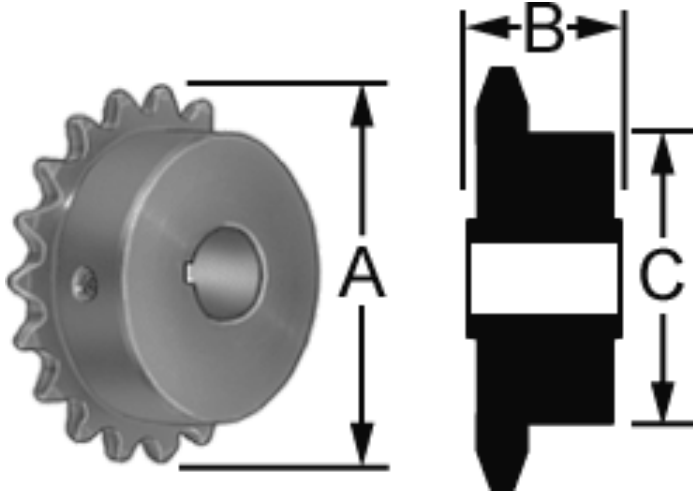
- McMaster-Carr
- Standard single strand
- Steel
- Working Load - 803 lbs
- Connecting link for lengths:
  - 1 - 20 ft
  - 50 ft
  - 100 ft



Nick Garcia

Sprockets

- Gear Box
  - 16 teeth
  - A - 4.22 in
  - B - 1.25 in
  - C - 3.06 in
- Wheel
  - 32 teeth
  - A - 8.07 in
  - B - 1.25 in
  - C - 4.00 in



Nick Garcia

Pneumatic Tires

- McMaster-Carr
- 16.1inch diameter
- J-Tread Type
- 4.7inch wheel width
- 590 lbf load rating
- 60 psi pressure rating
- Treaded tire has more load capacity vs smooth tire

James Ellis

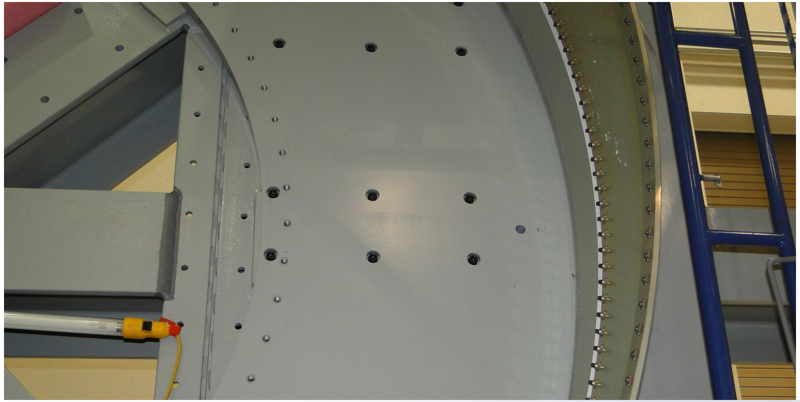
Spindle Assembly

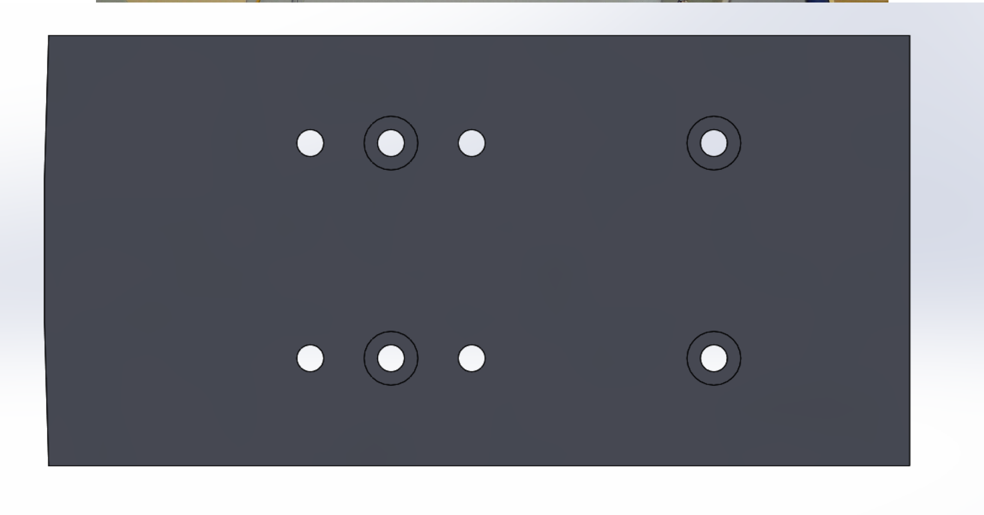
- Gempler’s
- 4 Hole Straight Spindle Stub Axle Assembly
- Option to weld onto flange or directly to mounting plate

James Ellis

Mounting Plate

- Motor and gearbox will be mounted to the plate
- The plate will be mounted to the test stand
- One uniform piece
- Utilize pre-existing holes on test stand





