

NASA

Exploration Systems Mission Directorate (ESMD) Summer 2010 Faculty Fellowship

Christina L. Carmen, Ph.D.

Mechanical and Aerospace Engineering Dept.

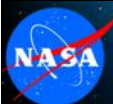
University of Alabama in Huntsville

Project: X-TOOLSS

Marshall Space Flight Center

Huntsville, Alabama

**Great Midwest Space Grant Meeting
Minneapolis, MN
Sept. 16-17, 2010**



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2010 ESMD Faculty Fellowship Project

Christina L. Carmen



Tommy Morris



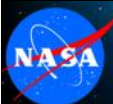
Peter Schmidt



Paul van Susante



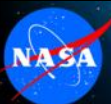
Janusz Zalewski



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Purpose of the NASA ESMD Faculty Fellowship

- Prepares 5 selected university faculty to enable senior design students to complete projects during the 2010-2011 academic year with potential contribution to NASA ESMD objectives.
- The faculty gain extensive knowledge on the ESMD project and develop materials for use by their senior design students using a systems engineering approach.

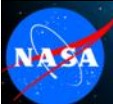


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Project Goal

2010 Faculty Fellowship Solicitation

- 8 weeks on a selected ESMD project
- at Kennedy Space Center (KSC) for one week
- Incorporate project into an existing senior design course or capstone course in the 2010/2011 academic year.
- work side-by-side with a NASA technical expert.
- Gain extensive knowledge on the ESMD project and associated requirements, interfaces and issues affecting the design and potential solution(s).
- develop materials for use during the 2010/2011 academic year
- Use a systems engineering approach



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Overview of ESMD projects

Spacecraft

Guidance, navigation, and control;
Thermal; Electrical; Avionics; Power systems; High-speed reentry;
Interoperability/Commonality; Advanced spacecraft materials; Crew/Vehicle health monitoring; Life-support systems;
Command/Communication software;
Modeling and simulation

Ground Operations

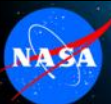
Pre-launch; Launch; Mission operations; Command, control, and communications; Landing and recovery operations

Propulsion

Methods that utilize materials found on the Moon and Mars; On-orbit propellant storage; Methods for soft-landing

Lunar & Planetary Surface Systems

Precision landing software; In-situ resource utilization; Navigation systems; Extended surface operations; Robotics; Environmental sensors and analysis; Radiation protection; Life-support systems; Electrical power and efficient power management systems



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Senior Design Projects Selected



Christina Carmen (**MSFC**) University of Alabama at Huntsville
MSFC1-20-SD NASA Exploration Toolset for Optimization of Launch and Space Systems (XTOOLSS)



Thomas Morris (**JSC**) Mississippi State University
JSC4-36-SD Implement Codecs on FPGA's



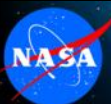
Peter Schmidt (**KSC**) University of North Carolina at Charlotte
KSC1-06-SD Umbilicals and Quick Disconnect Couplings



Paul van Susante (**KSC**) Colorado School of Mines
KSC1-05-SD Lunar Regolith Excavation 02 Prod/Outpost Emplace



Janusz Zalewski (**ARC**) Florida Gulf Coast University
ARC2-07-SD Prognostics for Complex Sytems

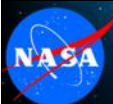


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NASA ESMD

2010 Faculty Fellowship Schedule

Date	Task
June 2- July 23, 2010	Report to NASA facility for 8 weeks to work on ESMD project
July 26-30, 2010	ESMD Faculty Fellows convene at KSC
Sept. 2010	Present at regional Space Grant Conference
Fall 2010-Spring 2011	Implement Senior Design Project



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NASA ESMD

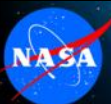
Space Grant Meeting Assignments

Faculty	Space Grant Meeting	Dates	KSC Attendee
Christina L. Carmen	Great Midwest Minneapolis, MN	9/17/10- 9/18/10	Diane Ingraham
Tommy Morris	Northeast Newport, RI	9/10/10- 9/11/10	Susan Sawyer
Peter Schmidt	Southeast South Carolina	TBA	Gloria Murphy
Paul J. van Susante	Mid-Atlantic Delaware	9/16/10- 9/18/10	Mandi Falconer
Janusz Zalewski	Western Omaha, NE	9/16/10- 9/18/10	Luis Rabelo



