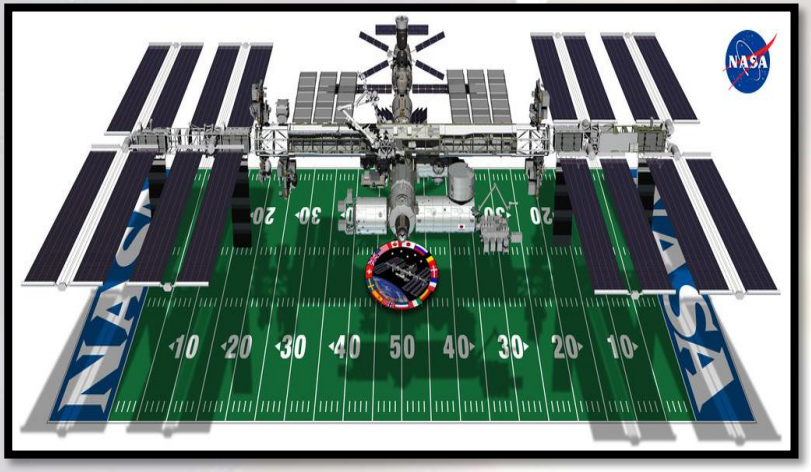
NASA, We have a data problem! ExMC and Bioinformatics

