

# Dutch Entertainment Computing Consortium (DECC) Roadmap Workshop Lorentz Center, Leiden



**Jack van Loon**

## Dutch Experiment Support Center (DESC)

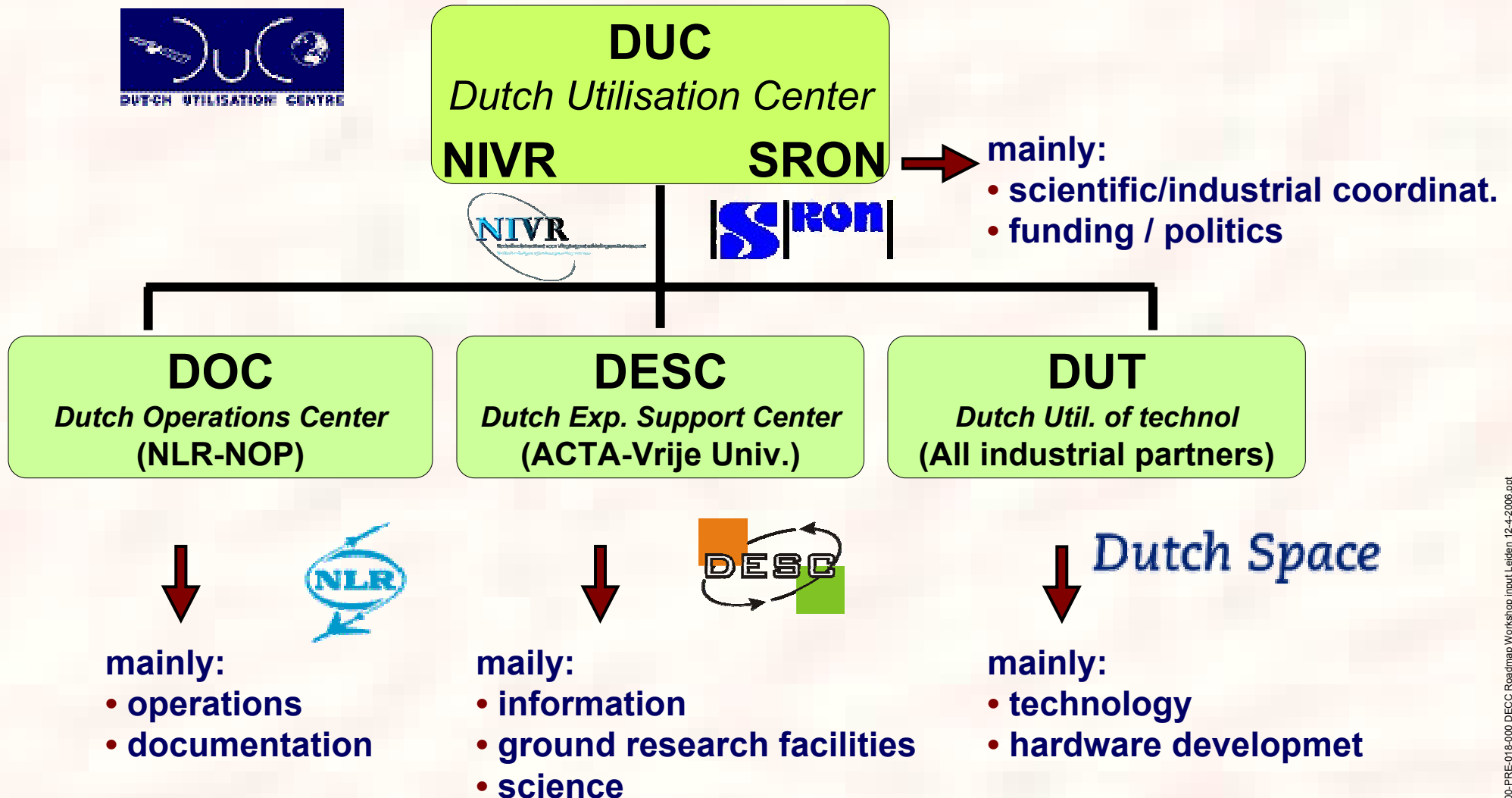
**ACTA - Vrije Universiteit  
Amsterdam**

