Introduction

Initial NASA Proposal a Decade Ago: “Ahead of Its Time”; Technology & Aerospace First

NASA New Focus—Leadership & Collectives (incl. Teams & Networks) for Mars Mission

Phase I (Small Grant: OU Team & Me)—Literature Review, Interviews, and Models
Introduction

Phase II (Large Grants: OU & BU Teams)

• Part A—Model Testing & Validation in Habitat, Lab Experiments, Interviews & Surveys, Content Coding of AARs (Historiometrics)

• Part B—Selection and Training of Crew

Overall Goals—There and Back Safe with Mars Mission Success
Setting & Situation

2.5-3 Year Trip to Mars (6-9 mos. there; 18 mos. on Mars; 6-9 mos. back)—Launch in ~15-20 years

Crew of 6-8 (8-10): Pilot, physician, geologist, biologist, mechanical engineer, electrical engineer; Combination of US (~2-4), Russia (~2), Europe, Canada, Japan;

Gender mix undefined (~2 females);

Currently in Elementary School!

Training likely 2.5 to 3.5 years+

NASA-Roscosmos Interactions
Setting & Situation

Small Space:

Orion - 8.95 m³       Surface habitat - 80 m³
Crew Transfer Vehicle - 80 m³

14.8 m³/person max      1.5 m³/person min

Some assembly & launch from Space Station (ISS) and/or “sling-shot”

Pre-launch supplies, fuel, habitat (for 6-10) and sub-habitat (for 2 with 1-2 week sorties, 6-8 sorties)

[Game changer: “pulse/plasma/nuclear” Orion rocket—16-18 crew and 36-day trip one way!]
Setting & Situation
Setting & Situation
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NASA Human Research Program

Investigates and mitigates the highest risks to human health and performance

Provides essential countermeasures and technologies for human space exploration

Risks include physiological effects from radiation, hypogravity, and terrestrial environments; and unique challenges in medical support, human factors, and behavioral health support
Setting & Situation

NASA Human Research Roadmap Risk:

- “Human Performance Failure Because of Poor Psychosocial Adaptation”
- “High Likelihood, High Consequence Risks with Low Risk Mitigation Status”

Need for Research on “Psychosocial Issues in Space”
Setting & Situation

Very Dangerous, High-Pressure & Dynamic, Boredom & High Stress, Small Space

22 minutes Communication (audio & video) Delay (one-way) minimum but up to 7 days

3-4 times more dangerous & hostile than Antarctica

Radiation Exposure:~1-2 millisieverts/day (~1000 msv total): same daily rate but 5 times total for 12 mos. on ISS (Genetic screening in crew selection?)

8 High Activity times (Launch, Jettison Tanks, Arrival, Undock Orion, Dock to Habitat Lander, Landing, Launch, Dock to Crew Transfer Vehicle, Landing)

Likely High Autonomy from Ground and Vehicle
Setting & Situation

Space: Extreme & Dangerous Environment

Analogue Environments:
- Antarctica (& Hawaii) Habitats
- Arctic Expeditions
- Submarine Crews
- Special Forces Operations*
- First Responders in Natural Disasters & Crises
- Space Habitat Studies on Earth
- Mir, Skylab, Space Station, Apollo Moon Missions
Prior Research

Analogue & Extreme Environments

- Leadership is difficult and demanding
- Team Dynamics are strained with conflicts and miscommunications
- Individual and Team Performance suffer; KSAs decline

Based on Traditional Models 1940s-1970s from Clinical Psych, Anthropology, & Sociology

Lacked Multi-Level Aspects and Work from I/O Psych & OB

Missed Key Aspects of Leadership, Interpersonal Relationships, and Team/Crew Dynamics
Current Research

Focus on the “Real Environment”
Use Theories/Models from 1990’s +
Foundations in OB (Management) and I/O (and Social) Psychology but include All Fields & Environments
Include Multiple and Integrative Aspects of Leadership and Team Dynamics
Interview Quotes

“The astronauts are just doing the flight director’s mission. They are merely an extension of the ground control. Astronauts are ‘tip of the spear.’ This has been the mentality of NASA for 50 years but this will have to change for Mars.”*

Behavioral Health and Performance Personnel

“NASA has spent the last 30 years breeding out leadership and breeding in management. Every leadership course I ever took was actually management training. As a result, NASA ended up with a lot of ineffective leaders at high level positions.”