EVA Technology Workshop 2017

October 17, 2017
Marlei Walton, PhD, MSE
Exploration Medical Capabilities

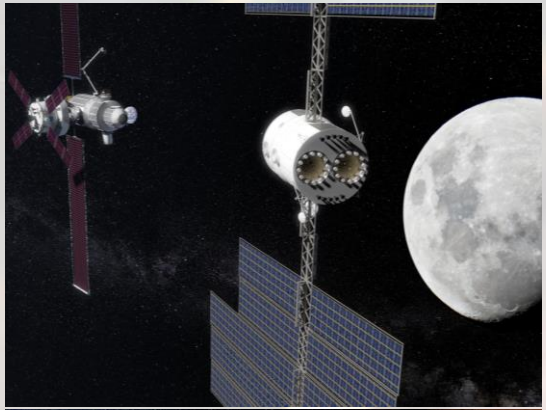
What are our mission and goals

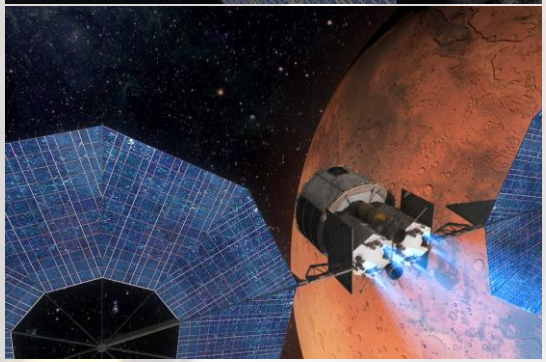
International Space Station

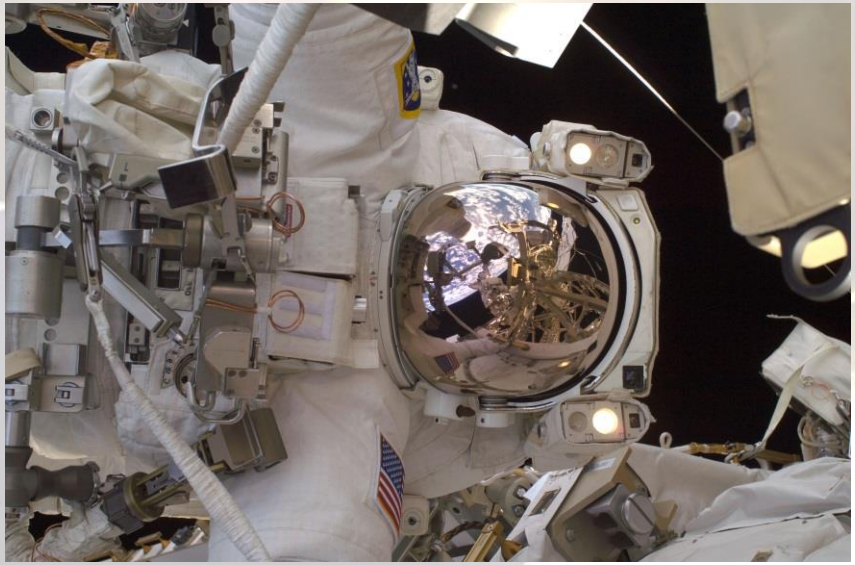


Orion Capsule

Gateway Missions



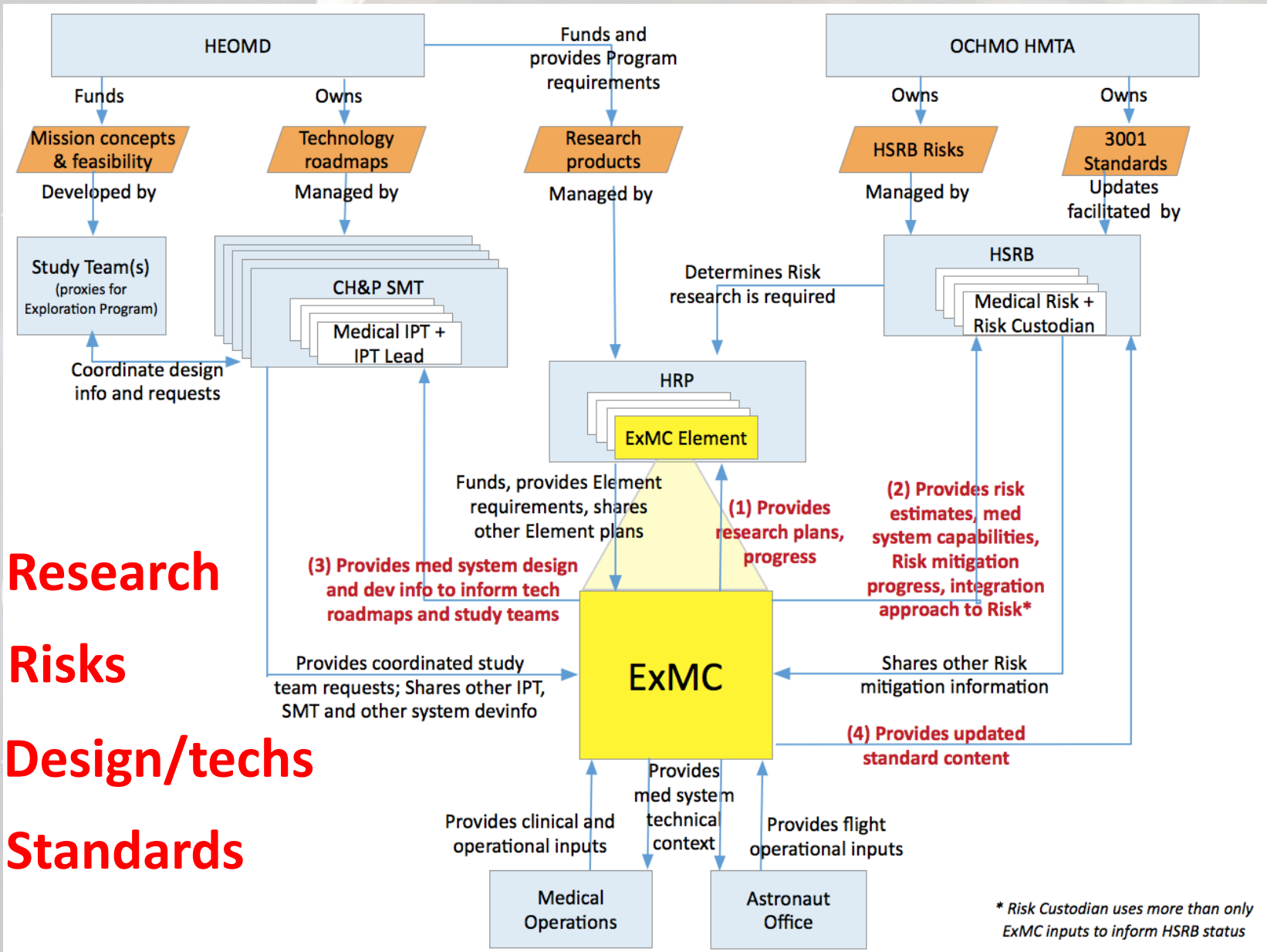




ExMC – Mission

Minimize mission medical risk through medical system design and integration into overall mission and vehicle design

ExMC Team: Organizational Context



1) Research

2) Risks

3) Design/techs

4) Standards

** Risk Custodian uses more than only ExMC inputs to inform HSRB status*

Types of Telemedicine Care

- Live remote guidance




- Live monitoring

MEDB 1.3 PMC

TABLE 3.5.1: IN-FLIGHT ACTIVITIES

In-flight Activity	Consultations will be conducted between the flight surgeon and U.S. crewmember via private air-to-ground loop and video to discuss medical status, human factors, and habitation systems.		
Description:			
Schedule:	**Duration:**	**Schedule:**	**Personnel Required:**
	Private Medical Conference 15 min. (each crewmember)	*Daily for first five days after docking (separately scheduled on all arriving USOS crewmembers.)	Flight Surgeon and Crewmember
	Private Medical Conference 15 min. (per crewmember)	Weekly	Flight Surgeon and Crewmember
	Private Medical Conference 15 min. (EVA participant)	Prior to each EVA (within 24 hrs. of suit donning)	Flight Surgeon and Crewmember
	Private Medical Conference 15 min. (EVA participant)	Following each EVA (within 24 hrs. of suit removal)	Flight Surgeon and Crewmember
	Private Medical Conference 15 min. (per crewmember)	*Daily beginning last five days prior to landing (individually scheduled on each returning USOS crewmember) and the morning of entry/landing.	Flight Surgeon and Crewmember
	Private Medical Conference 15 min. (per crewmember)	As clinically indicated	Flight Surgeon and Crewmember
Procedures:	Procedures for conducting PMCs are contained in the ISS IMC Console Handbook. Should a medical issue occur, contingency procedures are contained in the Systems Operations Data File (SODF) Medical Checklist.		
Constraints / Special Requirements:	A Private Medical Conference may be requested at any time by the Crew Commander, Flight Surgeon (FS), Flight Director (FD), or any crewmember.		
Photo / TV Requirements:	PMC nominally includes video if available at time PMC is scheduled.		
Mission Extension Requirements:	N/A		
Landing Wave-Off Requirements:	N/A		
Data Delivery	PMC data is entered into the PMC form located in the EMR. Video and audio recordings of PMCs are provided to the LSAH Knowledge Management Team for archiving.		

