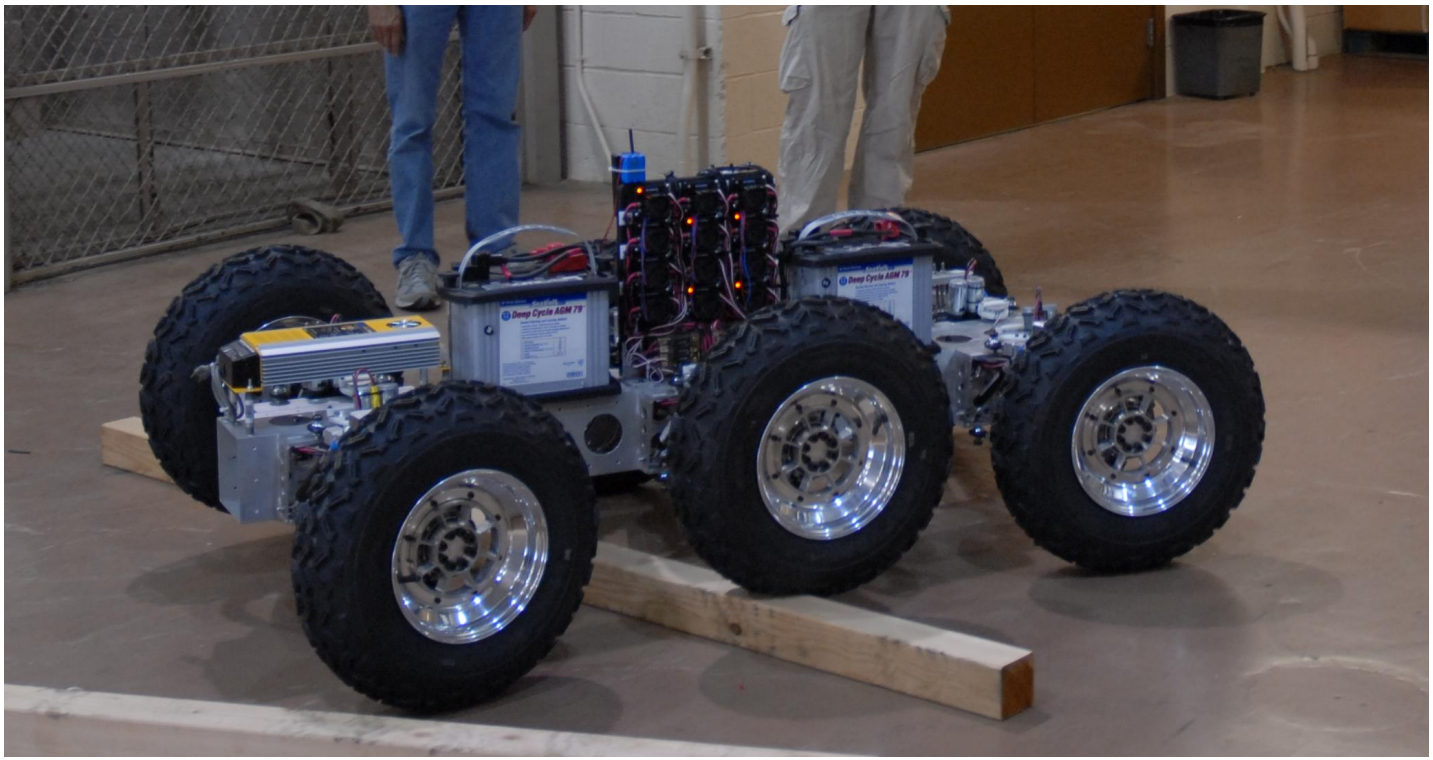
The Mobility Modular Technology Demonstrator - A First Look at its Role

Presented By:

Jim Zakrajsek (RXM) / Phillip Abel (RXT)



The Mobility Modular Technology Demonstrator

Outline:

- Mobility at GRC
- A Bit of History
- NASA Partners
- Glenn Contributions
- Acknowledgements

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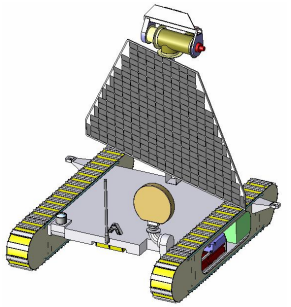
Mobility at GRC - at a glance

Various parallel and related (to varying degrees!) efforts:

- FIRST school robotics competition support
- Mobility component of Lunar Lander Study Team
- Carnegie Mellon University collaboration team
- Mobile sensor platform development
- ISRU Mobility Platform development



- ESAS Area 12 B,C,E - "Human-System Interaction, Surface Handling, and Surface Mobility Systems" - Chris Culbert, Project Manager, NASA JSC

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Mobility at GRC - ESAS 12E - Surface Mobility Systems

A bit of history (or how did we get here??)