Significance of ESMD Projects to NASA's Mission and ESMD Objectives

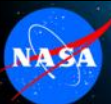
- Education and outreach of ESMD
- Gathering ideas while creating experience
- Create long lasting experience that translates to students for many years
- Create translation to lower level students for further development of workforce
- 600 students exposed this year alone



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ESMD-Faculty Fellowship Project

Dr. Christina L. Carmen, Ph.D.
Marshall Space Flight Center
Huntsville, AL.

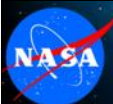


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Overview

1. X-TOOLSS Project
2. X-TOOLSS Optimization Using Nastran
3. Lunar Wormbot Design Project
4. Systems Engineering Design
5. Summary

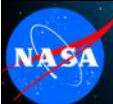


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NASA ESMD X-TOOLSS Project

- Marshall Space Flight Center (MSFC)
- X-TOOLSS (eXploration Toolset for Optimization Of Launch and Space Systems)
- Software package developed at North Carolina A & T (NCAT) via a grant from NASA
- Developed for scientists and engineers to solve optimization problems

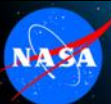


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NASA ESMD X-TOOLSS Project

- X-TOOLSS project history began with NEVOT (Nuclear Exploration Vehicle Optimization Team)
- Today, the development and use of X-TOOLSS continues with the following:
 - North Carolina A&T State University (Computer Science dept.)
 - Marshall Space Flight Center
 - Oak Ridge National Laboratory
 - Arnold Engineering Development Center
 - And now...The University of Alabama in Huntsville (UAH)
 - First use of X-TOOLSS in a senior capstone design class

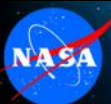


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NASA ESMD X-TOOLSS Project

- X-TOOLSS requires a code file (java script or an executable application file)
- X-TOOLSS can be used with MATLAB, COMSOL, Nastran, etc.
- The use of X-TOOLSS at UAH will focus upon the optimization of the design via FEA using Nastran
- All MAE students at UAH learn MATLAB and all mechanical engineering students learn Patran/Nastran



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X-TOOLSS Optimization Using Nastran

Example Application

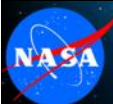
- Typical application of X-TOOLSS within the UAH Mechanical and Aerospace Engineering senior capstone design class.
- CO₂ Launching Mechanism, Team 10, Spring 2010.



Figure 1: HotShot Raceway™ CO2 Dragster Launcher



Figure 2: MAE Team 10 Final Product



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X-TOOLSS Optimization Using Nastran

Example Application

Visualization of the Finite Element Analysis (FEA) results via computer graphics and animation provides a critical understanding of a model's behavior, how the model/part will move and how the design can be improved.

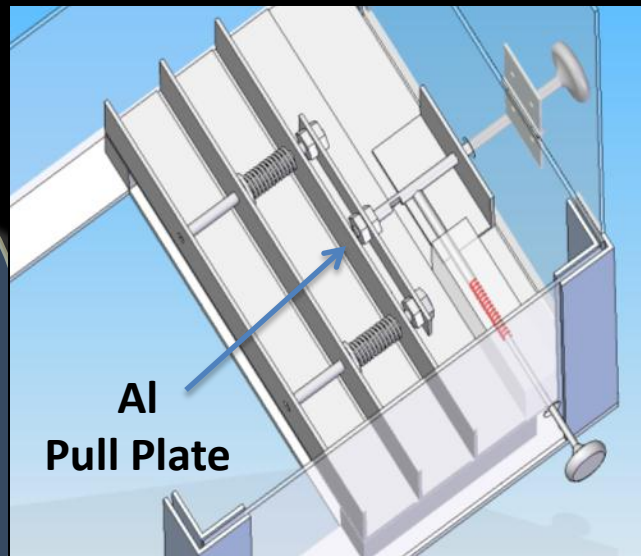


Figure 3: MAE Team 10 CAD Model

Patran 2008r2 Pre-Release 07-Jul-10 09:29:35

Contour: Default, A2:Static Subcase, Stress Tensor, , von Mises, At Z2

Fringe: Default, A2:Static Subcase, Stress Tensor, , von Mises, At Z2

Vector: Default, A2:Static Subcase, Constraint Forces, Translational, , (NON-LAYERED)