MEDB 7.2 PPC

TABLE 3.5.1: IN-FLIGHT ACTIVITIES

In-Flight Activity	The PPCs will be a recurring item in the schedule, and will occur two times per month.				
Description:	**Duration:**	**Schedule:**	**Flexibility:**	**Blood Volume:**	**Personnel Required:**
Schedule:	15 minutes	Every 2 weeks	At discretion of Crew Surgeon.	N/A	Crewmember and Behavioral Health and Performance (BHP) Specialist
Procedures:	N/A				
Constraints / Special Requirements:	A PPC may be requested at any time by the Crew Commander, Crew surgeon (CS), Flight Director (FD), or any crewmember. PPCs shall be conducted on two-way private voice with or without video communication between each individual ISS crewmember and a designee of the crewmember's home agency behavioral health and performance group, preferably in the crewmember's native language. Each CM to be scheduled individually during off-duty time.				
Photo / TV Requirements:	Private two-way video				
Cold Stowage Requirements:	N/A				
Mission Extension Requirements:	As required				
Landing Wave-Off Requirements:	N/A				
Data Delivery	Data are crew member controlled. The crewmember is the designated recipient of the data and sharing this information is at his/her discretion. Entries will be made in the EMR for each event showing completion of the MEDB requirement and stating if any aeromedical concerns were identified.				

- Store and forward

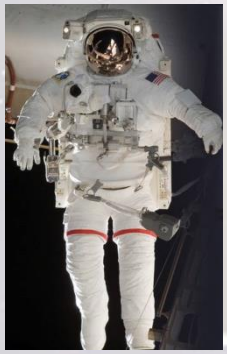



- Autonomous

Exploration EVA

Current ISS Ops

Live monitoring:
reliant on ground



Mission tasks

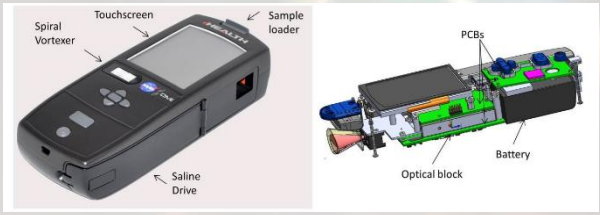
Exploration

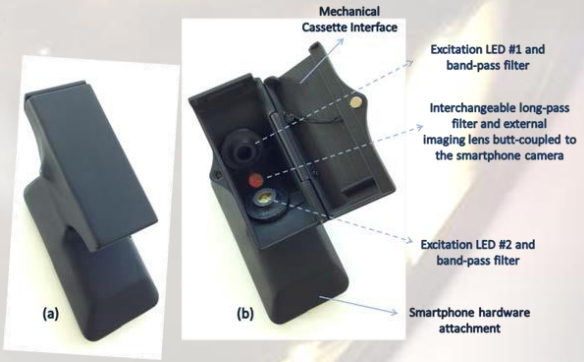
Live monitoring → space-based expertise

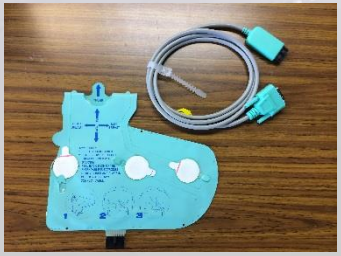
Mission tasks
Bioadvisory information
Navigation
Consumables tracking

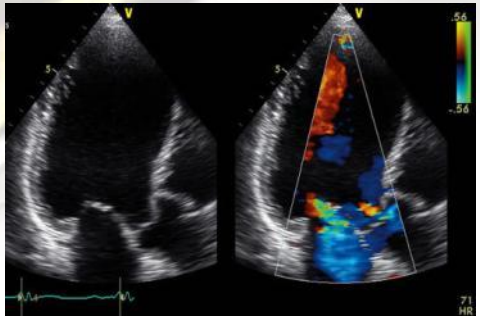
Medical Capabilities

- **Biomonitoring**
- Radiation Monitoring
- **Sleep Monitoring**
- **Flexible Ultrasound**
- Pharmaceutical stability
- Laboratory Analysis
- Medical Training Platforms
- **Medical Data Architecture**
- **Medical Systems Development**
- **Medical Risk Assessment**