Former Flight Director
Potential Model/Conceptualization

Leadership and Team Dynamics are both Context-Dependent and Multi-Level in Nature

Given the Context of Long-Term Space Flight, Leadership and Team Dynamics must address:

- Crews of Scientists & Engineers
- Ind., Dyadic (e.g., sorties), Team Perfm. & Collective (e.g., Crew-MC, US-Russia) Efforts
- Crises (Major & Minor) & Crisis Mgmt.
- Cognitive but also Socio-Emotional Issues
Leadership and Team Dynamics for Long-Term Space Flight

Leadership Dynamics

Team/Crew Formation and Assembly

Team/Crew Dynamics

Team/Crew Performance and Maintenance

Contextual Factors

Pre-Flight to Early Flight

Early Flight to Mid-Flight

Mid-Flight to Late Flight
Preliminary & Advanced Models

One Model of Context of Long-Term Space Flight and Multi-Level Leadership and Team Dynamics:

- Pragmatic & Crisis at Individual Level
- Individualized & Dyadic at Dyad Level
- Shared & Socio-Emotion at Team/Crew Level
- Collectivistic & Collective at Collective Level
- Integrated & Role Switching via Multiple Levels of Analysis
Pragmatic Leadership

Practical or Functional Problem-Solving
Focus on the Present
KSA’s for Solving Complex Social Problems: Knowledge, Perspective-Taking, Creativity, Social Judgment, Planning
Individual Differences in Leaders’ Styles
Individual Level of Analysis
Individuals
Organization of Individuals
Crisis Model: Selection of Leaders

1. Emergent Problem Definition
2. Assessment of Consequences and Control
3. Assessment of Timeframe
   - Assessment of Personal Expertise
     - Assessment of External Resources
       - Selection of Leader(s)
   - Assessment of Needed Expertise
     - Assessment of Socio-physical Constraints
Crisis Model: Forecasting and Planning

- Forecasting
  - Self-Reflection
    - Evaluation of Forecasts
    - Systems Reflection
  - Plan Formation
    - Backup Plan Formation
  - Opportunistic Implementation
    - Influence Attempts
Crisis Model
“We don’t currently have an Ops concept that works for Mars, as the crew will need to be more autonomous. But, we do know that the flight control team has hundreds of years of experience when you add them all up whereas the crew has much less experience. The knowledge depth here will be really critical.”

Psychological Operations, Behavioral Health and Performance
Individualized Leadership

Investments and Returns by Superiors and Subordinates or Peers

Support for Self-Worth and Satisfying Performance

Interpersonal (1-to-1) Relationships in Balance and “Rich”

Dyad Level of Analysis
Dyads
Organization of Dyads
**Dyadic Model**

**Dyad Level**
- Similarity
  - Affect
  - Belief
  - Needs
  - Values
  - Need for Achievement
  - Autonomy
  - Recognition of Another
- Attraction and Mutual Liking
- Trust
- Mutual Respect
- Interdependence
  - Task Interdependence
  - Outcome Interdependence
- Psychological Distance
- Physical Distance
- Formality of Exchanges
- Empowerment

**Individual Level** *(Leader & Follower)*
- Superior’s Accountability or Experience
- Feelings of Safety
  - No Personal Risk
  - Openness
  - Perceived Common Interests
- No Threats
- Autonomy Preference
- Commitment to Success
- Self-efficacy
- Inspiration To Do Best
- Positive Feedback
- Trust

**Situational Moderators**
- Nature of Tasks and Roles
- Standard Operating Procedures and Policies
- Multiple Goals and Constituencies
- Resource Constraints
- Political Agendas
- Structural Interdependence
  - Features of the Work
  - How Goals are Defined
  - How Rewards are Distributed

**Outcomes (Mostly Derived From Theory)**
- Satisfying Performance
- Objective Performance
- Support for Self-Worth
- Long-Term Interpersonal Relationships
- Promotions or Opportunities for Advancement
  - Not Necessarily Hierarchical
- Quality of Performance
- Morale
- Communication
- Delegation
- High-Quality LMX
- Cooperation
“If missions always went as planned, it wouldn’t make a difference. When things go bad, trust is needed. I really think trust is crucial...Being able to ensure trust is present throughout the duration of a mission is critical. “

Former Flight Director, Mission Control

“The most effective commanders that I have known have all ensured that every member of the crew had ownership of some significant aspect of the mission...Everybody had some significant role to play in the mission...”

Former Astronaut
Shared Leadership

Shared Mental Models
Shared Knowledge, Information, and Cognitions
Cross-Functional and Multi-Functional Skills
Role Shifting
Team Dynamics and “Teamwork”
Team/Group Level of Analysis
Homogeneous Groups

Group 1
- Superior
- Subordinate
- High Participation

Group 2
- Low Participation

Differences between groups
Heterogeneous Groups

Group 1

Superior

Subordinate

differences within groups

Group 2

Indicates in-group member with leadership

Indicates out-group member with supervision
Organization of Groups
Socio-Emotional Model

Train-Based Leader Characteristics
• Self-awareness
• Empathy
• Emotional stability
• Stress tolerance
• Patience/Tolerance
• Interpersonal Interest
• Open-minded
• Trust
• Sense of humor
• Self-Monitoring

Skills-Based Leader
Individual Differences
• Emotion recognition
• Emotion regulation
• Social insight/awareness
• Oral communication
• Maintaining relationships
• Consideration
• Integrity

