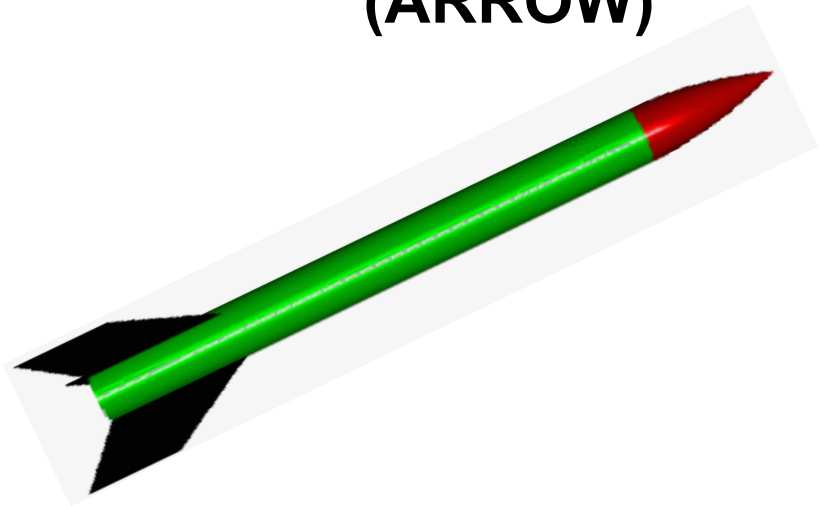
MORGAN STATE UNIVERSITY

GROWING THE FUTURE • LEADING THE WORLD

Aerospace Rocket Research for Opportunities in the Workforce Leadership (ARROW)



base 11

Base 11 Site Visit

Ms. Ingrid Ellerbe, Senior VP, Partner and Program Engagement

Ms. Tia Tucker, Senior Programs Manager

December 3, 2018

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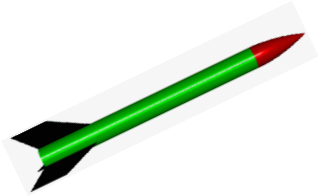


AIM: To Develop Leadership and Workforce in Aerospace Industry

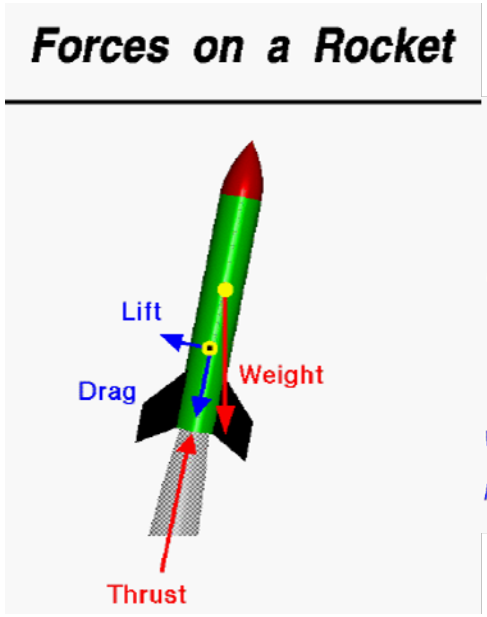
Morgan State University's Strategic Plan:

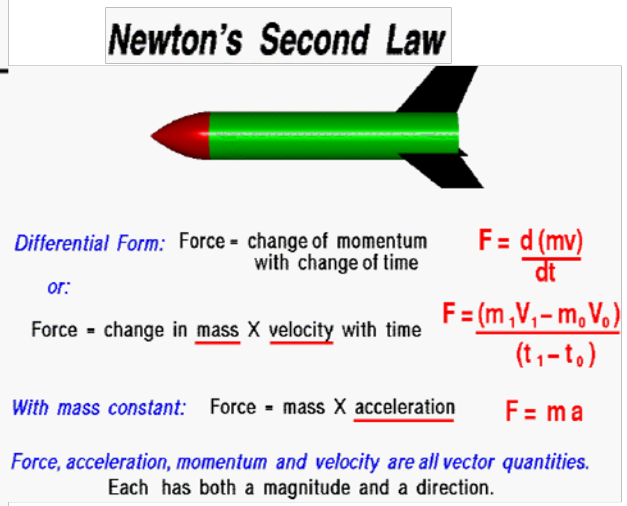
1. **Enhancing Student Success:** ARROW will provide unparalleled opportunities for students to engage with innovative academic programs;
2. **Enhancing Morgan's Status as a Doctoral Research University**: ARROW will provide faculty (as well as students) the opportunity to engage in cutting edge research;
3. **Improving and Sustaining Morgan's Infrastructure and Operational Processes:** ARROW will provide Morgan an opportunity to address the new need for new program space following the guidelines for environmental sustainability as demanded by the State of Maryland;
4. **Growing Morgan's Resources:** ARROW will provide additional dynamic opportunities to locate and pursue new grant, contract and entrepreneurial pathways to increase Morgan's resources as well as enhancing and establishing collaborative relationships with public and private entities; and
5. **Engaging with the Community:** ARROW will provide the University an additional tool to be used to reach out, engage and empower the community and the residents that surround Morgan.

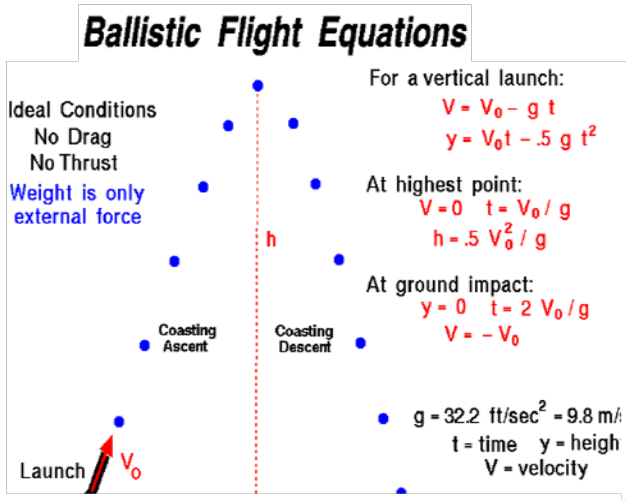
Student Recruitment

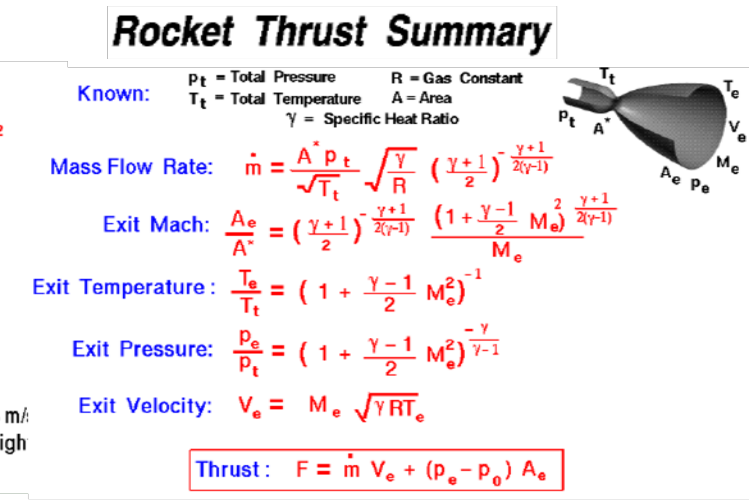
- Morgan State University students with STEM backgrounds
- Partner institution students with STEM backgrounds
- Outreach team

Training









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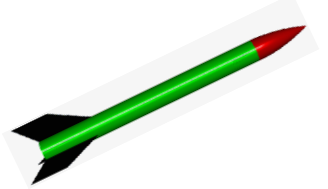