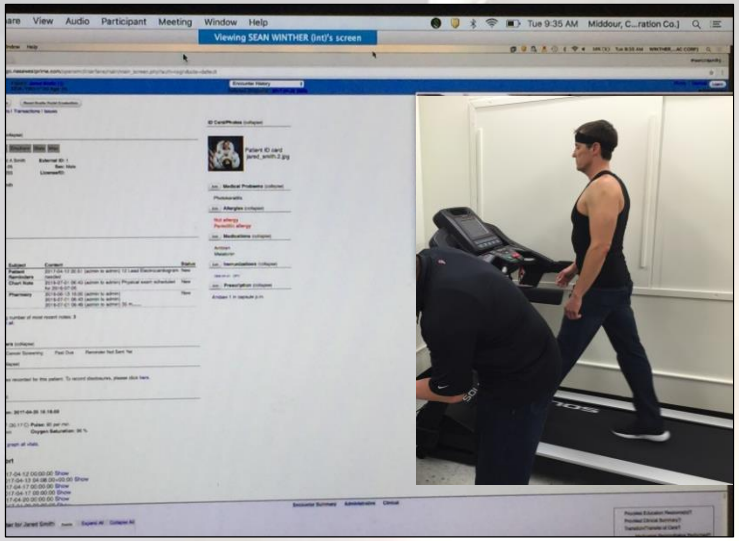


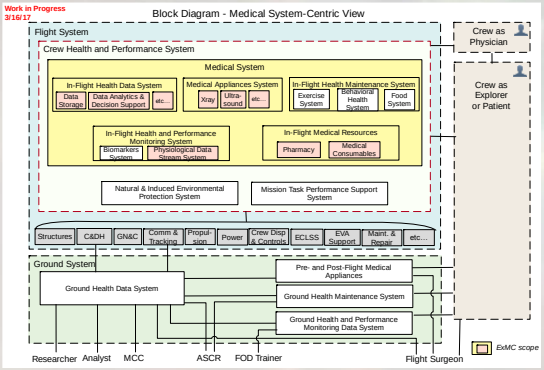


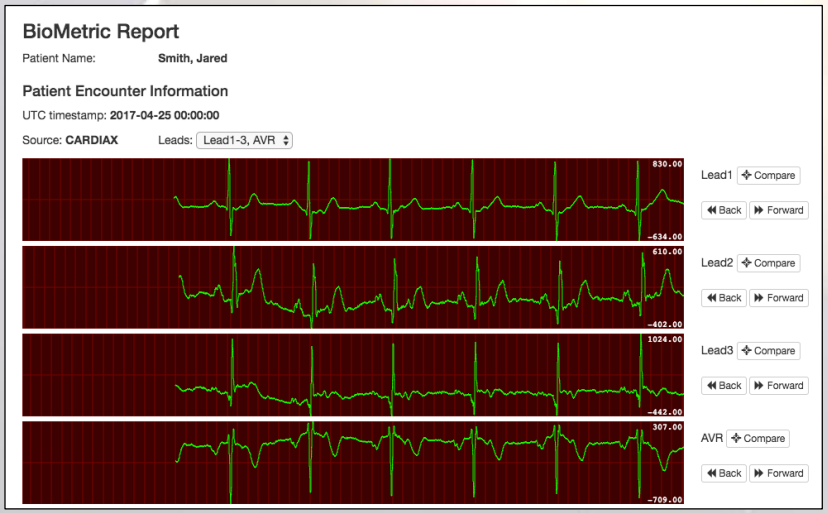


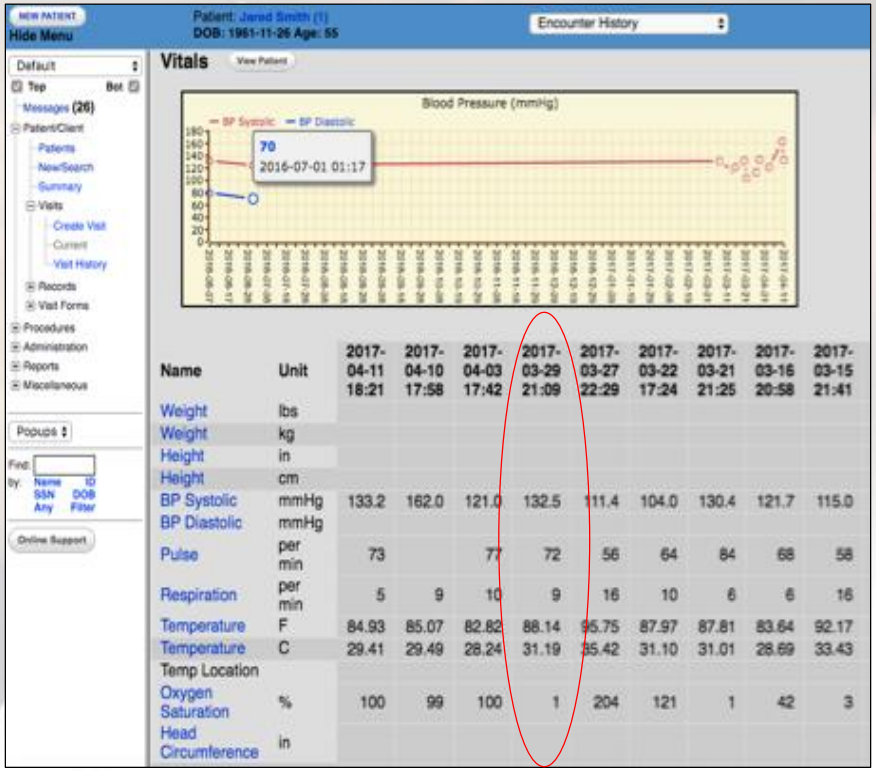


