Project Number: 900737

Project Start: Jan. 1, **2007** **Project Duration (in years):** **2**

Please indicate what type of project is being proposed (mark only one).

[ ]	[X]	[ ]	[ ]	[ ]	[ ]
Feasibility/Scoping [Less than 100 days effort]	**Development**[1]	**Research**	**Infrastructure**[1]	**Education**	**Time Series**

Project Manager/PI: Alana Sherman/Ken Smith

Project Title: Benthic Rover

[1] Development and infrastructure projects must complete the risk matrix (see item #5 at the end of the proposal form).

1) ABSTRACT (new projects only)

N/A

2) PROPOSAL

a) The problem addressed (new projects only)

Statement of the problem

N/A

b) Approach to the problem (new and continuing projects)

Status of project

Milestones achieved in 2006:

1. Frame, floatation, and propulsion system were built at Scripps and delivered to MBARI in February 2006.
2. Titanium housings were built and pressure tested.
3. Main vehicle controller and motor controllers were acquired, tested, and integrated on the vehicle.
4. All cables and connectors needed for 2006 were purchased.
5. The wiring chassis for the initial electronics and battery sphere was completed. Software scripts were written to control the Rover.
6. The proto-Rover, which consists of a working propulsion system, current meter, and acoustic modem/release, was built and tested in the test tank and cold room.
7. The proto-Rover was deployed twice from the Point Lobos at Smooth Ridge (depth 980m) in July 2006. During these deployments, we tested the propulsion system, the acoustic communication, and the drop weight release. All of these systems are working successfully.
8. We gathered accelerometer data which provided useful information about the Rover in free fall and the impact of hitting the sea floor.
9. We successfully deployed the proto-Rover twice to depths over 4100m at Station M in August 2006 during Ken Smith's Atlantis cruise.

We plan to accomplish the following tasks by the end of 2006:

1. Hold Critical Design Review
2. Complete design and fabrication of respirometer racks
3. Short autonomous deployments in late Fall 2006
4. Collection of first respirometer science data with Rover

Results to date

1. Successful test tank deployments
2. Successful development and deployment of basic Rover platform.
3. Engineering data which characterizes Rover dynamics
4. Presented design results at ASLO 2006

Publications (from the last 5 years)

McGill, P.R., A.D. Sherman, B.W. Hobson, A.H. Uhlman, R.C. Glatts, K.L. Smith, Jr. (2006) Rover II: An Autonomous Bottom-Transecting Instrument Platform for Long-Term Measurements in Deep Benthic Environments. Eos Trans AGU 87(36), Ocean Science Meeting Supplement. Abstract OSI5F – 15..

Smith, K.L., Jr., R.J. Baldwin, H.A. Ruhl, M. Kahru, B.G. Mitchell and R.S. Kaufmann (2006) Climate effect on food supply to depths greater than 4000 meters in the northeast Pacific. Limnol. Oceanogr. 51: 166-176.

Smith, K.L., Jr., R.J. Baldwin, D.M. Karl and A. Boetius (2002) Benthic community responses to pulses in pelagic food supply: North Pacific Subtropical Gyre. Deep-Sea Res. I., 49: 971-990.

Smith, K.L., Jr., R.S. Kaufmann, R.J. Baldwin and A.F. Carlucci (2001) Pelagic-benthic coupling in the abyssal eastern North Pacific: an eight-year time-series study of food supply and demand. Limnol. Oceanogr. 46: 543-556.

Smith, K.L. Jr. and R.S. Kaufmann (1999) Long-term discrepancy between food supply and demand in the deep Eastern North Pacific. Science 284: 1174-1177.

Smith, K.L., Jr., R.C. Glatts, R.J. Baldwin, A.H. Uhlman, R.C. Horn, C.E. Reimers and S.E. Beaulieu (1997) An autonomous bottom-transecting vehicle for making long time-series measurements of sediment community oxygen consumption to abyssal depths. Limnol. Oceanogr. 42: 1601-1612.

Plans for 2007

Since building an autonomous vehicle capable of six-month operations is a challenging task, we will start with a vehicle capable of short-term or tethered deployments. The tethered vehicle will take advantage of the available power and communications at the MARS node. This will allow us to work on developing some of the capabilities required for autonomous operation, and to recover from early software problems, while the vehicle is out in the field collecting data. If the MARS node is not available mid-2007, our contingency plan is deploy the Rover autonomously for month-long periods.

Engineering/technology development plan

1. Complete design and fabrication of the sediment scanner with fluorometer.
2. Continue development of ultrasound sediment imager for scanner. We plan to build a lab unit for testing and evaluation. The results of these tests will help dictate our future development plans.
3. Purchase and integrate transit camera.
4. Build and test cable pack.
5. Build and integrate Load Controllers for power switching, monitoring, and ground-fault detection.
6. Design and build MARS tether interface.
7. Deploy Rover on MARS node for at least six weeks. Transmit respirometer data, other instrument data, and video to shore.
8. Recover Rover and make necessary changes and updates based on initial tethered deployments.
9. Develop software for autonomy and fault recovery.
10. Lab testing and evaluation of ultrasound transducer array.
11. Develop GUI in conjunction with ESP project.
12. Deploy Rover on second tethered mission.
13. Publish in Engineering and Science journals.

