Testing and Manufacturing Update

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Our Main Problem

Rocket Classes

Model Rocket	A	2.5	Low Power
	B	5	
	C	10	
	D	20	
	E	40	
	F	80	Mid Power
	G	160	
High Power	H	320	Level 1
	I	640	
	J	1280	
	K	2560	Level 2
	L	5120	
	M	10240	
	N	20480	Level 3
	O	40960	

Cutoff Total Impulse

http://www.nar.org/standards-and-testing-committee/standard-motor-codes/

Our weight problem

- Current rocket *REQUIRES* M-class motor to reach 10,000 ft because of the weight
- Need to lighten the total weight such that an L-class motor can make the rocket reach 10,000 ft
- Our rocket motor may or may not perform at that level (will verify/confirm with testing)

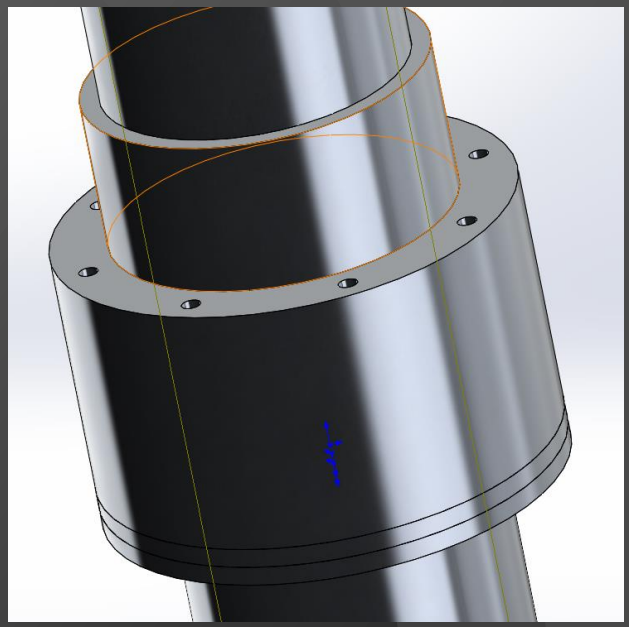
Methods of Trimming Weight

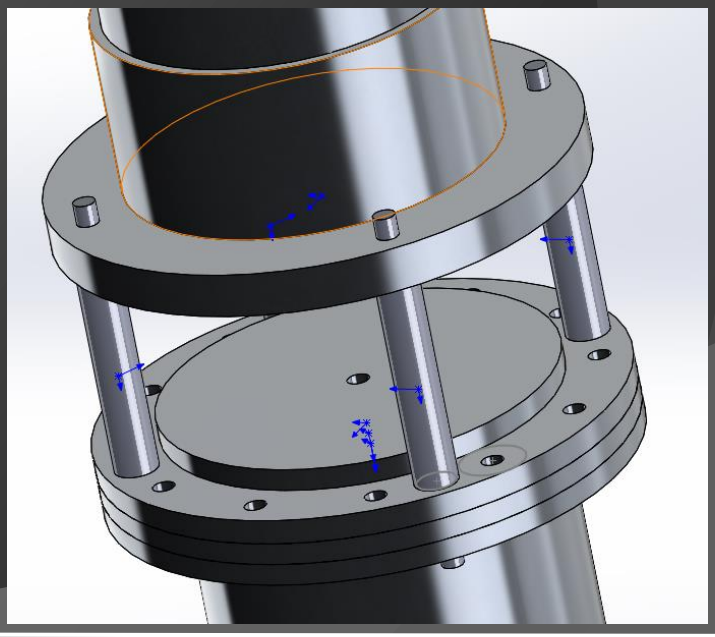
- Different Material
  - Material is already purchased
  - Aluminum is easy to machine
  - We have evidence that Aluminum has worked previously

- Less Material
  - Can design parts to be slimmer (lighter)
  - Trade off strength for weight savings
  - Balancing Act

Coupler Redesign

- Design Issues
  - Heavy
  - No room for valve wiring/filling port
- Redesign goals
  - Allow valve access
  - Retain strength (Bending)
  - Lighter weight
  - Allow for Length Adjustment
  - Alternative: Single diameter with 2 nuts on each side (4 Total)





Current Rocket Mass

- Old Weight: ~60lbs
  - Total Impulse Required: ~8200 N-s
- Class M
- Level 3 Certification required
  - Unattainable

- New Weight: ~40-45
  - Total Impulse Required: ~5800 N-s
- Still need to cut more weight
- Get the Total Impulse under 5120 N-s