Medical Data Architecture

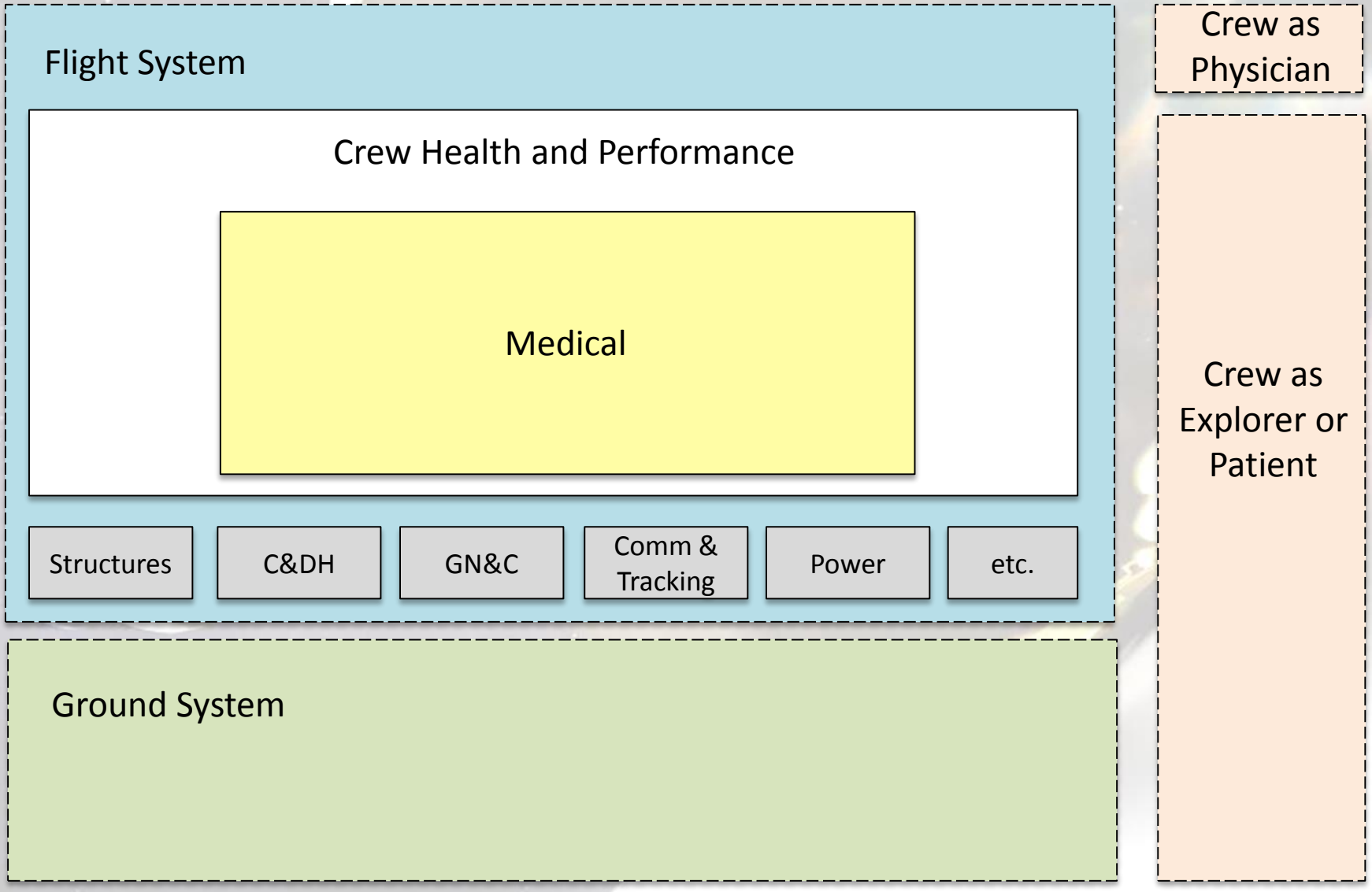








Translating to Engineering



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