Deform: Default, A2:Static Subcase, Displacements, Translational, , (NON-LAYERED)

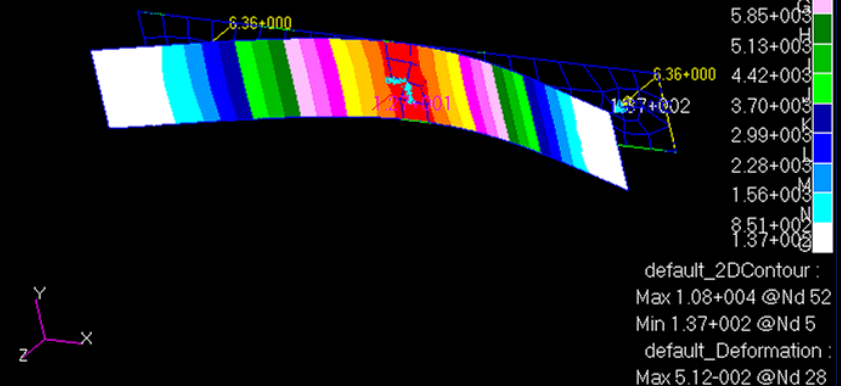
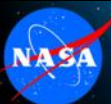


Figure 4: MAE Team 10 FEA



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X-TOOLSS Optimization Using Nastran

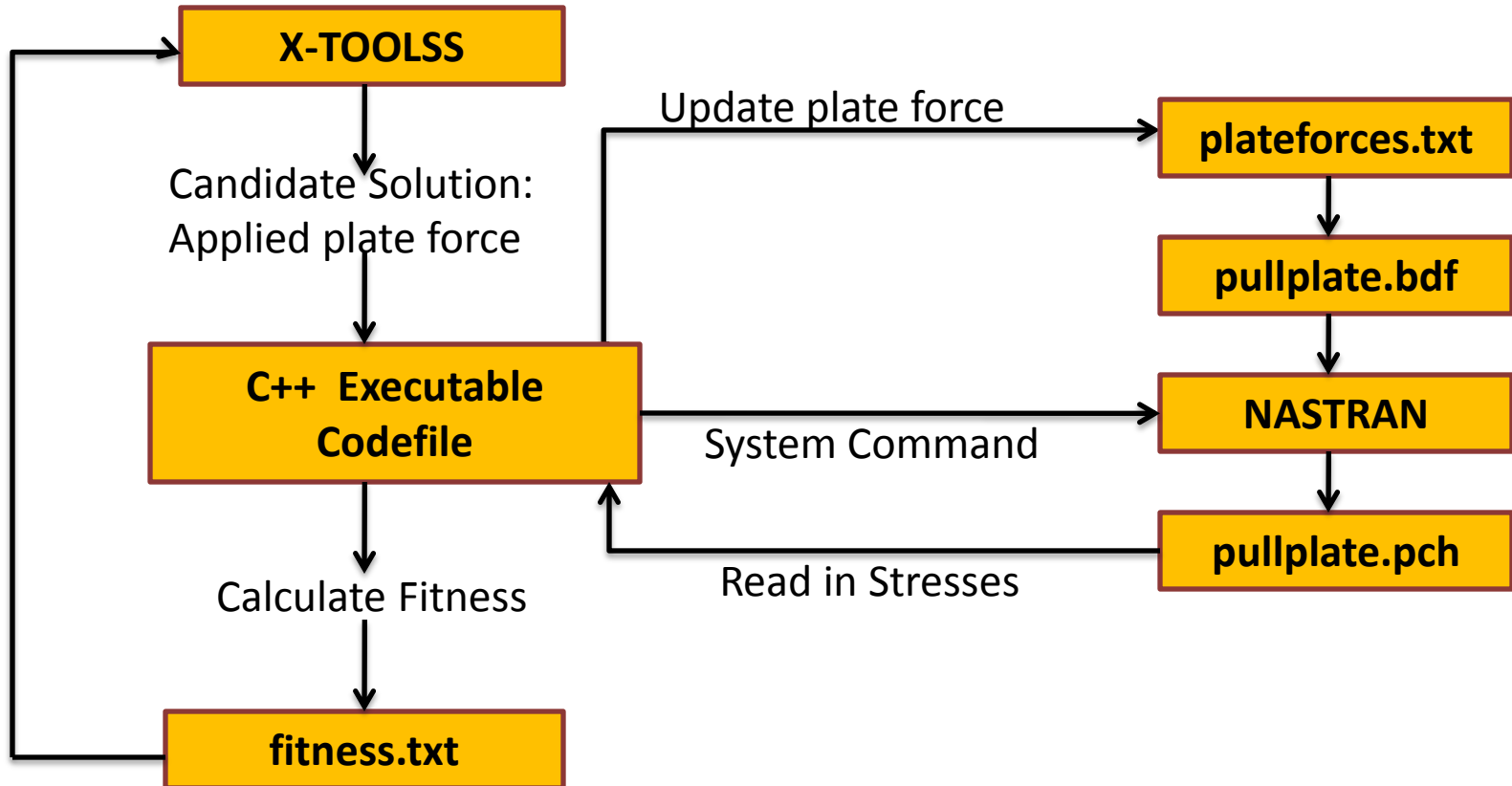
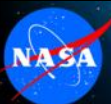


