Designing and Flying an Experimental Sounding Rocket

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1/24/2017 SPONSOR: FAMU-FSU COLLEGE OF ENGINEERING ADVISOR: DR. RAJAN KUMAR

Problem Statement & Scope

Design and construct a rocket capable of carrying an experimental payload to be launched and safely recovered within the parameters of the 2017 Intercollegiate Rocket Engineering Competition hosted by the Experimental Sounding Rocket Association.



Figure 1: 2015-2016 Intercollegiate Rocket Engineering Competition^[1]



Alex Mire

The Competition

•Category: 10,000 ft using COTS solid or hybrid propulsion

•Location: Truth or Consequences, New Mexico

•Date: June 20-24, 2017

•**Purpose:** To promote further experimentation in the field of sounding rocketry.



Figure 2: Spaceport America^[2]

Competition Requirements

Payload

- 8.8 lbs
- CubeSat outer dimensions (10cm x 10cm x 11.35cm)
- Scientific experiment or technology demonstrations (recommended)

Recovery

- Dual Deployment required for vehicles 1,500+ ft
- •Electronics
 - 1 COTS altimeter
 - Redundant electronics
 - Radio beacon





Figure 2: CubeSat Sizes^[3]

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Alex Mire

Point Breakdown (1,000 Points Total)

- •Entry Form and 3 Progress Updates (100)
- Project Technical Report (200)
 - Analysis
- •Design Implementation (200)
 - Competency of Design and Construction
 - Degree of SRAD
- •Flight Performance (500)
 - Apogee
 - Successful Recovery
- •Unsafe or Unsportsmanlike Conduct (-20)



Spaceport America Cup

Intercollegiate Rocket Engineering Competition Rules & Requirements Document

Figure 4: Competition rules document coverpage [4]

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Alex Mire

Design Overview

- Length: 97.7 in
- Mass: 66.7 lb
- Rocket ID: 6 in
- Rocket OD: 6.14 in
- 5 segments

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• Fiberglass Body



William Pohle

Booster Segment

- Cesaroni M1450-P motor (98mm)
 - 6.87 second burn
 - Rocket will experience 6.6 G's
- •Wooden centering rings
- •Fiberglass fins



Figure 6: Booster section and surrounding tube



Parachute Bays

•Drogue parachute: Rocketman 3ft parachute

- Decent rate of 90 ft/s
- •Main parachute: XXL B2 parachute
 - Decent rate of < 17 ft/s
- •"Zipper-less" design



Figure 7: Separated drogue parachute bay.



Avionics Bay

- •Fiberglass outer body
- •Ejection charges
- •Exposed ring for Altimeters
- •Parachute Mounting U-bolts
- Redundant electronics



Figure 7: Avionics sled and bay body section^{[5] [6] [7]}



Avionics



StratoLoggerCF Altimeter will serve as the official log of the rocket's altitude and meet the COTS requirement ^[8]



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Bandon Gusto

and log data ^[9]

[11]

Nose Cone and Payload

•3D printed nose epoxied to fiberglass tube

•Centering Rings hold CubeSat

•CubeSat contains 8.8lb payload





Parts Ordered

FIBERGLASS CONSTRUCTION

- Fiberglass Cloth
- Ероху
- Hardener
- Aluminum Pipe (Mandril)
- Mold Release Lubricant



Figure 10: Fiberglass [12]

AVIONICS

- StratoLoggerCF Altimeter
- 9 Volt Battery Clip
- Mounting Hardware
- Data Transfer Kit
- 20 AWG Wire F



Figure 12: StratoLoggerCF^[8]

STRUCTURAL COMPONENTS

- Hex Nuts
- Nut Plate
- Threaded Rods



Figure 11: Hex Nut [13]

COST

- Parts and materials: \$508.71
- Competition fees: \$200
- Total Spent: \$708.71

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Changes and Current Issues

Changes

• Transitioned from metal to wooden centering rings.

Current Issues

- May need to reevaluate motor choice.
- Fiberglass may affect weight more than anticipated.



Figure 13: Aircraft-grade Finnish Birch [14]