**Presentatie :  
DECC workshop  
12-4-2006**

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# *Dutch Utilisation Center, DUC (I)*

Project: 100  
Subject: DECC wrkshp  
12 April 2006



## ***Dutch Utilisation Center (DUC) (II)***

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Project: 100  
Subject: DECC wrkshp  
12 April 2006

- **National Support of Scientists, Instruments and Operations**
- **EDR-FRC in cooperation with ESA, Belgium and others**
- **National Instruments in cooperation with ESA, NASA, CNES and others**
- **Support of Erasmus User Center (EUC)**

- **Maintenance of ground based facilities**
- **Specific support and supervision for ground research**
- **Support development/testing of experiment hardware**
- **Support for preparations of flight experiments**
  
- **Identify and encourage new users**
- **Familiarisation of future users**
- **Development / stimulation of new research proposals**
- **Information and public relation activities**
- **Education / internships**

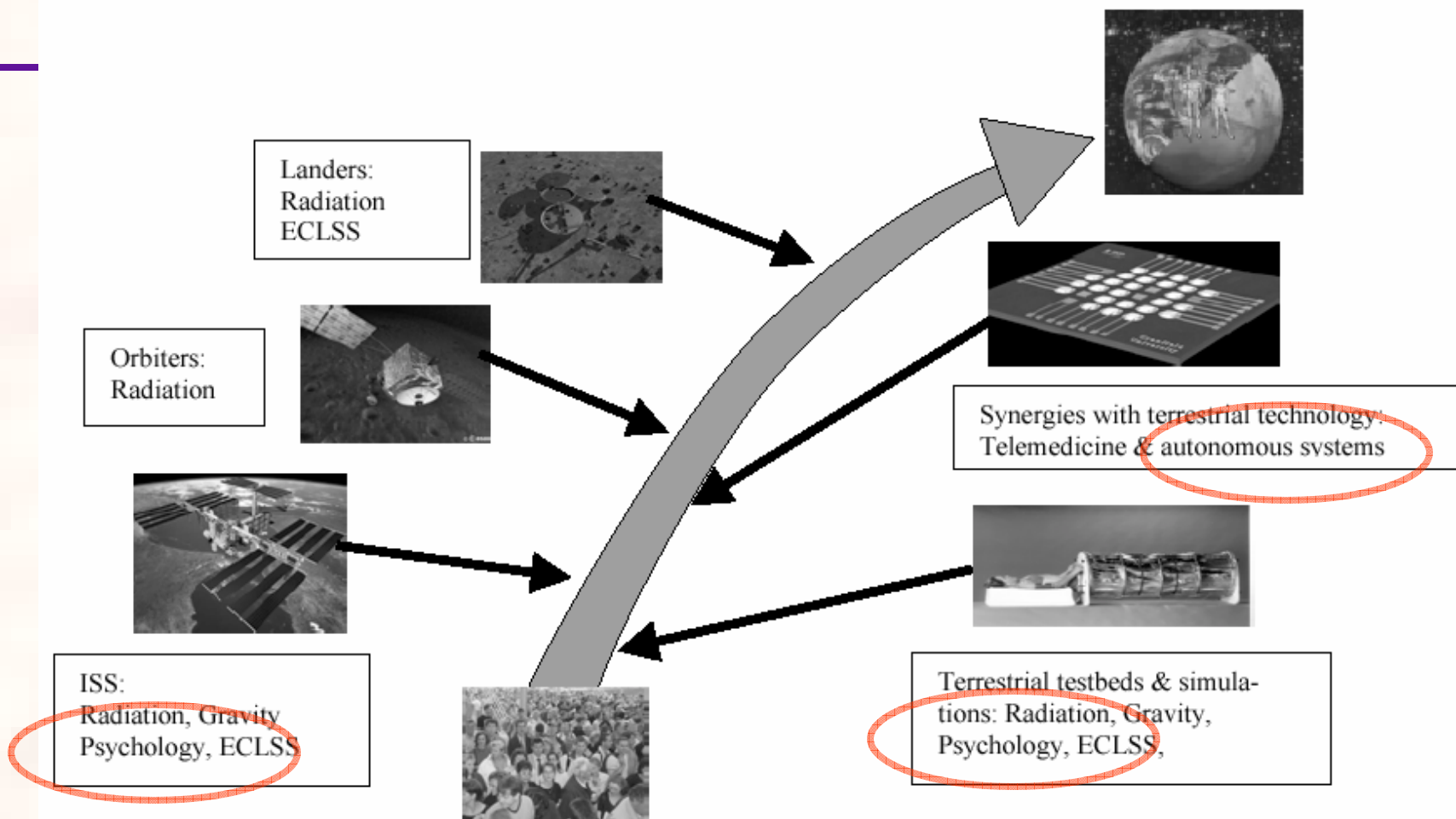


Fig. 5. Roadmap with regard to human health issues for a future Europe strategy towards human exploratory missions.

Gerda Horneck / DLR:

From: <http://www.weblab.dlr.de/exo/pdf/Human%20missions-ESA%20SP-021207-fin-fin.pdf>

# Psychological Risks Relevant to Long-Duration Spaceflight

## Mental Performance

- Performance decrements due to hypogravity-effects on brain mechanisms
- Performance decrements due to indirect effects of spaceflight-related stressors on the attentional state

## Individual Health and Well-Being

- Disturbances of sleep and circadian rhythm
- Dysfunctional affective reactions and impairments of mood
- Mental and behavioural illness

## Interpersonal Interactions

- Intracrew Issues
- Issues of Space-Ground Interactions
- Issues of Multicultural Crews

