Operations to Research: Communication of Lessons Learned

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Human/System Integration Process

Research
How can we do better?

Requirements Development

Operations
Lessons learned!

Verification
Were requirements met?

Requirements Integration
Negotiating project buy-in

Design
Hands-on architectural involvement
Human Spaceflight Experience: The Long and the Short of it…

- Characteristics of the Vehicle
- Habitat Environment
- Partial Gravity Exposure
- Countermeasure Availability
- Physiological, Medical, Environmental Data

Flight Duration vs. Number of individual exposures
Operational Approach

Selection and Retention Standards

Pre-, In-, and Post-flight Monitoring

Prevention, Mitigation, or Treatment

Reconditioning, Recovery, and Reassignment
What do we mean by that?

Selection and Retention Standards
Screening for disease, medical history, preventive strategies

Pre-, In-, and Post-flight Monitoring
Establish degree of bone loss, skeletal muscle loss, magnitude of cardiovascular deconditioning, medical conditions, etc

Prevention, Mitigation, or Treatment
In-flight countermeasures (exercise, nutrition, pharmaceuticals)

Reconditioning, Recovery, and Reassignment
Post-flight training regimen, return to pre-flight baseline, and flight assignment
Apollo Program

- Health Stabilization Program
- Video monitoring
- Biosensor harness
  - $O_2$ and $CO_2$ levels
  - Temperature
  - Vital statistics
- Metabolic expenditure during EVA
Skylab Program

- Data down-linking (12-24 hours after experiment)
- Real-time biomedical research meetings
- In-flight medical unit
Shuttle Program

- Cardiovascular
- Neuroscience
- Musculoskeletal
- Radiation
- Nutrition
- Exercise
Shuttle-Mir

- 975 days on Mir, 7 astronauts
  - Norman Thagard – 115
  - Shannon Lucid – 188
  - John Blaha – 128
  - Jerry Linenger – 132
  - Mike Foale – 134
  - David Wolf – 145
  - Andy Thomas – 128
International Space Station
Data can be used to assess the individual or the population.
International Space Station

ISS Exercise Hardware Availability Timeline

Constraints: Time; Money; Mass; Power; Volume
Orion Support to ISS Missions

- Transport up to 6 crew members on Orion for crew rotation
- 210 day stay time
- Emergency lifeboat for entire ISS crew
- Deliver pressurized cargo for ISS resupply
Orion Missions
More questions than answers

- How do we use previous experience to prepare for future exploration?
- Can we simply extrapolate or is the future more complex than that?
- What types of analogs are appropriate?