Field programs

The following is a list of our planned deployments for 2007:

1. June 2007 - Deploy tethered Rover on MARS node for 6 weeks. (2 Lobos days, 1 mobilization)
2. July 2007- Recover Rover after first tethered deployment (1 Lobos day)
3. August/Sept. 2007 - Deploy Rover on MARS for second tethered deployment for at least 6 weeks (2 Lobos days, 1 mobilization)
4. Fall 2007 - Recover Rover after second tethered deployment (1 Lobos day)

If the Rover is working successfully we may choose to leave it deployed for periods longer than 6 weeks. We will request an additional 2 Lobos days to use

Ventana to monitor the Rover and potentially assess problems that require direct observation.

Data (availability outside project team, uniqueness)

Rover II provides an autonomous platform from which to conduct a diverse series of measurements at the deep-sea sediment-water interface for extended periods of time. These measurements include sediment community oxygen consumption, sediment surface fluorescence, sediment structure, megafauna density and movements, and bottom current flow. In addition, sensors from other investigators can be accommodated on the Rover platform to increase the diversity of concurrent measurements of bottom water and sediment properties along a time-series transect of stations. A proposal is pending to DARPA to develop a microbial fuel cell system to power Rover in the future (development headed by C. Reimers at OSU).

Significant changes from previous project proposal (continuing projects only)
We had planned to design and fabricate both the respirometer racks and the scanner assemblies in 2006. However, due to our aggressive cruise schedule, more effort than anticipated was focused on getting the proto-Rover ready for deployment. Consequently, only the respirometer racks will be completed in 2006. We hope to also complete the design for the scanner assemblies this year, but will fabricate them in 2007.

While we have conducted a feasibility study into the ultrasound imaging transducer, we don't expect to begin lab testing until 2007.

c) Specific deliverables (new and continuing projects)

1. Rover Scanner assembly
2. Operational tethered vehicle
3. Real-time respirometry data and video from the tethered vehicle
4. Development of necessary components for autonomy (power management system, fault detection software)
5. Science and engineering publications

d) Project team (new and continuing projects)

Ken Smith: principle investigator
Paul McGill: lead engineer, electrical engineer
Alana Sherman: project manager, electrical engineer
Brett Hobson and/or Doug Pargett: mechanical engineer
Rich Henthorn: software engineer, embedded system development

Andrew Chase: software engineer, user interface and data systems development
John Ferreira: mechanical technician
Larry Bird: mechanical technician, cable pack management

e) Project lab space (new and continuing projects)

We would like to continue using our current lab space outside the cold room.

3) BUDGET JUSTIFICATION (new and continuing projects)

2007 Benthic Rover Budget:

Item	**Net cost**
Science Instruments	
Video Camera - benth resp	$2,137.94
Digital Camera - transect	$16,237.50
Camera strobe	$10,175.50
Current Meter with CTD	$13,569.14
Ultrasound xducer array	$5,412.50
Ultrasound electronics	$16,237.50
Recovery Instruments	
Acoustic modem	$11,658.14
Burn wires	$1,894.38
HomerPro	$5,196.00
Electronics	
Load Controller electronics	$10,825.00
Video server	$2,814.50
Development software	$1,082.50
Fluorometer	$8,660.00
Motor controller	$2,706.25
Cables and Connectors	$21,650.00
Batteries	$2,165.00
Misc. elec. components	$2,165.00
Mechanical System	
Scanner Assemblies	$13,639.50
Misc mech. parts	$5,412.50
MARS Deployment	
MARS ODI connector	$11,907.50
Umbilical cable	$5,412.50

Umbilical line drivers	$1,623.75
Adhesive for umbilical pack	$433.00
400V power converters	$1,082.50
Housing for MARS interface	$5,412.50
General	
Freight	$1,000.00
Tools	$2,165.00
Supplies- Eng. Lab	$3,247.50
Supplies- General	$4,330.00
Travel	$6,495.00
Conference fees	$1,800.00
Total Budget	$198,548.09

This budget assumes that the respirometers and rack will be completed by the end of 2006. The money earmarked for the MARS deployments will be used for Lithium battery packs if MARS is not ready and we need to make autonomous deployments instead.

4) MILESTONES (new and continuing projects)

	Milestone 1	Milestone 2	Milestone 3	Milestone 4	Milestone 5	**Total Resources**[2] for each resource category for all milestones listed here
Milestone Date	**Spring 2007**	**June 2007**	**2007**	**Fall 2007**	**mid 2007**	
Milestone Description	**Scanner Integration**	**Tethered deployment on MARS**	**Development of Ultrasound Imager**	**Second tethered deployment**	**Engineering & Science publication**	
EE	**40**	**40**	**50**	**20**	**20**	**170 (includes project mgmt)**
SE	**35**	**50**	**30**	**35**	**10**	**160 (40 A.C.)**
ME	**30**	**25**	**15**	**20**	**10**	**100**
Support Engineering						
EE Tech	**20**	**5**	**10**	**5**	**2**	**42**
SE Tech						
ME Tech	**20**	**5**	**10**	**5**	**2**	**42**
Machine Shop	**25**		**5**			**30**

[2] This number should be the same number you entered on the resource requests for this particular resource.

5) RISK MATRIX (development and infrastructure projects only)

Please carefully read Section 5.2.3 in the instructions for internal proposals for an explanation regarding the risk matrix. This table must be completed for **ALL** development and infrastructure proposals (new and continuing). The instructions can be found at http://mww.mbari.org/resources/2007_Proposal_Process/Internal-only_Instructions_2007.htm.

	Technical Risk	Organizational Risk	Tech Transfer Risk	Labor Estimate Risk
High				X
Medium	X			
Low		X	X	