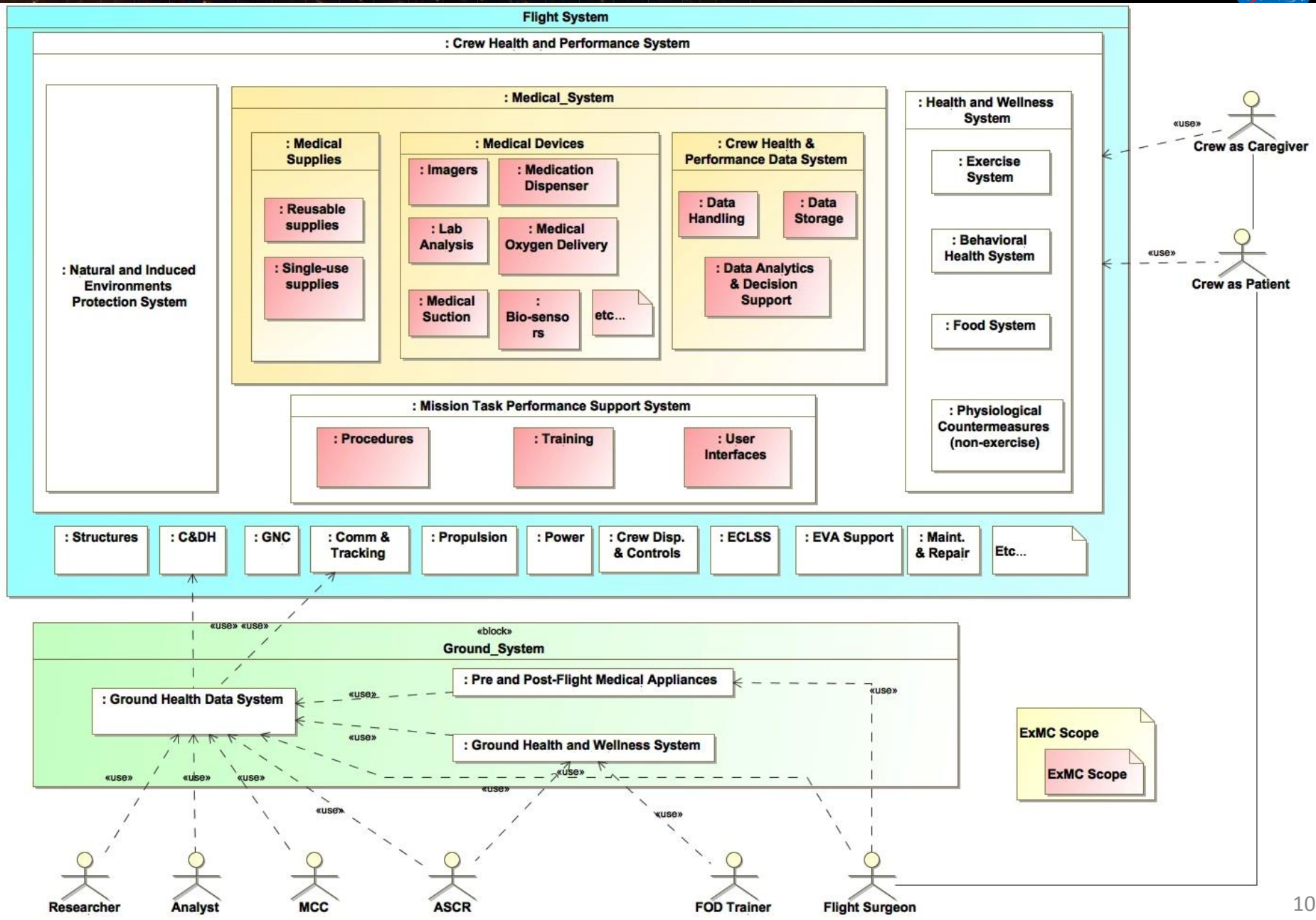
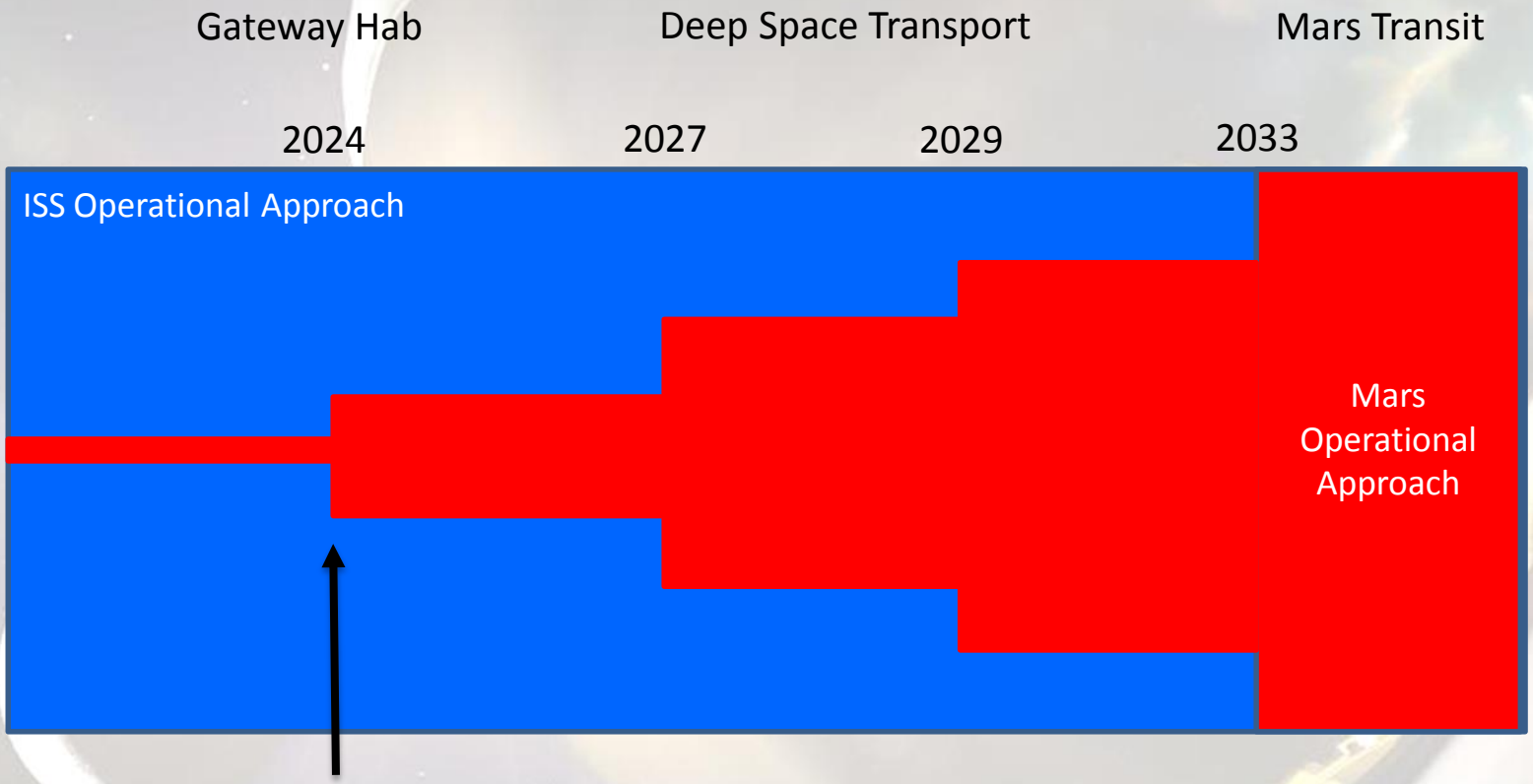


Development Timeline



What are the early entry vehicle and mission medical integration needs?