Testing Update

Safety: Standards

- National Association of Rocketry (NAR)
  - High Power Rocket Safety Code
- National Fire Protection Association (NFPA)
  - 1125: Code for the Manufacture of Model Rocket and High Power Rocket Motors
    - Chapter 8 = Testing
  - 1127: Code for High Power Rocketry
- American Institute of Aeronautics and Astronautics (AIAA)
  - Handling Considerations of Nitrous Oxide in Hybrid Rocket Motor Testing (written by SpaceDev)

Safety: Manual

- Adapted from Yale Propulsion Laboratories' Experimental Rocket Motor Safety & Standards Manual
- Stand alone manual for Hybrid testing or easily adapted for general rocket testing with dedication sections to each rocket type
- First Draft Finished 04/08

- ***Table of Contents***
  - ***Overview***
  - ***General Safety Procedures***
  - ***Static Test Stand Design/Considerations***
  - ***System Plumbing Design/Considerations***
  - ***Rocket Motor Design/Considerations***
  - ***Testing Locations***
  - ***Testing Procedures***
  - ***Appendices***
  - ***References***

Safety: Tests

- Low Pressure (Water) Injector Test
  - Similar to Liquids Team
  - April 9th
- Nitrous Injector Test
  - Nitrous Flows through Injector and is ignited
  - Week of April 13th
- Hot-Fire Test
  - Week of April 20th
- Hydrostatic Test for Oxidizer Tank if possible

