NASA MARS SCIENCE LABORATORY

Affordability of Space Robots

Brian H. Wilcox - Team Lead
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818-354-4625

Jan 21, 2003

Team and Review Charter

- **Tiger Team Charter: Role is to carry the concepts developed at the MSL Rover Workshop (Oct 28-30 2002) to the next level of maturity.**
- **Review objectives:**
  - Review the validation (or not) of the use of the recommendations of the rover workshop. Among the key concepts which require validation are
    - the "one pass" design philosophy, where each subsystem is given sufficient mass, power, volume and other resources that their design can proceed with minimal analysis and zero risk of affecting other subsystems,
    - the "isothermal" rover, where waste heat from the (presumed) radioisotope power source is piped throughout the vehicle as required to prevent thermal issues from driving the development budget.
  - Review the system and subsystem designs for completeness and compliance with requirements.
  - Review the credibility of the cost estimate for the proposed rover.
  - Review recommended changes to the technology plan that support the proposed rover for credibility and efficacy.

PRE-DECISIONAL DRAFT; For planning and discussion purposes only

Agenda
JPL Building 264 Room 824

Topic - Presenter	Time
Overview - Wilcox	8:30
EDL - Chen	8:50
System/Scenarios - Eelkema/McCullar	9:05
Science/manipulation - Tamppari/Zimmerman	9:25
Mechanical - Lindeman	9:45
Thermal- Birur	10:15
Avionics/Power - Bolotin/Dawson	10:35
Flight Software - Rasmussen	11:20
Telecom - Valas	11:35
ATLO and Testbeds - LaBorde	12:05
Summary and Discussions - Wilcox	12:35
Lunch	1:00
Resume Discussions in 301-422	2:00
Close	4:30

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Tiger Team Background

- Workshop held off-lab Oct 28-30 with charter to brainstorm ways to reduce cost of rover from ~$240M (Team X estimate) to ~$120M
- Workshop proposed an approach with associated cost estimate of $144M
- Result considered "good enough" to carry to next level of maturity
- Tiger team started late November to report out late January.

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Workshop Problem Statement

- Define a moderately long-range, long-life rover which can carry the science package (MER-like remote and contact sensing PLUS an analytical laboratory) within the cost constraints, and without significantly increasing the cost of EDL, MOS, etc.

	FY 02	$M
FY'02 Cost Cap		630.0
Reserves		165.0
PM/SE/MA/Sci		60.0
MOS/GDS		45.0
Project ATLO		20.0
EDL		140.0
Payload office		80.0
Available for Rover		120.0

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Oct 28-30 Workshop
Strategic Decision Summary

- Spend mass and volume to save money.
- Use largest launch vehicle we can afford (Atlas V/Delta IV).
- Use 5 m launch vehicle fairing and biconic backshell to maximize volume and entry mass.
- Use two RTGs at 110W each and fluid loop to rover extremities for benign component environment everywhere.
- Make minimal use of composite or advanced materials
- Use "catalog" space electronics boards to configure avionics
- Use MER-like telecom system (UHF and X-band, but not fully redundant in both)

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Workshop Cost Estimate

	Team X Surf Sys	Workshop Estimate	comment
- telecom	30.0	18	MER copy $11.3M, ~$7M engineering (use MER spares)
- thermal	10.0	5	HRS kills problems, big margins everywhere
- Power	10.0	10	
- Str/Mob	50.0	25	"one-pass" design philosophy
- CDS	30.0	10	"catalog" computer/IOcards, REU design from MTP
- GNC	20.0	15	fewer/COTS cameras, algorithms from MTP
- FSW	10.0	20	MER FSW w/o CEDL ~$18M, MTP investing $16M
-Testbed	30.0	14	$10M EM SSTB + $4M for simulations
-Mgt	10.0	7	approximately proportional to total Surface System
-ATLO	40.0	20	MER was 23M$+$4M counted elsewhere for 2 systems
	240.0	144	M$