From ESA-Humex study (2001) by D. Manzey, DLR, Hamburg

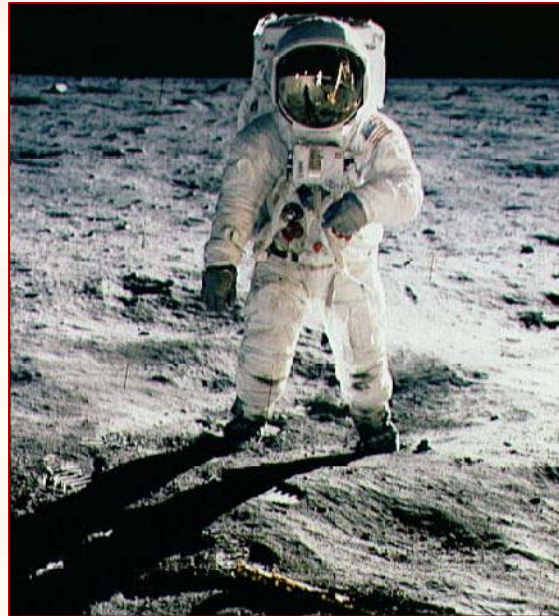
## Stressors in Space

Space Environment

Mission Tasks

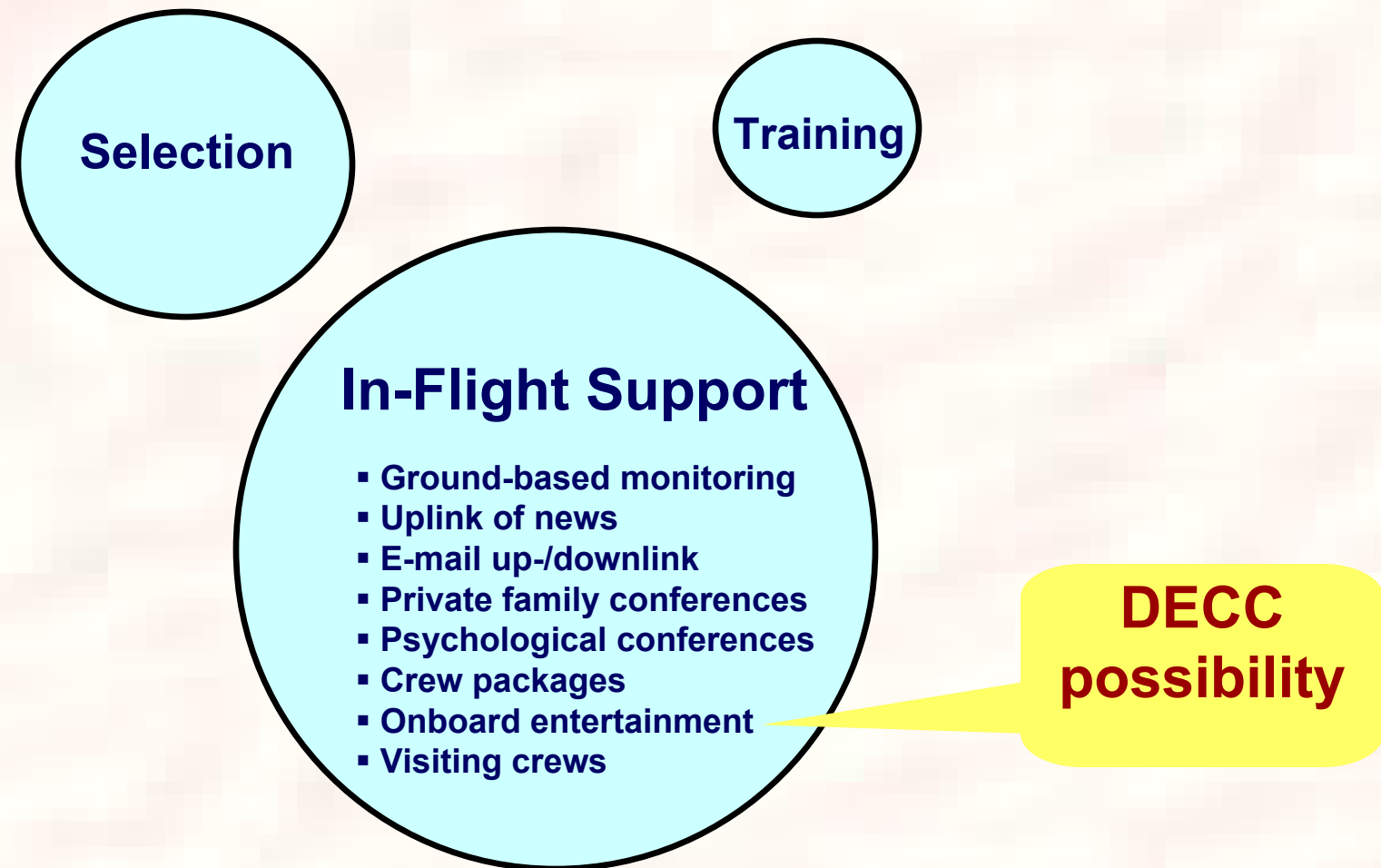
Space Habitat

Social Situation



From ESA-Humex study (2001) by D. Manzey, DLR, Hamburg

## Currently Applied Psychological Countermeasures



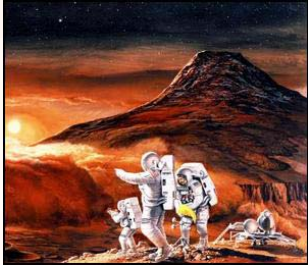
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	Station in LEO (MIR, ISS)	Lunar Mission	Mars Mission
Duration	4-6 months	6 months	16-36 months
Crew Size	3-6	4	6 (4/2)
Isolation/Social Monotony	moderate	high	extremely high
Crew Autonomy	low	medium	extremely high
Evacuation Opportunities	yes	yes	no
In-Flight Support Measures			
• ground-based monitoring	yes	yes	very restricted
• audio/video transmission	yes	yes	very restricted
• e-mail up-/downlink	yes	yes	yes
• internet access	yes	yes	no
• onboard entertainment	yes	yes	yes
• re-supply flights	yes	no	no
• visiting crews	yes	no	no
Visual Link to Earth	yes	yes	no