James Ellis

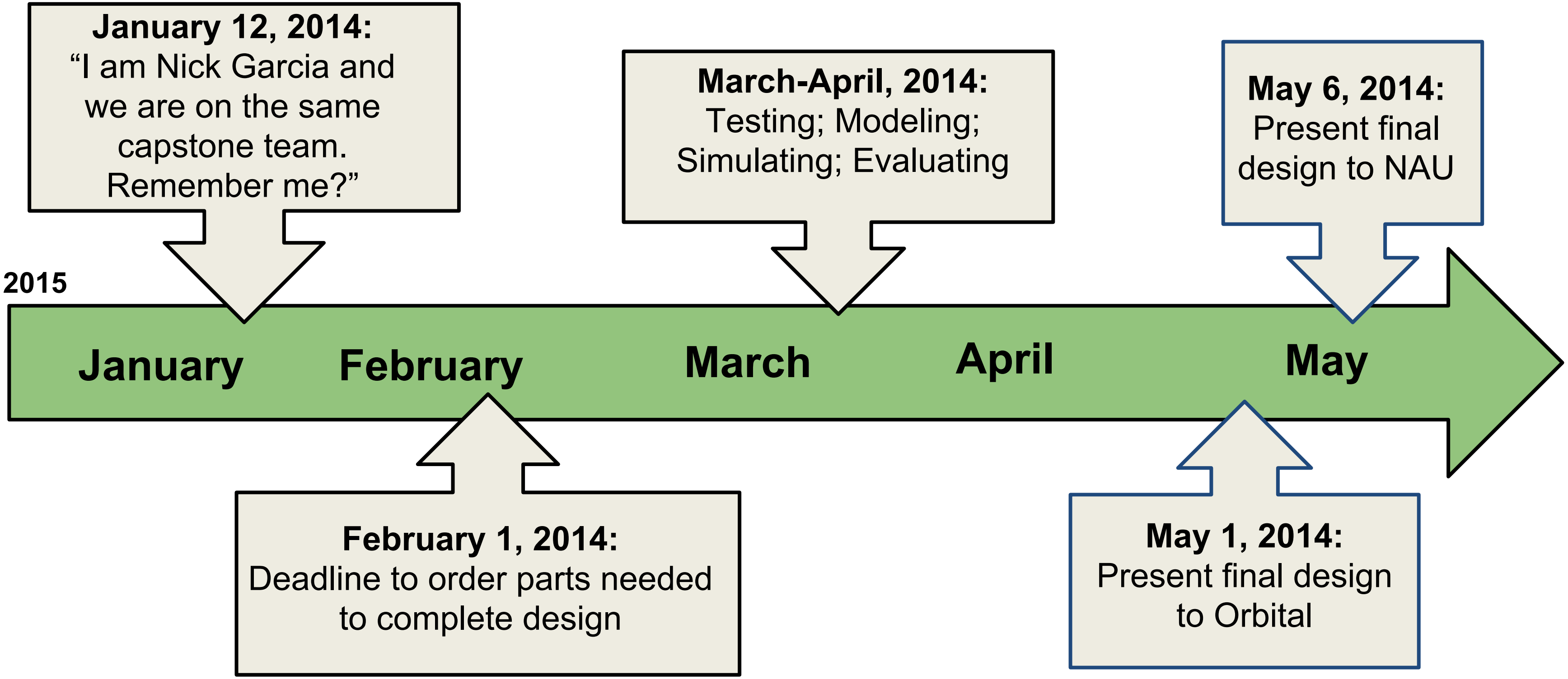
PHASE III

Cost Analysis

Description	Quantity	Cost (each)	Line Total
Motor	2	$241.79	$483.58
Speed Reducer	2	$983.00	$1966.00
Roller Chain	2	$38.90	$77.80
16 T Sprocket	2	$37.03	$74.06
32 T Sprocket	2	$80.13	$160.26
Pneumatic Tire	2	$35.78	$71.56
Mounts	2	$15.00	$30.00
Spindle Assy.	2	$75.85	$151.70
Labor	n/a	$1000.00	$1000.00
		Total	$4014.96

James Ellis

Spring 2015 Timeline



James Ellis

Conclusion

10 Concepts

↓

3 Concepts

↓

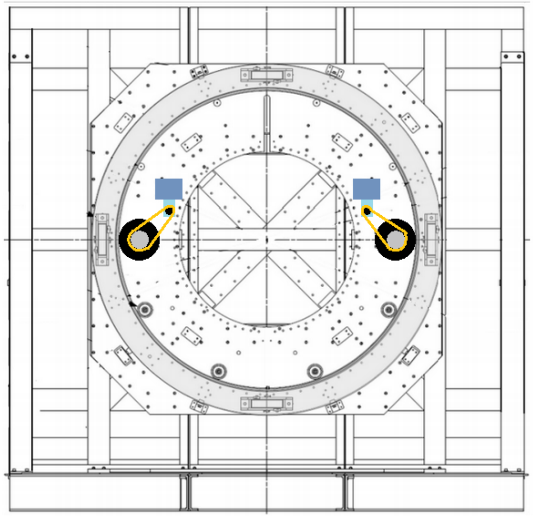
2 Concepts

↓

INTERIOR WHEELS

INTERIOR WHEELS

↓



Total Budget:
$4,014.96*

*Only accounts for $1,000 in labor.

James Ellis

Orbital Test Stand

NAU Senior Capstone Design Team

Left to Right:

James Ellis
Brett Booen
Calvin Boothe
Mary Begay
Nick Garcia