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- Rover/team lead - Wilcox
- Thermal - Birur
- Mechanical - Lindeman/ Bickler/Johnson
- Designer - Kennedy
- FSW - Bob Rasmussen
- Comm - Valas
- CDH/GNC - Bolotin
- Power - Steve Dawson

- RPS - Dodge
- System Engineering - Emily Eelkema/ Michelle McCullar
- Consultant - Bill Layman
- Science - Leslie Tamppari
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Initial Guidelines to Tiger Team
(based on a day with Bill Layman)

- Entry mass ~2400 kg based on 4.6 m aeroshell (ballistic coefficient of 95 kg/m^2)
- Rover mass allocation of 960 kg (scaled up from "Design Cycle 2" 600 kg rover by area of entry body).
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- Power 220 W continuous, 1.5 kW peak power, 50 kg battery.
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Tiger Team Rover Point Design

Mass: 960 kg
Configuration: 6-wheeled rocker-bogie; square 3.05m footprint
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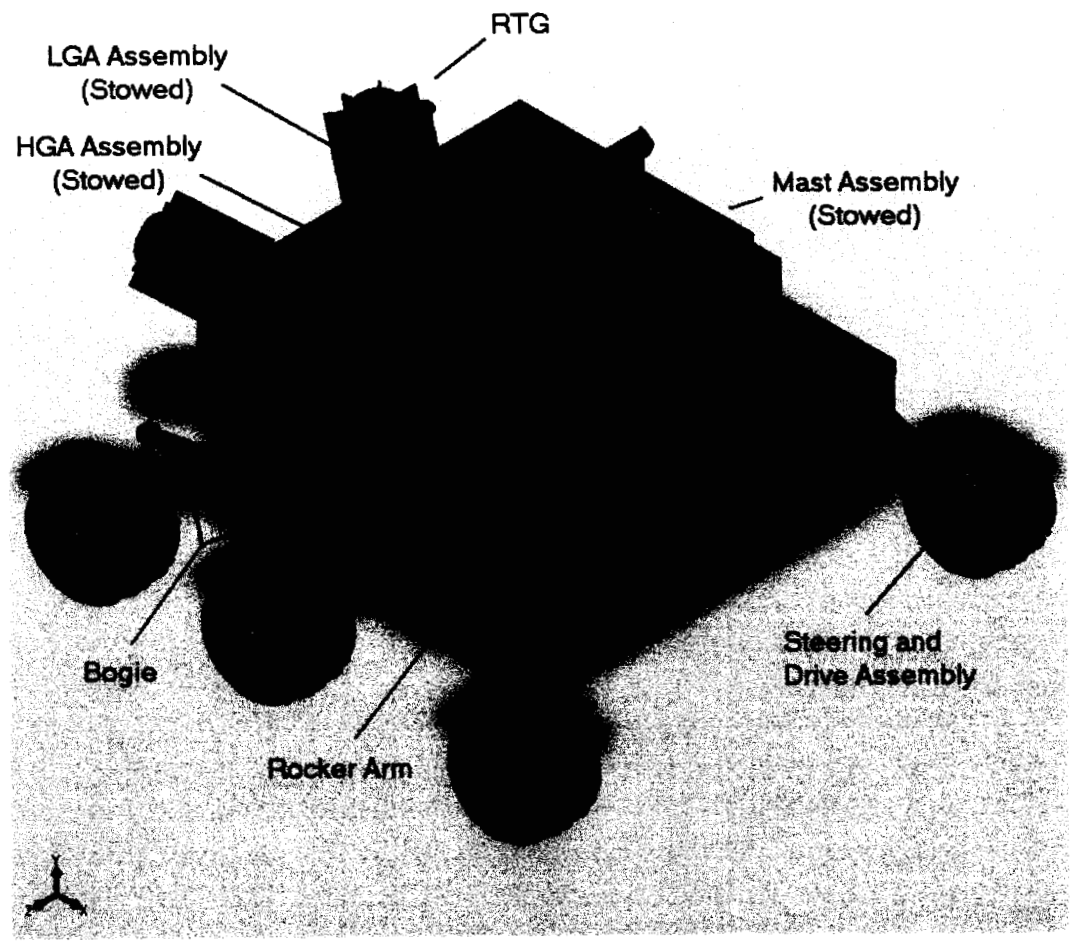