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possibility

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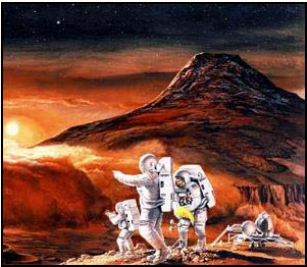
## The 500 and 1000-Day Mars Mission Scenarios:

### Generalisability of Current Knowledge from Orbital Flight and Analogue Environments

- Missions to Mars will not be comparable to any other undertaking humans have ever attempted given the distance of travel, the duration of life under constant dependence on life-support systems in isolation and confinement, and the lack of short-term rescue possibilities
- Currently applied countermeasures to maintain individual performance, health and well-being, as well as crew morale via audio-/video contacts can only be provided to a very limited degree

➔ **Most of the possible risks arising from psychological issues will be **LARGELY INCREASED**. In addition new psychological risks will arise which, in principle, cannot be assessed in advance.**

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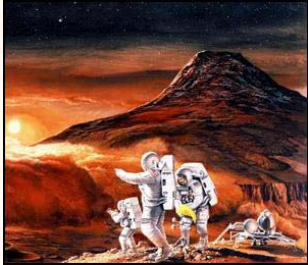


## Psychological Key Issues Related to *Behavioural Health, Well-Being, and Interpersonal Interactions* Shared by Both Reference Missions

- **disturbances of circadian rhythm and sleep** during transfer phases
- extremely long periods of **low workload, monotony, and boredom** during transfer phases
- **long-term dependence on autonomous life-support systems**
- extreme level of **social monotony**
- extreme high degree of **crew autonomy**
  - issues of autonomous management of external and internal crises
  - issues of “group-think”
- increased risk of **mental and behavioural illness** (WP 2200)
- high risk of **motivational decline** during transfer back
- **post-flight adaptation problems**

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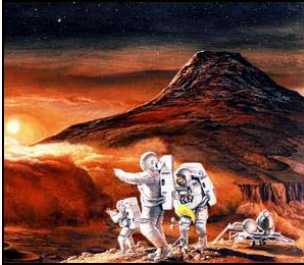
## Specific Psychological Key Issues of the 1000-Day Mission Arising from Leaving 2 CM's in Orbit

- The orbiting crew members will be exposed to excessive levels of
  - **monotony and boredom** (due to low variety of task demands)
  - **social monotony** (only partially balanced by intercom contacts to surface crew)
  - **sensory deprivation** (due to stay in the same spaceship for 1000 days)
- **Issues of maintaining motivation of orbiting crew**
- **Break-down of crew cohesiveness**
  - interpersonal and “inter-subcrew” conflicts after re-union during transfer back
  - leadership issues



**Whenever possible this feature of the 1000-day reference mission should be avoided**

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## Indeterminable and Uncontrollable Risks of Mars Missions

### Earth-Out-Of-View Phenomenon

Human responses to loosing the visual link to their home planet are unknown. Conceivable responses include:

- **maladaptive affective reactions** (e.g. feeling of anxiety, sadness)
- **development of mental illness** (e.g. anxiety disorder, depression)
- **partial or complete loss of commitment to expected system of values and behavioural norms**

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## Levels of Possible Countermeasures

### Accommodation of living and working conditions during the mission to human needs and capabilities

- Design of habitat (e.g. private crew quarters, interior decor)
- Design of **autonomous systems** (e.g. concepts of ajustable autonomy)
- Work-Rest Scheduling