Figure 5: The X-TOOLSS/Nastran Optimization Loop

Lunar Wormbot Design Project

- Engineers at the National Space Science and Technology Center (NSSTC) in Huntsville, AL have developed conceptual designs of a “Lunar Wormbot” – a device to burrow into lunar regolith.
- UAH MAE design teams will refine the design and fabricate the hardware.
- X-TOOLSS will be utilized during the conceptual design phase.



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Lunar Wormbot Design Project

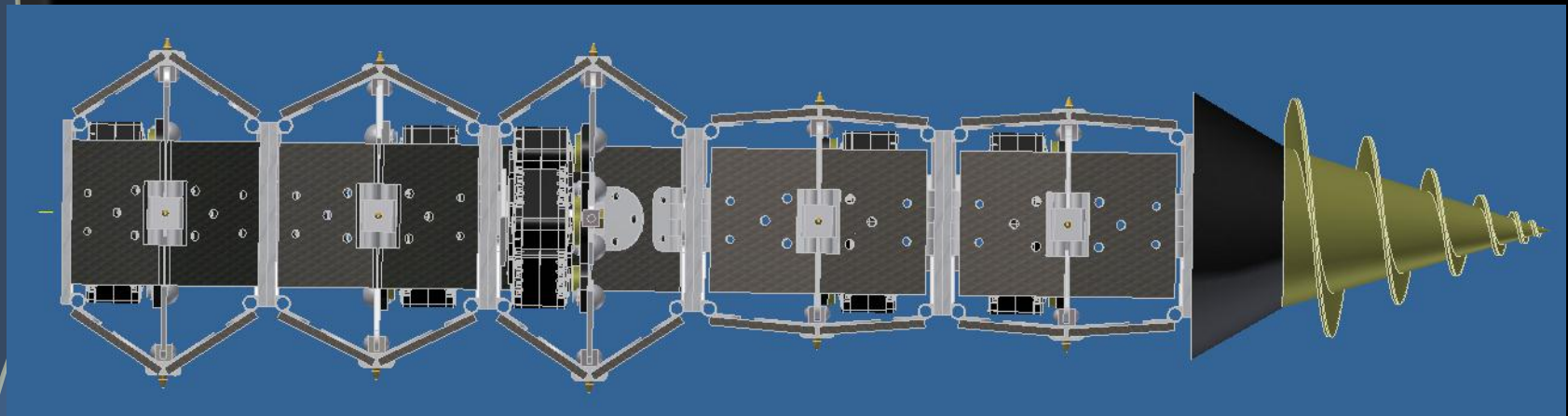


Figure 6: Lunar Wormbot - Sideview

Lunar Wormbot Design Project

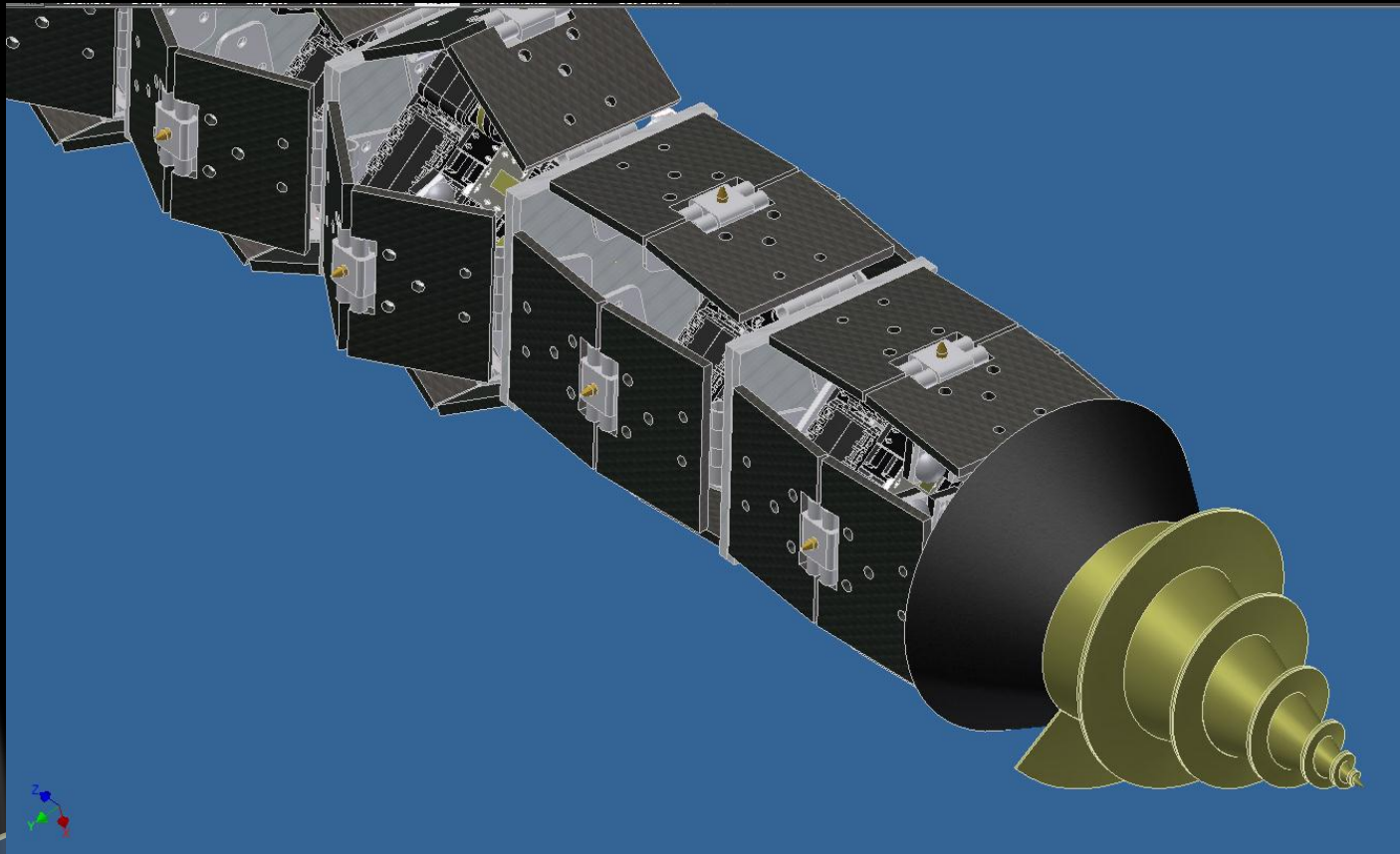
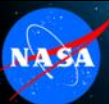


Figure 7: NSSTC Conceptual Design of the Lunar Wormbot



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Lunar Wormbot Design Project