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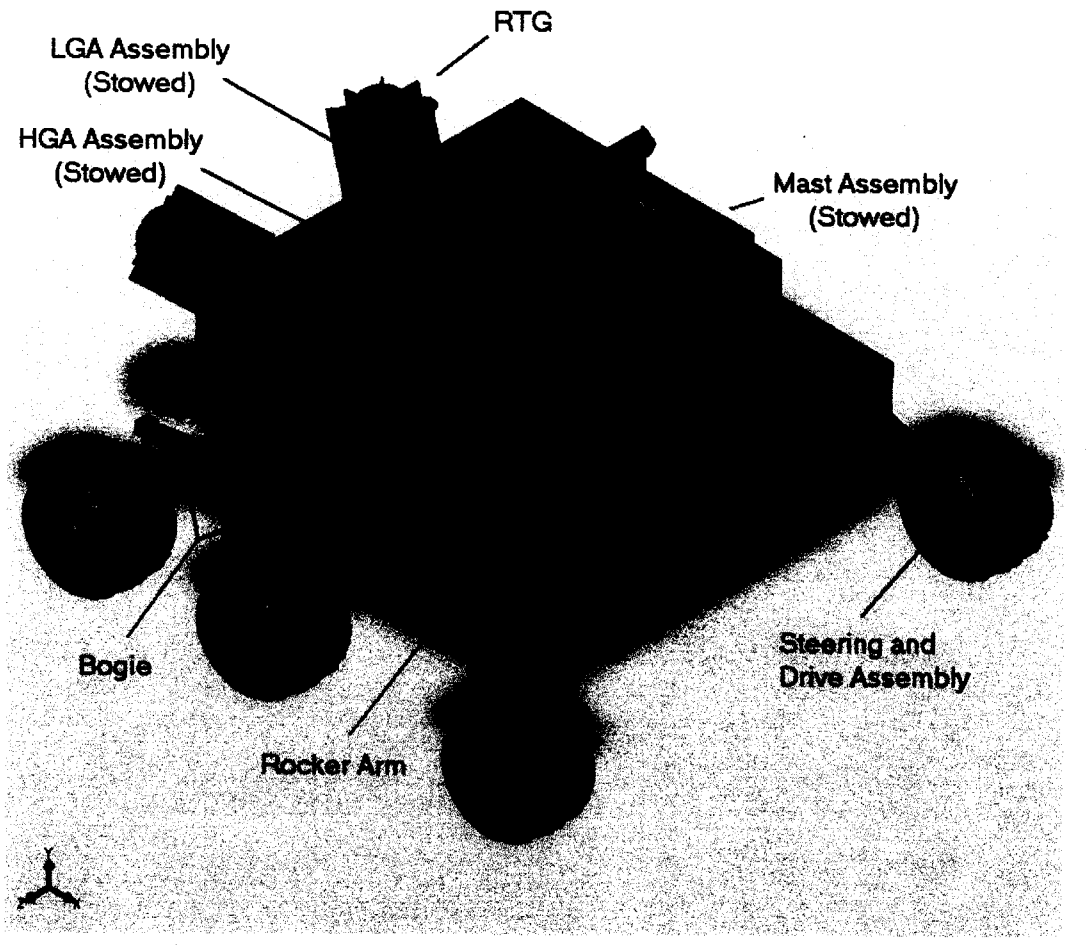

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