Project Title: TIME FOR TWO WORLDS: THE EFFECTS OF DISPARATE TEMPORAL REGIMES ON MARS ROVER MISSION CONTROL CREWS

Title	Name	Field of Expertise	Telephone	Email	Organization
Lead	Marilyn Dudley-Rowley, Ph.D.	Space Human Factors, Organizational Behavior Analysis of Base and Field Settings, Social Interaction	707-773-1037	md-r@ops-alaska.com	OPS-Alaska
Co-Lead	Constance Adams	NASA Safety/Health Concerns; Aerospace Environments, Architecture	713/862.5959	constance.m.adams@lmco.com www.synthesis-intl.com	Independent space architect consultant with Synthesis International USA.
Other	Sheryl Bishop, Ph.D.	Space Human Factors, Organizational Behavior Analysis, Social Psychology	407-747-6027	slb@ops-alaska.com	OPS-Alaska and the University of Texas Medical Branch, Galveston
Other	John Austin, Ph.D.	Organizational Behavior Analysis	269-387-4500	john.austin@wmich.edu	Western Michigan University & Organizational Behavior Management Network
Other	Thomas Gangale, M.Cand.	Earth-Mars Time Architecture, Aerospace Engineering	707-494-0666 mobile	teg@ops-alaska.com	OPS-Alaska & San Francisco State University

Other Relevant NASA Personnel	NASA Organization
Charlotte Linde	Ames Research Center

Provide work background summaries of key personnel relative to the type of project that is being proposed. For Advanced Space Technology Program projects, where appropriate include titles of 1-2 papers that each key member has published or presented at a conference.

Max 75 words per member

Lead: Dudley-Rowley. Over 20 years' experience in the study of space and polar exploration environments. Skilled in the DARPA project management style. Funded by National Science Foundation. Expert agreement with Human Systems Information Analysis Center (USAF Research Laboratory's Human Effectiveness Directorate). Invited member, DoD Human Factors Engineering Technical Advisory Group. Teaches deviant behavior analysis and research methods, California State University system. Active member, AIAA. Latin American Mars Rover Project. Alumna, Planetary Sciences Summer School, CalTech/JPL.

Dudley-Rowley, Marilyn, Cohen, Marc M., Flores, Pablo. (2004, March), 1985 NASA Rockwell Space Station Crew Safety Study: Results From *Mir.* In *The Journal of Aerospace and Environmental Medicine, Moscow.*

Dudley-Rowley, Marilyn, Bishop, Sheryl L. (2002 October), Extended Mission Systems Integration Standards for the Human-Environment and Human-Human Interfaces (AIAA 2002-6110). 1st Space Architecture Symposium (SAS 2002), Houston, Texas, USA, 10-11 October 2002. Reston, Virginia, USA: American Institute of Aeronautics and Astronautics.

Co-Lead: Adams. Worked independently and at NASA in recent years on human systems, that is, the usable design of spacecraft and space missions. Master's in Architecture from Yale. Apprenticed in Tokyo, worked in Berlin before landing at the Johnson Space Center in Houston, Texas. Most recently, supported the NASA Mission Science console in the Mission Control Center for Columbia flight STS-107. Currently supporting system architecture/management for the ISS Crew Health Care System.

Adams, Constance M. (1998 July). Defin(design)ing the Human Domain: the Process of Architectural Integration in Long-Duration Space Facilities (SAE 981789). 28th International Conference on Environmental Systems (ICES), Danvers, Massachusetts, USA, 13-16 July 1998. Warrendale, Pennsylvania, USA: Society of Automotive Engineers.

Adams, Constance M. (2002). "Sociokinetic Analysis as a Tool for Optimization of Environmental Design." In H. Lane, R. Sauer, D. Feeback (Eds.), *Isolation: NASA Experiments in Closed-Environment Living* (American Astronautical Society, Science and Technology Series, Vol. 104, chapter 3.7, p. 165-175). San Diego, California, USA: Univelt,

Other: Bishop. Also, faculty member of the International Space University. Research include prevention of CAD in commercial airline pilots, (collaborating with Stanford University and United Airlines), extending the MSIS, and the development of a database on multicultural group dynamics. Publication topics include assessment in astronaut screening and evaluation, the interrelated aspects of physiology, psychology, human factors and life support in space, the psychological selection of astronauts and cosmonauts, gender in space, space mission support parameters.

Dudley-Rowley, Marilyn, Whitney, Stewart, Bishop, Sheryl, Caldwell, Barrett, Nolan, Patrick D. (2001, July), Crew Size, Composition, and Time: Implications for Habitat and Workplace Design in Extreme Environments, SAE 2001-01-2139), 31st International Conference on Environmental Systems (ICES), Orlando, Florida, USA, 9-12 July 2001. Warrendale, Pennsylvania, USA: Society of Automotive Engineers.

Other: Austin. Faculty, Industrial/Organizational Psychology, WMU. Organizational Behavior Management, Behavioral Safety, and Human Services consulting, includes: Shell Oil (Deep Sea Drilling Division), WMU's College of Aviation, Aerospace Valves and Hydraulic Systems, Duncan Aviation, other. CDC, other venues (occupational safety) funding: $1.2 million+. Widely published: performance feedback, safety/injury reduction, analysis/diagnostics, evaluating/improving productivity/safety in the workplace, effects of individualized computer workstation changes and performance management on safe behavior, readiness and planning for implementation, and behavior/ergonomic safety topics.