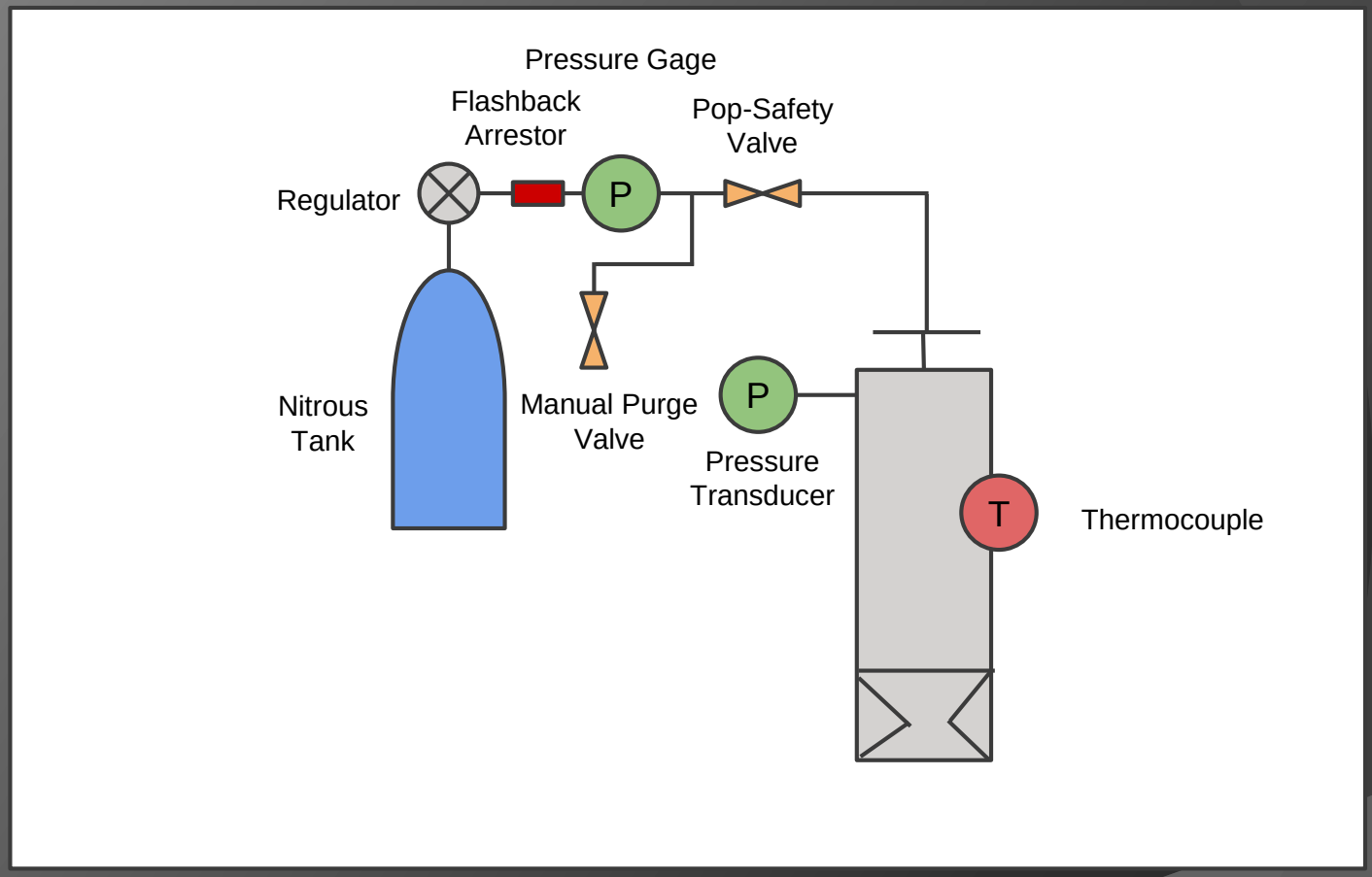
Equipment: Test Stand

- Led by the Liquids Team
- Slightly Redesigned to save money and increase modularity
- Load Cell Mounted
- Holding Plate in Process
- Final Additions
  - Hose Clamps to secure rocket in place
  - Impact Resistant Plexiglas
  - Possible Second Sliding Cross Member

Equipment: Data Acquisition and Sensors

- Load Cell
  - Several Available - provided by 406 Lab
- Thermocouples
  - 1 - Surface Temp
    - Not to exceed 200 C (NFPA Code 1125)
  - 1 - If possible, thermocouple to measure nozzle temp
    - Self-Renewing Thermocouple from Nanmac
- Pressure
  - Pressure Transducer in Forward Closure

Equipment: Set-Up



Adapted from YPL's Experimental Set Up

Location: Requirements

MINIMUM DISTANCE TABLE				
Installed Total Impulse (Newton-Seconds)	**Equivalent High Power Motor Type**	**Minimum Diameter of Cleared Area (ft.)**	**Minimum Personnel Distance (ft.)**	**Minimum Personnel Distance (Complex Rocket) (ft.)**
0 — 320.00	H or smaller	50	100	200
320.01 — 640.00	I	50	100	200
640.01 — 1,280.00	J	50	100	200
1,280.01 — 2,560.00	K	75	200	300
2,560.01 — 5,120.00	L	100	300	500
5,120.01 — 10,240.00	M	125	500	1000
10,240.01 — 20,480.00	N	125	1000	1500
20,480.01 — 40,960.00	O	125	1500	2000

National Association of Rocketry, *High Power Rocket Safety Code*

Location: Requirements

- Total Impulse = Impulse x Burn Time
  - Reduce T.I. by reducing burn time
  - Limit Oxidizer per test
  - Still collect peak thrust and regression data
- 50’ cleared area; 100’ personnel distance
- Access to power for data logging system
- Easy access for emergency response
- On Campus small scale desired
  - Off campus full scale if possible