Altitude / Phases	STAGES OF ROCKET BUILD		
	13,000	100,000	150,000
Phase I: Design	Lead: Dr. Damoah Co-Lead: Dr. Willoughby Students (n = 4)	Lead: Dr. Damoah Co-Lead: Dr. Willoughby Students (n = 4)	Lead: Dr. Damoah Co-Lead: Dr. Willoughby Students (n = 4)
Phase II: Build	Lead: Dr. Willoughby Co-Lead: Dr. Damoah Students (n = 4)	Lead: Dr. Willoughby Co-Lead: Dr. Damoah Students (n = 4)	Lead: Dr. Willoughby Co-Lead: Dr. Damoah Students (n = 4)
Phase III: Safety	Lead: Dr. Lee Co-Lead: Dr. Chen Students (n = 4)	Lead: Dr. Lee Co-Lead: Dr. Chen Students (n = 4)	Lead: Dr. Lee Co-Lead: Dr. Chen Students (n = 4)
Phase IV: Launch	Lead: Dr. Willoughby Co-Lead: Dr. Kinyua Students (n = 4)	Lead: Dr. Willoughby Co-Lead: Dr. Kinyua Students (n = 4)	Lead: Dr. Willoughby Co-Lead: Dr. Kinyua Students (n = 4)

Phase I: Design

SEB 104 Design Stations

3D printer

Earthquake simulator

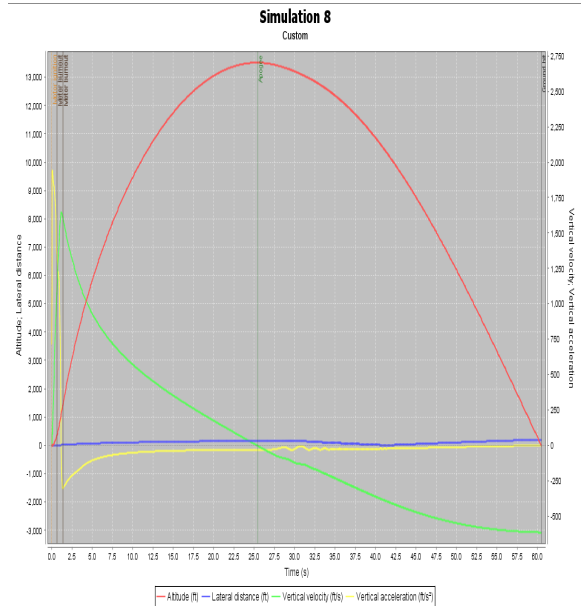
Wind Tunnel

Rocket Design

Rocket
Stages: 1
Mass (with motor): 7048 g
Stability: 2.98 cal
CG: 96.2 cm
CP: 123 cm

Altitude	4120 m
Flight Time	60.5 s
Time to Apogee	25.3 s
Optimum Delay	24 s
Velocity off Pad	35.1 m/s
Max Velocity	501 m/s
Velocity at Deployment	N/A
Landing Velocity	187 m/s

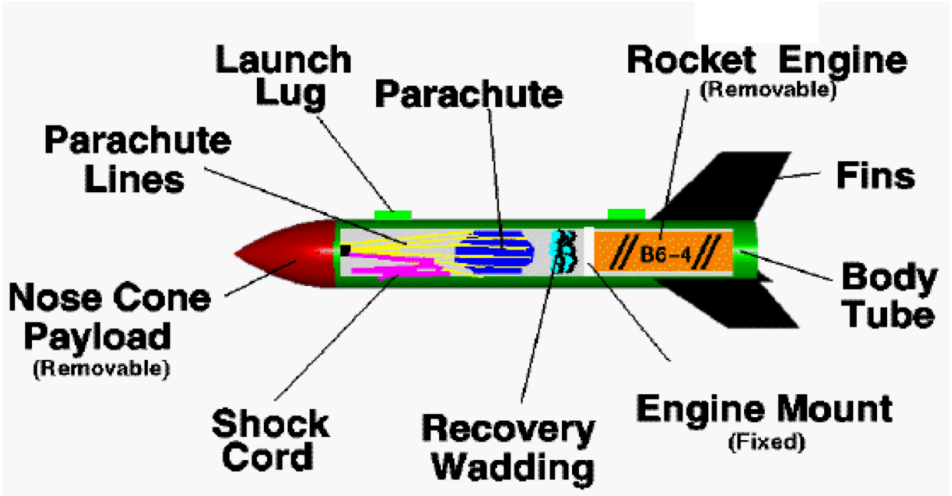
Motor	Avg Thrust	Burn Time	Max Thrust	Total Impulse	Thrust to Wt	Propellant Wt	Size
H550	553 N	0.567 s	643 N	313 Ns	7.99:1	176 g	38/206 mm
I435T	470 N	1.27 s	702 N	596 Ns	6.80:1	287 g	38/298 mm
J605F	586 N	1.26 s	886 N	738 Ns	8.48:1	367 g	38/476 mm
I500	508 N	0.663 s	1155 N	338 Ns	7.35:1	748 g	38/719 mm
J1026	1039 N	1.21 s	1193 N	1264 Ns	15.03:1	616 g	38/625 mm
Total:				3249 Ns	45.64:1	2194 g	