- Just two short years ago, responding to the call for "Internal Competitive Proposals" (ICP), and looking at the future technology needs of the nascent Exploration Systems program,

  we recognized and advocated **unique GRC strengths** / areas of expertise, in collaboration with JSC, KSC, & MSFC,

  resulting in the selection of:

Advanced Mechanisms and Tribology Technologies for Durable Lightweight Actuation & Mechanical Power Transmission Systems

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A bit of history:

Human & Robotics Technology

Advanced Space Technology Program

Advanced Materials and Structural Concepts

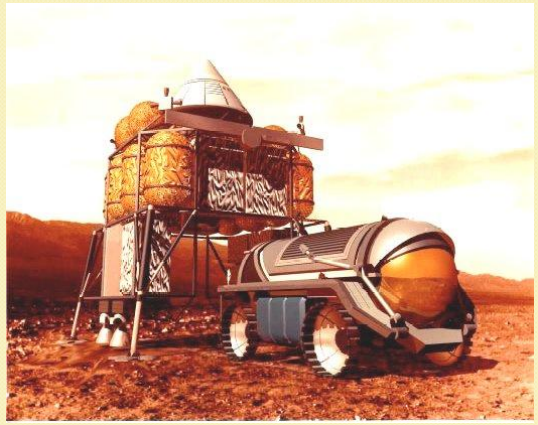
Proposal #: HRT-ICP-04-0000-0056, Advanced Mechanisms and Tribology Technologies for Durable Lightweight Actuation and Mechanical Power Transmission Systems

Key Personnel: Phillip B. Abel /GRC, PI; James J. Zakrajsek /GRC, Co-PI; Wayne Jermstad /JSC; Robert P. Mueller /KSC; Howard G. Gibson /MSFC

Objective: Design and build highly reliable, longer lived, lightweight moving mechanical assemblies for space environments with significantly improved mechanisms and tribology capabilities. Advance expertise in mechanisms and tribology technologies to reduce overall mission risk with confidence in maintenance intervals and reliability predictors. Expand space mechanisms predictive database.

Approach: Phase I technology assessments will be matched with developing mission requirements to target enabling mechanism designs. Phase II component testing will lead to a space mechanisms database of use to space exploration hardware designers.

Impact: Enables long duration Moon and Mars exploration missions with high levels of reliability crucial to astronaut safety. The Technology Maturation Program to benefit most from this effort will be Lunar and Planetary Surface Operations Technology.



Artist concept multi-person, pressurized Mars reference mission transport. (NASA SP 6107)

Planned Resources: $14.8M over 4 years

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Mobility at GRC - ESAS 12E - Surface Mobility Systems

With nine of ten ICP's cancelled, and effectively all external awards terminated, our broad applicability (and specifically to robotics) caused our survival, with **new partners**:

JSC (lead), ARC, JPL, KSC, LaRC

in

ESAS Area 12 B,C,E - "Human-System Interaction, Surface Handling, and Surface Mobility Systems"

Chris Culbert, Project Manager, NASA JSC

Jim Zakrajsek, GRC PI, Phil Abel, Co-I,

John Caruso, PM, Tim Krantz, Team Lead

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Mobility at GRC - New Partners - JSC:

Centaur Mechanical Assembly - Base

Fit Checking **Robonaut**'s "Dust Proof" Suit

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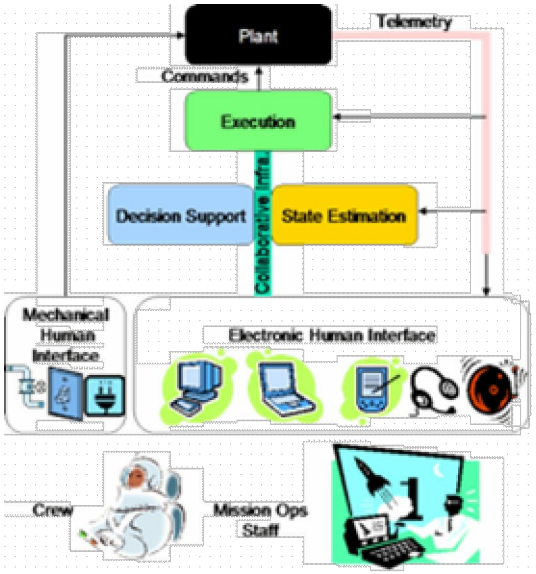
Mobility at GRC - New Partners - ARC:



SAVH Architecture

Brahms/Mobile Agents team is responsible for developing "Collaborative Infrastructure" (center green bar) by which Spacecraft Autonomy and Vehicle Health components interact with each other and with people.

Up-Graded K-10 Rover

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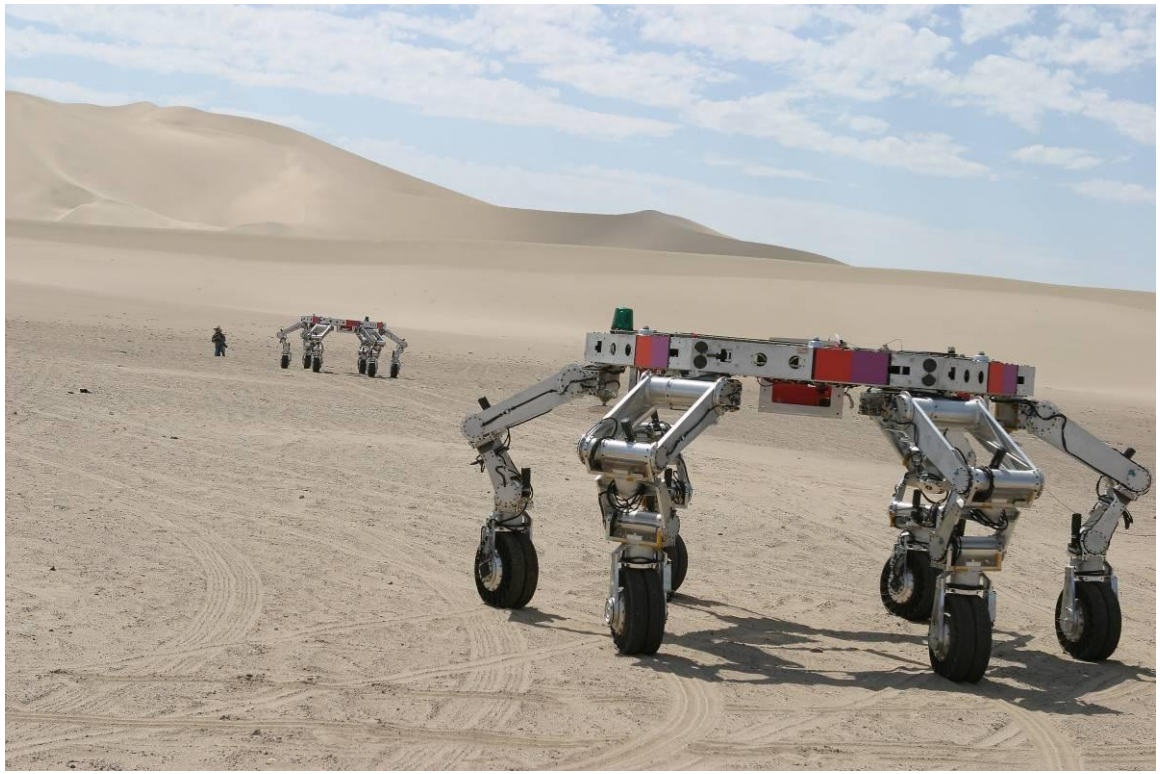
Mobility at GRC - New Partners - JPL:



Desert testing of Athlete half-scale prototypes

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Mobility at GRC - New Partners - KSC, LaRC:

"Preliminary Design Study For Lightweight Efficient Lunar Cranes"

KSC - Umbilicals

Umbilical subsystem hardware and interface requirements -

Demonstrated auto-docking by robotic vehicle seeking recharge.