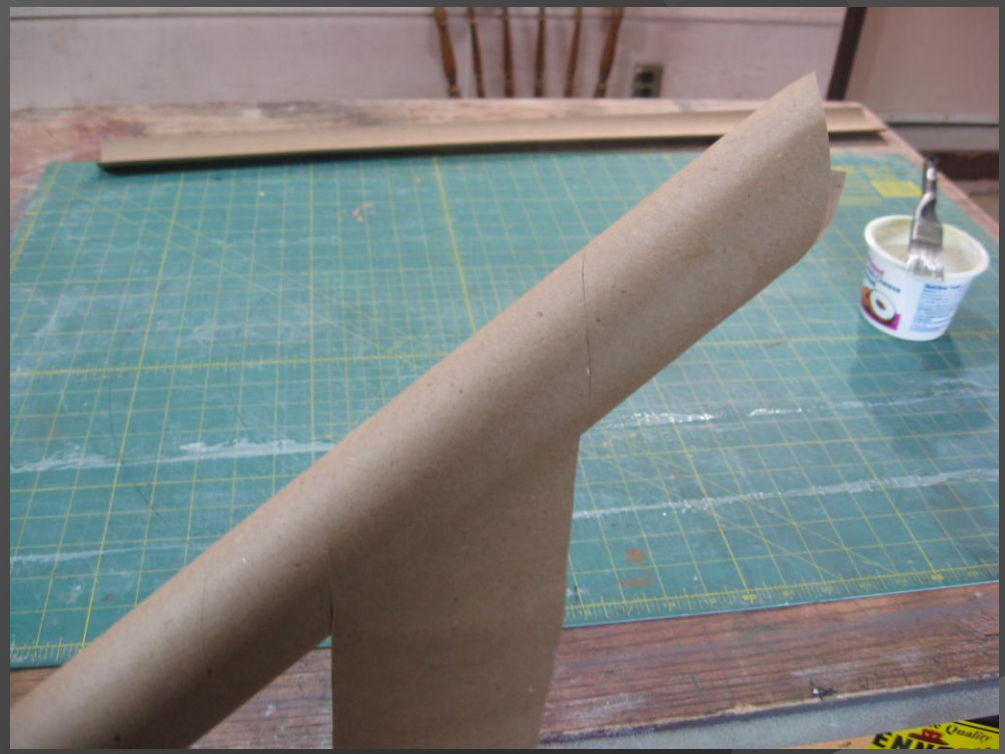
Manufacturing

Manufacturing

- Combustion Chambers are cut
- Coupler/Injector Plate Material has been cut
- Currently manufacturing only components absolutely required for testing
  - Injector
  - Coupler
  - Combustion Chamber
  - Nozzle
  - End Cap

Manufacturing: Propellants

- Cannot find casting tubes with correct dimensions
- Need to make our own
- Procedure - based on Fintels.com (amateur hybrid rocketeur)
  - Wrap Kraft Paper around Form
  - Spiral Wrap Glued Paper Strips
  - Trim, Dry, and Coat with Sodium Silicate - final dimensions: 12” H x 3.5” OD
  - Casting Propellants
  - Wrap in EDPM (thermal liner)
  - Wrap in Foil Tape



Additional Manufacturing

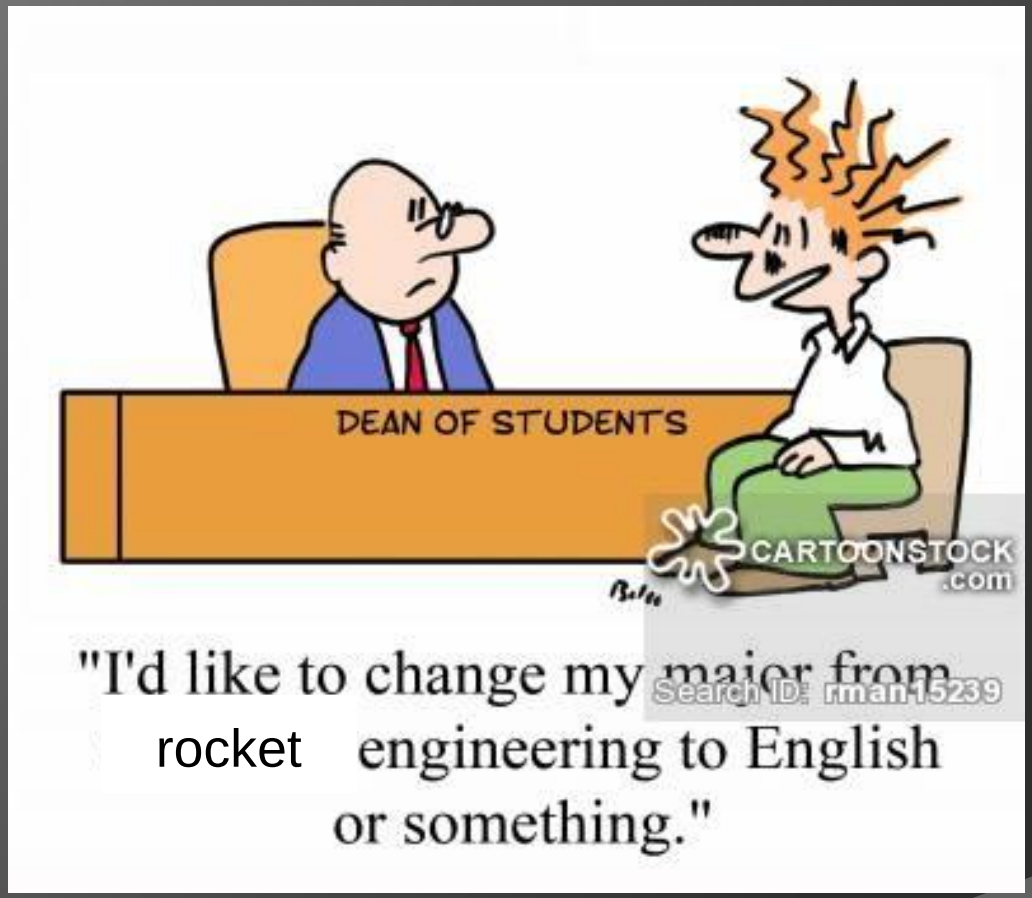
Immediately:

	Date
• Injector	04/08
• Couplers	04/14
• Graphite Nozzle	04/16
• Casting the Fuel Grain	04/08

Soon:

- Oxidizer Flight Tank
- Nose Cone

Thank You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"I'd like to change my major from rocket engineering to English or something."