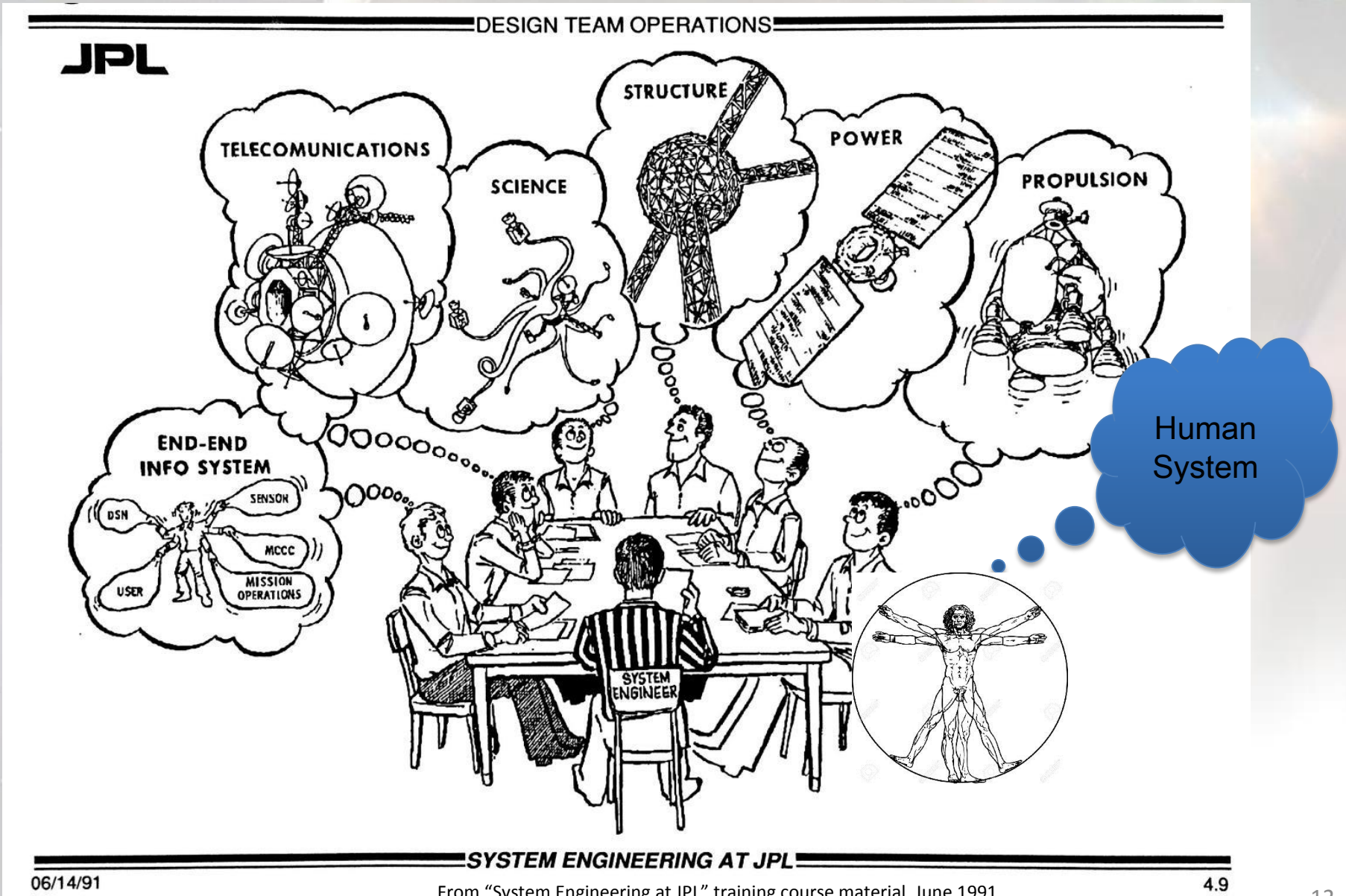
- Data Architecture
- Training and Skills
- Ground Support Model Dev

- Data System Maturation
- System Integration with Vehicle
- System Testing
- Ground Support Initial Ops

- System Validation
- Ground Support Mature Ops

- Validated Flight System
- Validated Ground Support Ops
- Fully Integrated Human System

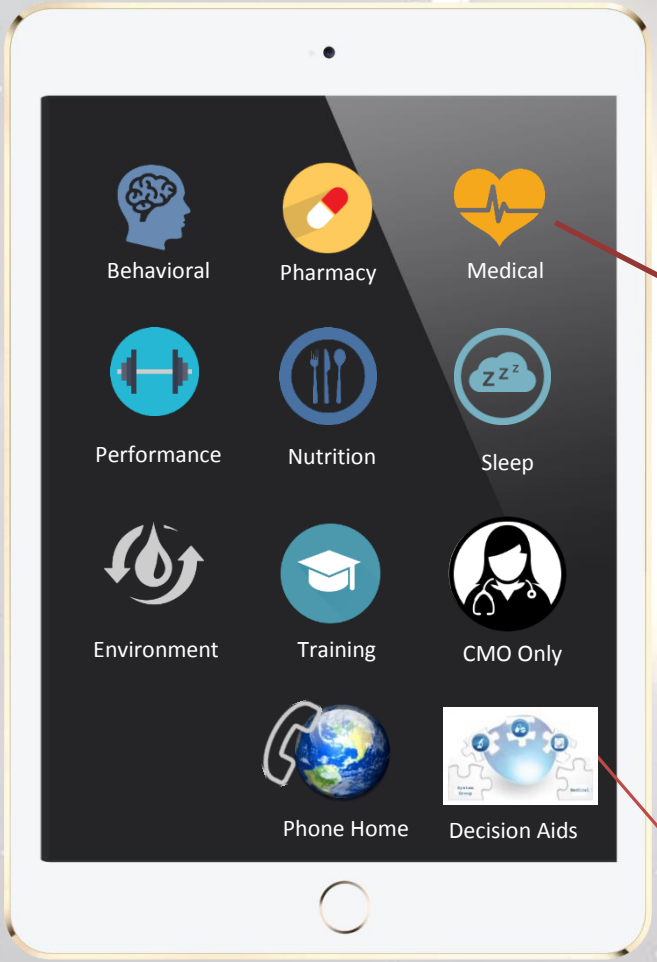
Human System Integration



From "System Engineering at JPL" training course material, June 1991.