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possibility**

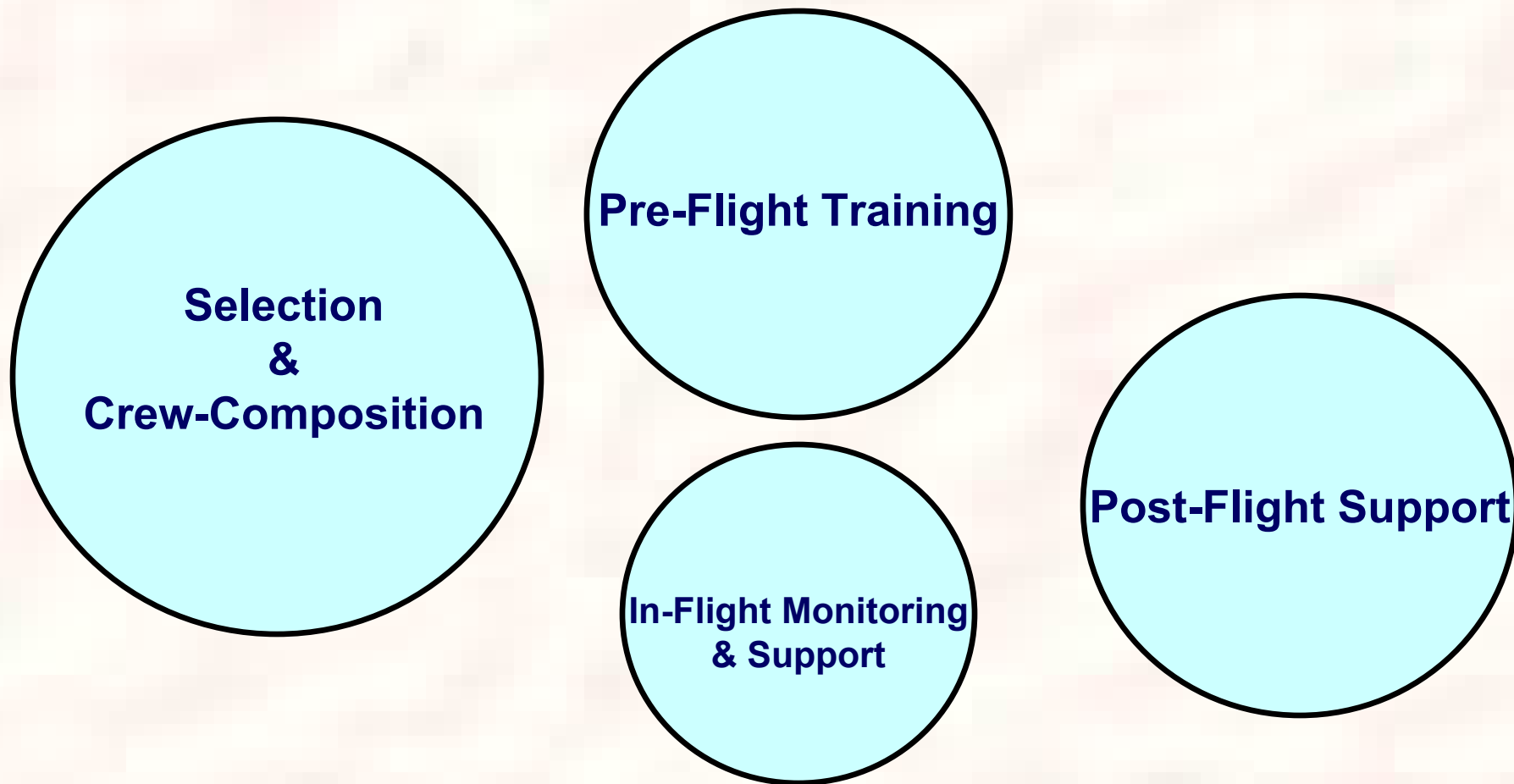


### Adaptation of humans to the extreme living and working conditions during the mission

- Selection
- Training
- In-flight support
- Post-flight support

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## Relative Significance of Psychological Countermeasures for Mars Missions



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## Proposed Countermeasures: Selection and Crew-Composition

### Selection

#### Psychiatric screening (select-out)

- Review of biographical and family history

#### Psychological selection (select-in)

- Task motivation
- Cognitive and psychomotor performance capabilities
- Personality traits related to interpersonal behaviour
- Personality traits related to performance under stress
- Interpersonal needs, attitudes, skills