-CAD/CAM (Drawing Generation)
-CFD (Theory Analysis)
- 3D Printer (Prototype)
-Wind Tunnel (Experimental Analysis)
- Rocket design simulator (like OpenRocket or ANSYS)

Phase II: Build

Rocket Engine Components
- Air Frame
- Payload
- Recovery System

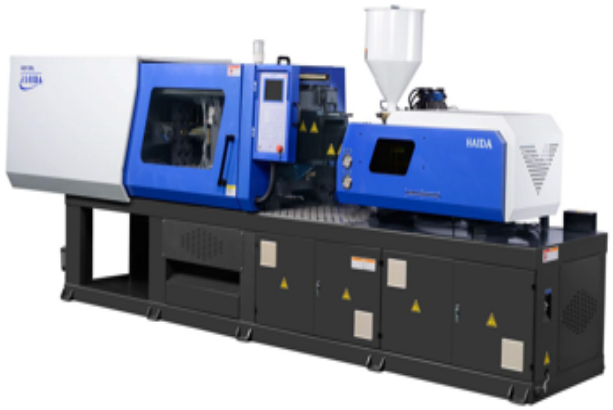


CBEIS 018: Component Fabrication

MEB 136 Lab: Components Assembly

Phase II: Build

Arc-Welding Machine



Injection Molding Machine

CNC Cutting Machine

Other Tools

Phase III: Safety

Establish Morgan Safety Council

- Vice President of Research and Economic Development
- Manager of Building Construction and Management
- Fire Marshall
- Lead faculty
- Supporting staff

Conduct Safety Training

Observe Safety Precautions

Contact Information for Safety Related Issues

Fire Marshal
Christopher G. Evans
Fire Life and Environmental Health Safety
Programs - DCM
Phone: 443-885-4451
Cell: 443-757-7486, Fax: 443-885-8269

University Police
Phone: 443-885-3103

For Minor Accidents
University Health Center

For Serious Accidents Dial:
911 or 0

Hospital & Ambulance
Med-Star Good Samarian Hospital

Phase III: Safety

Create safety guidelines and procedures

- General rules
- Work areas and apparatus
- Injuries and & accident guidelines
- Emergency procedures
- Personal protective equipment
- Guidelines to use tools and equipment


Fire Extinguisher


Gas Masks Protection


Eye Protection Googles


Dust Protection Masks

First Aid Kit Box

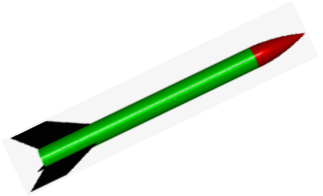

High Temperature Gloves


General Machine Gloves


Head Protection


Hearing Protection

Phase IV: Launch



1. Training and Combustion Testing
2. Launch Location Coordination
   - ➢ Goddard Space Flight Center or
   - ➢ Wallops Space Flight Center
3. Launch Window Determination
   - ❖ Risk Analysis
     - ❖ Determining go or no-go flight launch at
     - our flight headquarters.
4. Recovery by Streamer, Parachute or GPS
5. Evaluation