Influence Processes
• Diplomacy
• Negotiation
• Networking
• Proactive influence tactics
• Trust Building
• Boundary spanning
• Emotional Contagion

Relations-Oriented Leadership Behavior
Supervisory
• Supporting
• Developing
• Recognizing
Political
• Building networks
• Negotiating means and ends
• Maintaining diplomatic relations (internal, external)

Outcomes
• Performance
  • Individual
  • Team
• Effective intra- and interagency coordination
• Well-being
• Trust

Situational Influences
Uncertainty
Stress/conflict
Timeframe
Complexity
Alignment with Objectives
Deindividuation
Affective Climate
“The most effective crew commanders that I have seen have made everyone feel that they were the most important person on the team. You need to be interested in what the person has to say. You need to be engaged and understand big picture.... You can’t have military mindset. You need to be involved with folks at every level.”

Former Flight Director
Collectivistic Leadership

Dynamic Multi-Level Process
Leader(s) selectively utilize Skills of Others
Leader(s) distribute elements of Leadership Role among Others as Situation demands
Involves use of Networks (formal & informal)
Crew-Mission Control Interface
Collective Level of Analysis
Organization of Collectives
Collectives Time 2
Collectives Time 3
Collectives Time 4
Collectives Time 5
Collectives Time 6
Collective: Interview Support

“As part of the selection process for astronauts, we run them through an experiential course/field exercise and look for competencies. During a ropes course challenge, they need to meet certain obstacles and are expected to change leadership positions after they meet each obstacle. We want to see if they are good leaders as well as good followers during this time. One of the things we are interested in is how can you be competitive but still be a good follower? And some can’t give up being a leader. Broadly speaking, during this ropes course, we are looking at candidates’ communication style, leadership, followership, and how good of a ‘team player’ they are.”

Psychological Operations, Behavioral Health and Performance

“One of the most important aspects of being an effective leader is knowing what questions to ask. It’s easy to come up with a plan when you are the expert in that area but you may not have technical expertise in certain areas. That means you need to know strengths and weaknesses of yourself and others. You need to gain an understanding of how to ask what other options are out there while still keeping the goal in front of the team.”

Psychological Operations, Behavioral Human Performance
Leadership and Team Dynamics Integration

- Crisis (Individual) Model
- Collective (-Leader) Model
- Socio-Emotional (Team) Model
- Dyadic (Sortie) Model

Multi-Level Social & Emotional Dynamics & Problem-Solving
Integrated Model
Role Switching between Mission Control and Crew
Role Switching between Crew Members

Sensemaking / sensegiving

Trust building
Role Switching between Crew Members

Sensemaking / Sensegiving

Trust building
Role Switching between Crew Members
Role Switching between Crew Members
Role Switching between Crew Members

Sensemaking / sensegiving
# Variables & Levels for Leadership & Team Dynamics

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### Variables & Levels for Leadership & Team Dynamics

#### STAGE AND CONSTRUCTS

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<td>Performance (Quality, Quantity, General, Specific)</td>
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<td>Multi-Level</td>
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<td>Individual</td>
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<td>Team-Organization (Crew-NASA)</td>
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<tr>
<td>Affect</td>
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<td>Stress</td>
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<td>Conflict</td>
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<tr>
<th>All Stages</th>
<th>Contextual Factors</th>
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<td><strong>Cultural Values (Power Distance, Individualism-Collectivism)</strong></td>
<td>Society/Country</td>
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Note: Although relevant for more than one stage, variables are listed for the primary stage of flight.
Validation & Test of Model

Multiple Studies and Multiple Methods
Eliminate Single-Study and Common-Method Bias Potential
Cross-Validation of Results
Designs: Historiometrics, Experiments, Simulations, Dynamic & Multi-Level Modeling
Results: Basis for Crew Selection & Training
Studies

Mission Reports & Other Docs—Historiometrics: Content-Coding of AAR’s and Audio Tapes

Experimental/Laboratory—“True” Experiments using Student Subjects with Pre- and Post-Measures and Manipulations

Interviews—Former Astronauts & Mission Control Personnel (Semi-Structured with “Probing”)

Surveys—Current and Former NASA Personnel

Houston Habitat—Observations & Experiments

Agent-Based Simulations & Dynamic Models of Interactions, Networks, & Collectives
Potential Contributions

An approach that is interdisciplinary in nature, integrating management and industrial/organizational psychology literatures

A new, integrative model of leadership and team dynamics that will work well in long-term space flight—there and back safe with mission success

Examination of leadership and team dynamics as context-relevant notions going beyond analogue environments

A multi-source, multi-method, multi-study design that includes data (primary and secondary) from former astronauts and past missions

Inclusion of multiple levels of analysis as well as multi-level and cross-level ideas and tests

Creation and implementation of key “countermeasures” to enhance long-term space flight for crew selection, training, & performance
Leadership, Levels, & NASA: Mars Mission

Thank You

Questions & Comments?