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## Proposed Countermeasures: Selection and Crew-Composition

### Crew-Composition

**Crew Size:** 4-6 CMs represent minimum size, 6-8 would be better

**Age:** homogeneous crews are to be preferred

**Gender:**

- lack of systematic research/inconsistent experiences
- mixed gender crews involve specific issue of contraception
- sending married couples is unrealistic and does not solve the problem
- minimum of 2 CMs of each sex recommended in mixed gender crews
- more open discussion needed

**Culture:** Crew should consist of individuals who

- are as homogeneous as possible (e.g. have lived in common culture)
- have experiences with other national/organisational cultures
- possess flexibility to adapt to other cultures

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## Proposed Countermeasures: Selection and Crew-Composition

### Crew-Composition

#### Key Challenge: Compatibility of Individual Characteristics

- **Homogeneous personality traits** (e.g. agreeableness, conscientiousness)
- **Complementary needs** instead of need competition (e.g. dominance)
- **Congruent needs** that can be mutually satisfied (e.g. need for social contact)
- **Complementary skills and cognitive abilities**
- **Shared system of values and behavioural norms**
- **Positive emotional attitude towards each other**

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## Proposed Countermeasures: Pre-Flight Training

### Individual training

- Individual self-care strategies and stress-management skills
- Interpersonal skills

### Crew-training

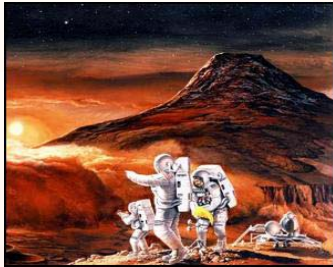
- Support of team-building process
- Anticipatory problem-solving
- Development of crew-supporting skills
- Self-experience and coaching under simulated conditions

### Specific training for selected crew members

- Commander: leadership skills
- Physician(s): diagnosis and treatment of psychiatric disorders

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## Proposed Countermeasures: In-Flight Monitoring and Support

### In-Flight Monitoring

- Mental performance
- Circadian rhythm and sleep
- Emotional state and behavioural health
- Interpersonal relationships

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possibility**

Technological developments needed which take the operational constraints of Mars missions into account (e.g. evaluation of mood based on analysis of e-mail communication)

Issues of self-assessment needs to be explored

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## Proposed Countermeasures: In-Flight Monitoring and Support

### In-Flight Support

- **On-board support for maintaining critical skills**
  - identify level of fidelity needed
  - exploring suitable advanced technology (virtual reality)
- **Sensory stimulation**
  - Earth-bound views and sounds (based on advanced technology)
- **Recreational opportunities**
  - variable exercise equipment for release of stress
  - library of paperback and electronic books
  - personal entertainment supplies (e.g. DVD, computer games)
  - support of recreational crew activities
  - support of constructive leisure activities (e.g. academic studies, hobbies)

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## Proposed Countermeasures: In-Flight Monitoring and Support

### In-Flight Support (cont'd)

#### ■ News from Earth

- innovative concepts needed (e.g. simulation of 'internet' on on-board server)
- technological developments to increase transmission capacity needed

#### ■ Social contacts to family and friends

- on Mars only possible via e-mail and one-way audio/video transmissions

#### ■ Psychological counselling and guidance

- on Mars only possible via e-mail or one-way audio/video transmissions

#### ■ Tools for treatment of psychiatric disorders

- restraint system and identified list of psychoactive drugs

#### ■ Family-support during the mission

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possibility  
(digital  
buddy)**

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## Conclusion: 34 R & D Needs Identified

### Fundamental Research (15)

- Cognitive performance and perceptual-motor skills
- Maladaptive individual reactions
  - Sleep and circadian rhythms
  - mood, behavioural health and coping
- Interpersonal interactions

### Applied Research and Development (19)

- Habitability and Autonomous Systems
- Selection & Composition
- Training
- Monitoring
- In-flight support