- Components include:
 - piezoelectric ultrasonic drill
 - conical auger
 - multiple elongating segments mimicking the peristaltic motion of an earthworm
- Sensor platform may include: heat vision, microphone array, navigation, density sensors, radar

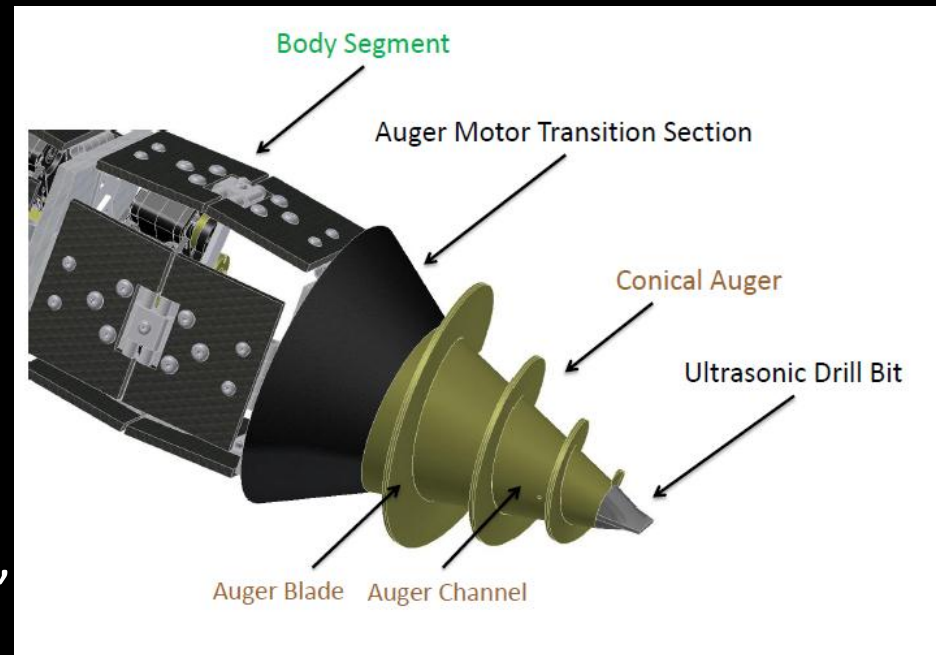
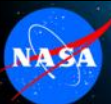


Figure 8: Lunar Wormbot

Lunar Wormbot Design Project

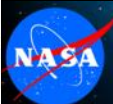
- UAH MAE design teams
 - Conduct multiple design reviews
 - Interact with NASA/NSSTC engineers and technical advisors at Johns Hopkins University, Embry Riddle University and the University of Maryland
 - Implement X-TOOLSS design optimization software
 - Gain critical experience designing, analyzing, fabricating, testing and demonstrating space hardware.



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Systems Engineering Design

- NASA ESMD website:
<http://education.ksc.nasa.gov/esmdspacegrant/>
- Apply SE design process to senior design projects at UAH
- Integrate lectures available at the ESMD Space Grant website in the senior Mechanical and Aerospace Engineering product realization design class at UAH.

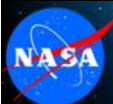


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Summary

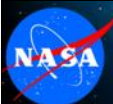
- 2010 Faculty Fellowship program supports NASA's ESMD objectives
- X-TOOLSS provides a flexible optimization methodology that leads to improved designs
- Lunar Wormbot hardware will be developed by UAH MAE senior design teams during 2010-2011
- Systems Engineering lectures and material will be developed during 2010-2011



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Acknowledgements

- NASA ESMD Space Grant Project
 - Gloria Murphy
 - Diane Ingraham
- MSFC ES-22
 - Dr. Michael Tinker-NASA Mentor
 - Ben Dimiero
 - Jesse Huguet, Adam Burt, Erin Moore, Paula Ditteon
- NSSTC Lunar Wormbot Project
 - Dr. Jessica Gaskin
 - Blaze Sanders
 - Lafe Zabowski
 - Michael Kuhlman
- UAH Office of Sponsored Programs
- UAH MAE Department
- Great Midwest Space Grant Meeting – University of Minnesota



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