Moving Towards Mars: Intuitive, Usable

Notional Human System Interface

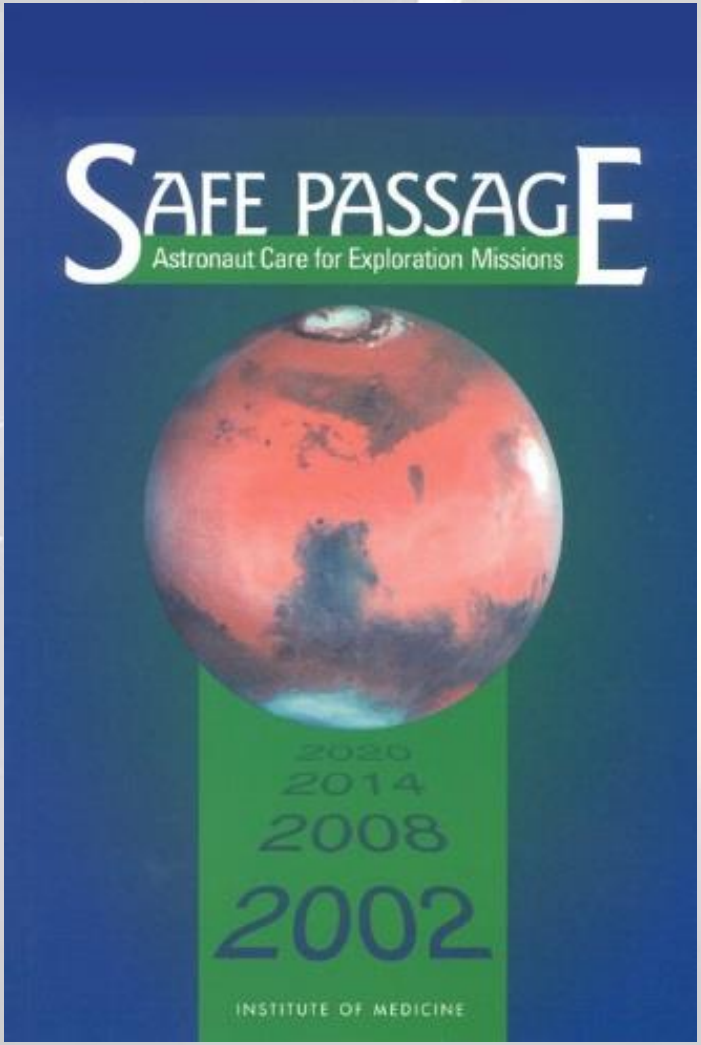


Medical

Developing Decision Aids to Enable Human Spaceflight Autonomy

Jeremy D. Frank, Kerry McGuire, Haifa R. Moses, Jerri Stephenson

Future Direction



2001, Conclusion 6:

NASA, because of its mission and history, has tended to be an insular organization dominated by traditional engineering. Because of the engineering problems associated with early space endeavors, the historical approach to solving problems has been that of engineering. Long duration space travel will require a different approach, one requiring wider participation of those with expertise in divergent, emerging, and evolving fields. NASA has only recently begun to recognize this insufficiency and to reach out to communities, both domestic and international, to gain expertise on how to remedy it.

Committee on Creating a Vision for Space Medicine During Travel Beyond Earth Orbit, Board on Health Sciences Policy and I. O. Medicine, *Safe Passage: Astronaut Care for Exploration Missions,* Institute of Medicine of the National Academies Press, 2001.

BACK UP

ExMC – Risks

- Pharmaceutical Stability Risk
- Renal Stone Risk
- Acute Bone Fracture Risk
- Celestial dust Exposure Risk

- Medical Risk

Select ExMC Medical Risk Gaps

Med01	We do not have a concept of operations for medical care during exploration missions. **ConOps**
Med02	We do not have the capability to provide a safe and effective pharmacy for exploration missions. **Pharmacy**
Med03	We do not know how we are going to apply personalized medicine to reduce health risk for a selected crew. **Personalized Medicine**
Med05	We do not know how to train crew for medical decision making or to perform diagnostic and therapeutic medical procedures to enable extended mission or autonomous operations. **Training for Autonomy**
Med07	We do not have the capability to comprehensively process medically-relevant information to support medical operations during exploration missions. **Real-time Comprehensive Data Processing**
Med08	We do not have quantified knowledge bases and modeling to estimate medical risk incurred on exploration missions. **Databases and Modeling**
Med10	We do not have the capability to provide computed medical decision support during exploration missions. **Real-time Decision Support**

ExMC – Bioinformatics

Biosensor Integration Development
ExMC/Canadian Space Agency Collaboration

- M. Krihak[1], S. Wolfe[2], A. Lindsey[2], C. Middour[3], W. Toscano[2], S. Winther[4], N. Marker[5], and T. Shaw[2]

- [1]Universities Space Research Association, NASA Ames Research Center, Moffett Field, CA
- [2]NASA Ames Research Center, Moffett Field, CA
- [3]Millennium Engineering and Integration Co, NASA Ames Research Center, Moffett Field, CA
- [4]Wyle Laboratories, NASA Ames Research Center, Moffett Field, CA
- [5]SGT Inc., NASA Ames Research Center, Moffett Field, CA

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