Langley Articulated Truss Space Crane

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Mobility at GRC - ESAS 12E - Surface Mobility Systems

We determined that our new partners still lacked vacuum compatible, cryogenic capable lunar running gear. So in addition to the component / subsystem work, we embarked on a campaign to provide the means to quantitatively compare tractive options:

Simulated Lunar OPErations facility (SLOPE)

Soils Design Laboratory

Mobility Modular Technology Demonstrator (MMTD)

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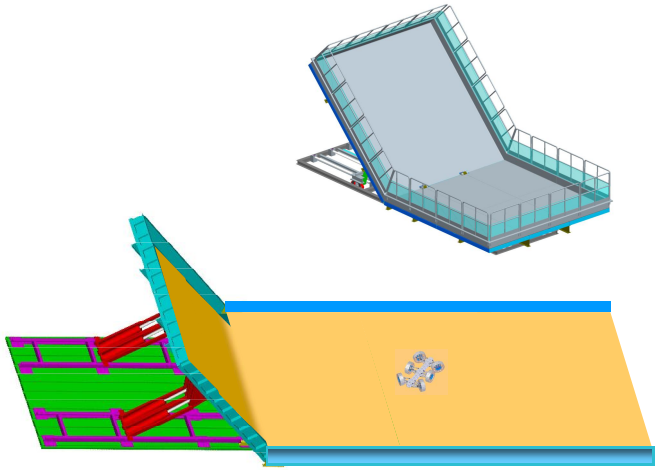
Simulated Lunar OPErations facility (SLOPE)



SLOPE Concept - granular media mobility comparisons.
Dimensions: 20’ x 60’ x 12”
Tilt bed to 45° - 20’ x 20’

Partially complete - 20’ x 40’ flat section

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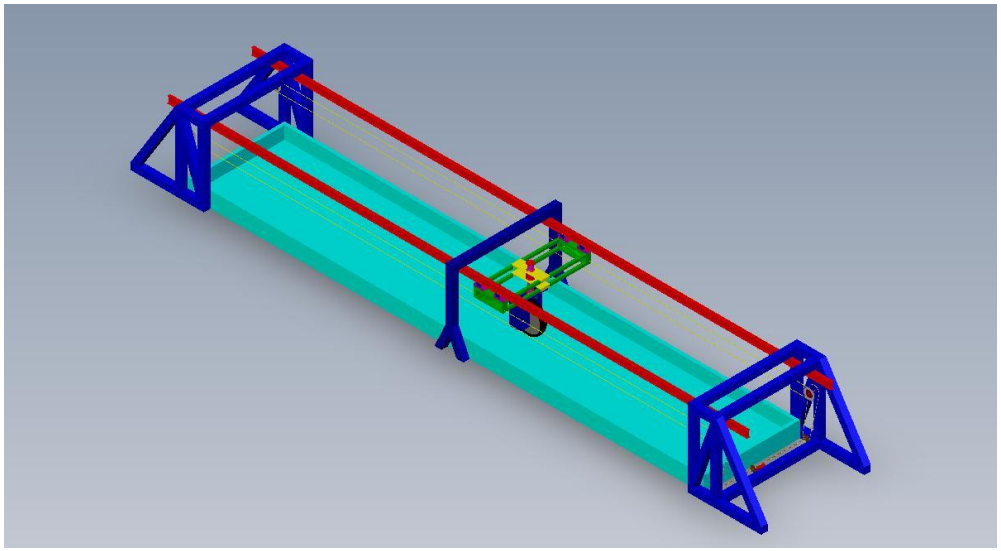
Soils Design Laboratory