Gantt Chart

Task Name	Duration	Start	Finish			February 2017		Mar	h 2017			April 2017
				19 22	25 2	28 31 3 6 9 1	2 15 18 21	24 27 2	5 8 11	14 17 20	23 26 29	1 4 7 10
Fiberglass	16 days	? Mon 1/23/17	Mon 2/13/17				1					
Order Fiberglass	1 day	Mon 1/23/17	Mon 1/23/17		Į.							
Build booster tube	7 days	Fri 1/27/17	Mon 2/6/17									
Build lower parachute bay	7 days	Fri 1/27/17	Mon 2/6/17									
Build avionics bay	12 days	Fri 1/27/17	Mon 2/13/17				I					
Build upper parachute bay	7 days	Fri 1/27/17	Mon 2/6/17									
Build payload bay	7 days	Fri 1/27/17	Mon 2/6/17									
Build couplers	11 days	Mon 1/30/17	Mon 2/13/17				L					
Build any spares	11 days	Mon 1/30/17	Mon 2/13/17				I					
Booster	50 days	? Mon 1/23/17	Sat 4/1/17	ſ								1
Order centering rings and hardware	5 days	Mon 1/23/17	Fri 1/27/17									
Complete fiberglass (booster)	0 days	Mon 2/6/17	Mon 2/6/17			🔶 2/6						
Machine centering rings	6 days	Wed 2/1/17	Wed 2/8/17									
Build fins	9 days	Fri 1/27/17	Wed 2/8/17									
Install rail button	7 days	Fri 1/27/17	Mon 2/6/17									
Install centering rings/fins	6 days	Mon 2/6/17	Mon 2/13/17									
Order motor grains	1 day	Wed 3/15/17	Wed 3/15/17									
Complete booster segment	0 days	Sat 4/1/17	Sat 4/1/17									• 4/1
Avionics	50 days	Mon 1/23/17	Sat 4/1/17	ſ								7
Order altimeters and radio beacon	5 days	Mon 1/23/17	Fri 1/27/17									
Oder parts for inner avionics	5 days	Mon 1/23/17	Fri 1/27/17									
Machine inner avionics	6 days	Wed 2/1/17	Wed 2/8/17									
Program altimeters and beacons	45 days	Mon 1/30/17	Fri 3/31/17									
Obtain ham radio license?	24 days	Wed 3/1/17	Sat 4/1/17									
Complete fiberglass (avionics)	0 days	Mon 2/6/17	Mon 2/6/17			2/6						
Wire buttons and drill holes	6 days	Wed 3/1/17	Wed 3/8/17									
Complete avionics segment	0 days	Sat 4/1/17	Sat 4/1/17									• 4/1

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Gantt Chart

Task Name	Duration	Start	Finish	February 2017 March 2017 April 2017
Recovery	50 days	Mon 1/23/17	Fri 3/31/17	19 22 25 28 31 3 6 9 12 15 18 21 24 27 2 5 8 11 14 17 20 23 26 29 1 4 7 10
Complete fiberglass (recovery)	0 days	Mon 2/6/17	Mon 2/6/17	♦ 2/6
Order shock chord and hardware	5 days	Mon 1/23/17	Fri 1/27/17	
Order parachutes	5 days	Mon 2/6/17	Fri 2/10/17	
Install mounting hardware	5 days	Mon 2/6/17	Fri 2/10/17	
Complete recovery system	0 days	Tue 2/28/17	Tue 2/28/17	◆ 2/28
Schedule testing date with FSU/CoE	5 days	Mon 3/20/17	Fri 3/24/17	
Test deployment of recovery system	5 days	Mon 3/27/17	Fri 3/31/17	
Payload and Nosecone	43 days	Wed 2/1/17	Sat 4/1/17	
Determine/design payload	6 days	Wed 2/1/17	Wed 2/8/17	
Order any payload parts	3 days	Wed 2/8/17	Fri 2/10/17	
Check payload dimensions/weight	3 days	Wed 2/15/17	Fri 2/17/17	
Complete fiberglass (payload)	0 days	Mon 2/6/17	Mon 2/6/17	♦ 2/6
Build nosecone	6 days	Wed 2/15/17	Wed 2/22/17	
Build payload mounting	3 days	Wed 2/22/17	Fri 2/24/17	
Integrate payload	11 days	Wed 3/1/17	Wed 3/15/17	
Complete payload/nosecone section	0 days	Sat 4/1/17	Sat 4/1/17	♦ 4/1
Test Launch	8 days	Wed 3/22/17	Sat 4/1/17	· · · · · · · · · · · · · · · · · · ·
Schedule test launch	7 days	Wed 3/22/17	Thu 3/30/17	
Test launch	1 day	Sat 4/1/17	Sat 4/1/17	
Complete safety and operations manual	0 days	Sat 4/1/17	Sat 4/1/17	♦ 4/1

Safety

Fiberglass Production	Recovery System Test	Flight Test	Storage & Handling Energetics	Electrical
 Nitrile gloves Safety glasses Face masks Skin coverage Defined roles & procedure Off-campus 	 Remote arming & detonation On-campus Supervision 	 Off-campus Launch Safety Officer Remote arming & launch Review protocol 	 On-campus Limited access Safety protocol Staff notice 	 Research Review Proper purchasing Circuit Testing

References

[1] http://www.soundingrocket.org/latest-news

[2] http://www.americaspace.com/?p=72686

[3] Vyonyx Itd

[4] http://www.soundingrocket.org/sac-documents-forms.html

[5] https://grabcad.com/library/battery-pack-2

[6] https://grabcad.com/library/printed-circuit-board-4

[7] http://www.pro38.com/products/pro24/pro24.php#

[8] http://openrocket.sourceforge.net/

[9] http://www.nxp.com/products/software-andtools/hardware-development-tools/freedom-developmentboards:FREDEVPLA?tid=vanFREEDOM [10] http://www.mouser.com/ProductDetail/Digi-International/XBP9B-DMWT-012/?qs=NnxJOTDiCpOOEE6pVdOjDg%3D%3D&gclid=CLPj 7J3T2dECFUkDhgodvHAEDw

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[12] https://www.urbanwebsites.com/sabalanenterprises/index.html

[13] http://www.webstaurantstore.com/nemco-45050stainless-steel-hex-nut-for-easy-frykutters/59245050.html

[14] https://woodcraft-assets-weblinc.netdnassl.com/Images/products/600/152976.jpg

Thank you! Questions?