Austin, J. & Wilson, K. G. (in press). Response-response relationships in organizational behavior management. *Journal of Organizational Behavior Management, 21*(4).

Alvero, A., Bucklin, B., Austin, J. (2001). An objective review of the effectiveness and essential characteristics of performance feedback in organizational settings (1985-1998). *Journal of Organizational Behavior Management, 21*(1), 3-30.

Other: Capt. Gangale (USAF Ret.). Former air traffic controller, weapon system officer. Managed two DoD Space Shuttle payloads. World's leading expert in planetary time architecture Inventor, Earth-Mars solar conjunction communication satellite orbits. Co-designer, Mars Arctic Research Station. Active, AIAA. Fellow, British Interplanetary Society. Latin American Mars Rover Project. Invited, mission controller, Voyager program.

Architecture of Time: Design Implications for Extended Space Missions, SAE 2004-01-2533; accepted to the SAE Transactions, *Journal of Aerospace.*

Crew Size, Composition, and Time: Implications for Exploration Design, AIAA 2002-6111).

Lead Organization: OPS-Alaska

Names of any additional participating NASA and other collaborating institutions, if applicable.

1. Mars Exploration Rover Mission Control	NASA-Jet Propulsion Laboratory
2. Mission Control Center	NASA-Johnson Space Center
3.	
4.	
5.	

Brief Summary - which will serve as proposal abstract
Max 750 words

The problem of scheduling mission personnel on multiple shifts and multiple planetary times is a problem that has to be solved during the first spiral, well in advance of the lunar lander and rover missions of the later decade, since it has a make or break effect on possible mission designs. And, it is certainly a problem that has to be solved before human crews are sent to Mars because then, the safety issues become even more complex and the risks multiply with humans operating in base and field configurations. This problem resembles rotating shift schedules in air traffic control and other venues. However, it is unique because of the scheduling involving different planetary diurnal interfaces.

Research begins with data from JPL Mars mission control, however it is a safety/health concern that will acquire larger importance to JSC mission control in near future. Exploring the JPL experience now offers a way to avoid problems later at JPL and JSC.

The TRL of this concept is around Level 2. Two years' study under the ASTP would improve it to Level 6.

The end products needed are optimal crew shift schedules minimizing health/safety risks. The overall perspective of this study takes the comprehensive human factors approach examining human-environment, human-technology, and human-human interfaces.

Study team composition makes its management and methodology strong. These are the world's foremost experts on the various factors that make up this problem. Gangale has published the most peer-reviewed articles on Earth-Mars time architecture/mission dysfunction than anyone -- some co-authored with Dudley-Rowley. All have interacted together in various combinations previously. For example, Gangale and Dudley-Rowley on Earth-Mars time architecture/mission dysfunction; Dudley-Rowley and Bishop on MSIS enhancement and negotiating a cooperative agreement between NASA-Ames/NASA-JSC; Gangale, Dudley-Rowley, and Adams on projects as members of the Design Engineering Technical Committee and its AeroSpace Architecture Sub-committee, AIAA; Gangale, Bishop, and Dudley-Rowley on studies of team size, composition, and time factors; and Bishop, Austin, and Dudley-Rowley, responding to a recent NASA RFI, offered to make an organizational behavior analysis of the ISS program office.

Joining this unique team is Linde, Senior Research Scientist, Work Systems Design and Evaluation, Computational Sciences Division (Code IC) at NASA-ARC, specializing in knowledge management, empirical requirements generation and institutional memory. She is a member of the NASA Agency-Wide Knowledge Management Team, and the Code T Lessons Learned Team (Langley based). Recent NASA work includes a study of the PRACA database, focusing on the workarounds people actually use to put data in and get data out, and an ongoing study of the work practices and computational and procedural support needed by the Science Operations Team of the JPL MER mission. She also served on the ARC Orbital Space Plane team, specializing in knowledge management issues. Earlier NASA contractor work included studies of the relation of crew communication patterns to commercial aviation accidents, and an observational/video-based study of the work of civilian helicopter pilots, to discover safety issues related to communication factors.

Already, teammates have studied a model of MER shifts for quantitative comprehension of issues. Discrete methods for the study include:

- Surveys
- Participant observation
- Unobtrusive observation
- Content analysis of existing records

Some topical data points of interest are meal times, sleep patterns, partial sensory deprivation, changing commute problems, and social/family interactions. Data will be examined from both prior and ongoing mission controller experiences.

The overall deliverable package is an optimal schema that schedules Mars mission controller work based on mission requirements. Mission requirements are expected to change according to implications of the configuration of mission fielded, i.e., expected duration of the mission, number and placement of vehicles on Mars, their unique technologies, fixed station or rover, robotic or human mission, etc. These considerations drive scheduling decisions for the performance of exploration/science. Sub-deliverables "stepping to" the overall deliverable will be regular report packets of reports/presentations for MER managers, future mission planners, and other stakeholders.

The first year of the study will focus on the JPL MER mission controller experience/optimal schedules, and the second year of the study will focus on different mission configurations/optimal schedules.

Milestone: Year 1: Step 1

Deliverable: Year 1: Expanded Model TRL 4-5 expanded and enhanced model at the component and subsystem levels.

Milestone: Year 2: Step 2: TRL-6 useful instrument at the system level

Deliverable: Year 2: Expanded Model

Quarterly reporting of substantive progress, in addition to the monthly technical-financial/EVM reporting.