Single Wheel-Soil Dynamometer

Completed **Bevameter** instrument

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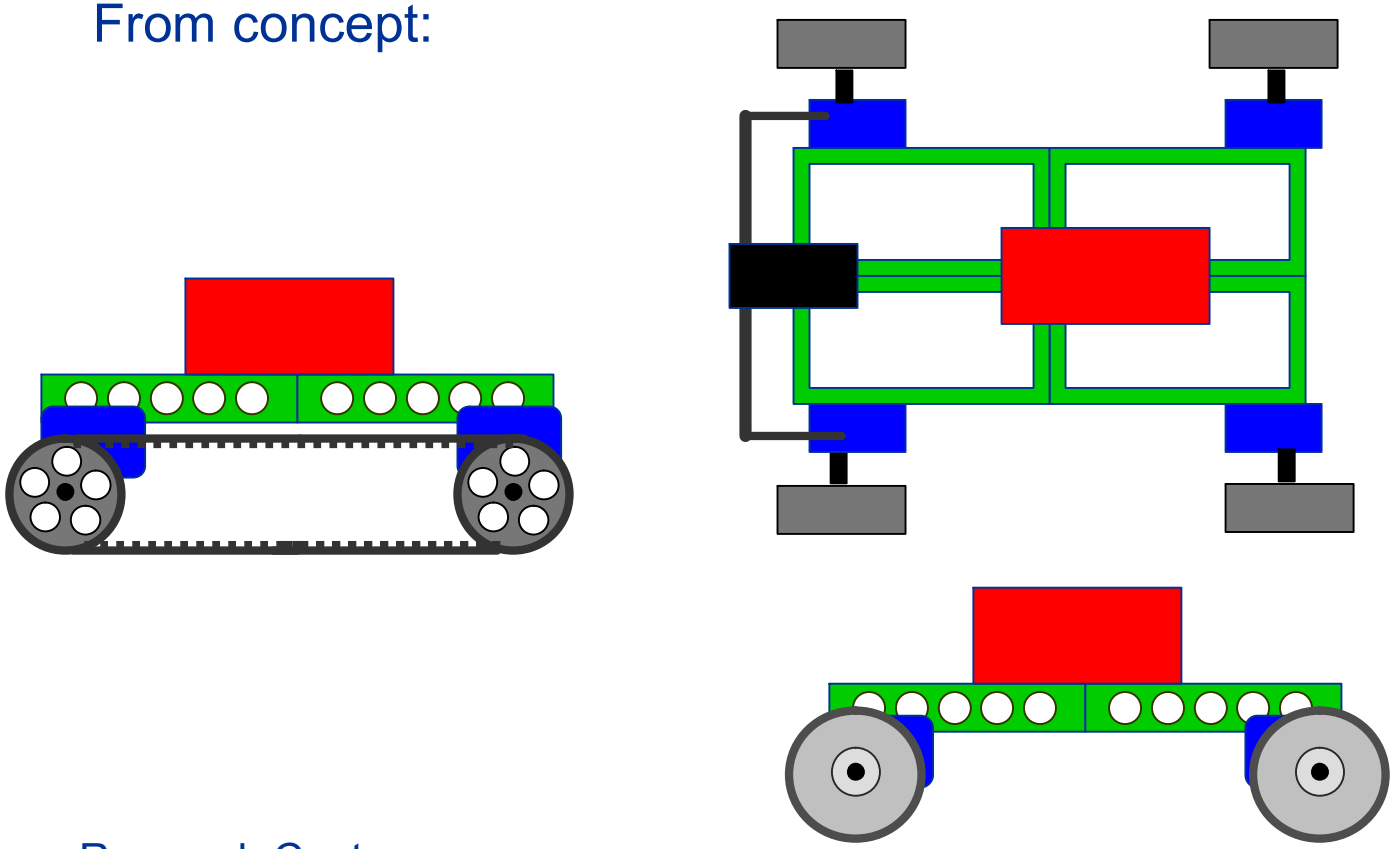
Mobility Modular Technology Demonstrator (MMTD)

From concept:



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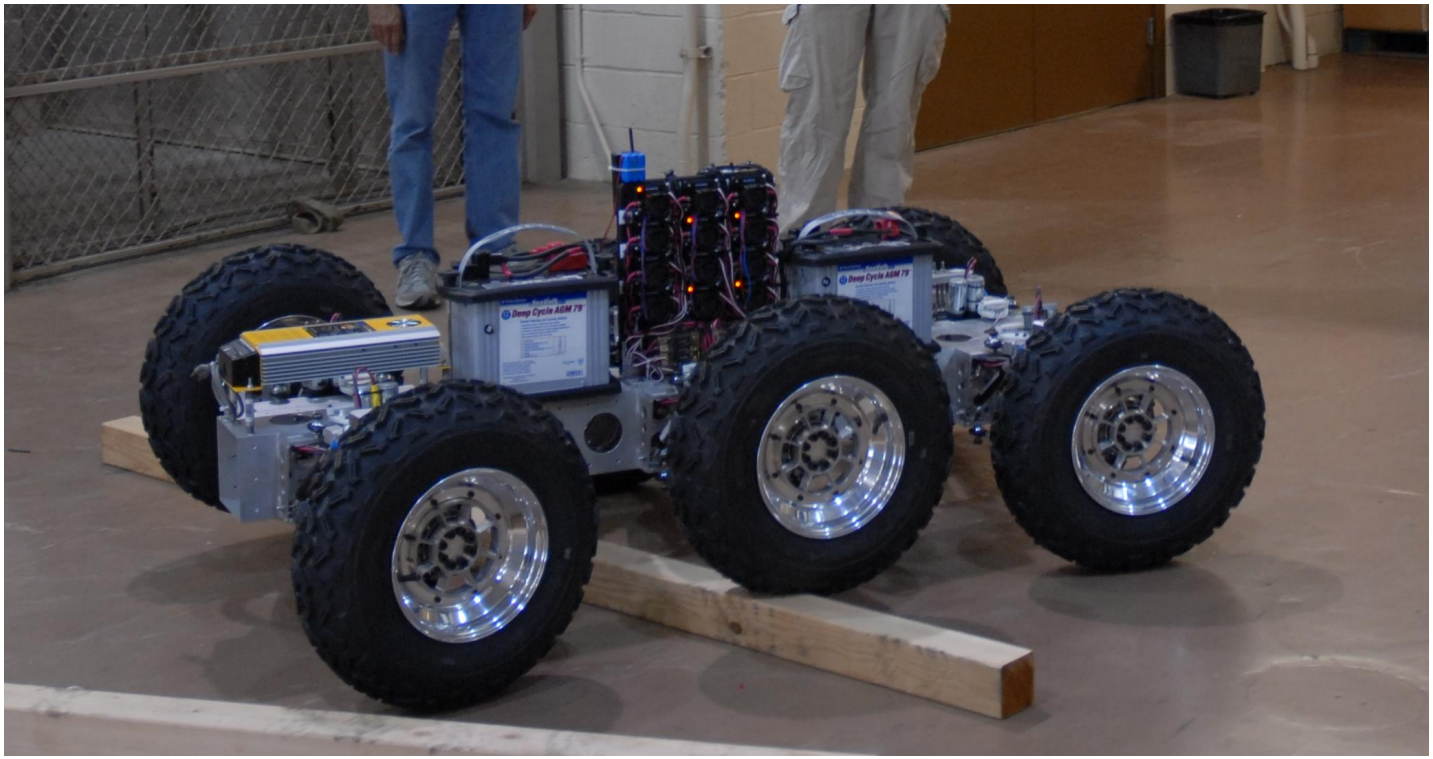
Mobility Modular Technology Demonstrator (MMTD)

To accomplishment, in 6 months:



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Mobility at GRC - ESAS 12E - Surface Mobility Systems

Mobility Modular Technology Demonstrator (MMTD)

- A demonstrator vehicle designed to allow rapid, quantitative comparisons of rover propulsor technologies as applied to simulated lunar and Martian terrain
- Modular to allow alternate technologies to be compared in parallel or serially in a timely manner
- Instrumented to provide high fidelity measurements made under highly controlled conditions

June 30, 2006 - First roll out.

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Mobility at GRC - ESAS 12E - Surface Mobility Systems

Overview of Research & Development Planned with new Facilities:

- Develop validated soil similitude relationships to accurately link results of MMTD tests in SLOPE facility to anticipated performance under lunar conditions
- Conduct traction & grade tests to evaluate state of the art and advanced running gear designs
- Develop validated lunar traction mechanics model
- Research & development of advanced traction control and obstacle avoidance

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Acknowledgements

The design and development of the MMTD, SLOPE facility and soil lab was made possible through the hard work & dedication of the following people at GRC:

Tim Krantz (*Team Lead*), Vivake Asnani, Steve Bauman, Mark Poljak, Damon Delap, Fred Oswald, Jeff Trudell, Frank Kmiecik, Eric Miller, Ken Street, Bob McClusky, John Veneziano, Colin Creager, and many more.

THANK-YOU!