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possibility**

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## Conclusion: 34 R & D Needs Identified

### Strategical Considerations

- **Research on ISS**
  - only required for questions addressing effects of space specific factors
  - cognitive performance, perceptual-motor skills, sleep, circadian rhythm
- **Research in analogue natural environments (e.g. Antartica, deserts)**
- **Secondary analyses of existing data bases from analogue environments**
- **Ground-based simulations**



Compared to the past a much more coherent long-term research program is needed which assures both, a systematic investigation of individual, environmental and organisational issues critical for Moon/Mars missions, as well as a comparability of different studies

From ESA-Humex study (2001) by D. Manzey, DLR, Hamburg



# NASA Bioastronautics Roadmap

Project: 100  
Subject: DECC wrkshp  
12 April 2006

Risks

Page 1 of 3



## Bioastronautics Roadmap

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[Missions](#) [CC Areas](#) [Disciplines](#) [Risks](#) [R & T Questions](#) [Tasks](#) [Deliverables](#) [Processes](#) [Search](#) [Links](#) [Help](#)

### Current Selection Filters

Crosscutting Area(s)

- 23 Medical Skill Training and Maintenance
- 24 Human Performance Failure Due to Poor Psychosocial Adaptation
- 25 Human Performance Failure Due to Neurobehavioral Problems

Clear All Filters

Get All Risks in PDF

45 Risks found.

21 Rehabilitation on Mars

22 Medical Informatics

## Risk 24: Human Performance Failure Due to Poor Psychosocial Adaptation

[Print Risk Data Sheet \(All Missions\)](#)

[Print Risk Data Sheet \(Selected Mission\)](#)

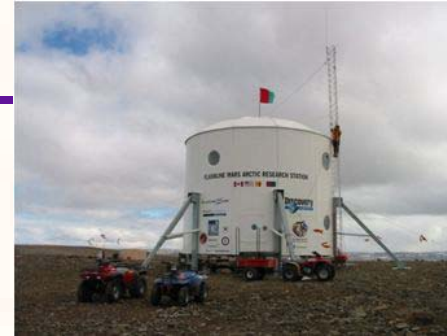
**Crosscutting Area :** Behavioral Health and Performance

**Discipline :** Behavioral Health & Performance and Space Human Factors (Cognitive)

**Description :** Human performance failure may occur due to problems associated with adapting to the space environment, interpersonal relationships, group dynamics, team cohesiveness, and pre-mission preparation.

**Context / Risk Factors :** The isolated and confined nature of space flight, along with its potential hazards, pose human performance related challenges. This risk may be influenced by boredom with available food, crew autonomy and increased reliance on each other, crowding, distance from family and friends, duration of flight, incompatible crewmembers, interpersonal tensions, mechanical breakdowns, poor communications, scheduling constraints and requirements, sleep disturbances, or social isolation.

**Justification / Rationale :** Moderate likelihood/high consequence risk with low risk mitigation status. Serious interpersonal conflicts have occurred in space flight. The failure



*A typical image of the F-MARS station*

- test in ground research : “Mars stations”, Antarctic Stations, military systems (submarines etc.)
- In flight : ISS studies
- Moon-base studies
- Finally : Mars scenarios



# SPACE PSYCHOLOGY AND PSYCHIATRY

Nick Kanas  
Dietrich Manzey

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# SPACE PSYCHOLOGY AND PSYCHIATRY

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**"Unprecedented periods of confinements, people being away for three years or more, the period of isolation, the lack of capability to rescue people-- all these things become intensified in the case of Mars," Harrison notes. uit: Hariis, Univ. Davis, USA**

**<http://www.org.id.tue.nl/DECC/Mental%20Preparation%20for%20Mars.pdf>**

**2001 *Aviation, Space and Environmental Medicine* (Vol. 72, No. 5)**

Kosslyn and his NSBRI- funded team have worked since 2000 to develop a Palm Pilot- based program called MiniCog, which measures astronauts' cognitive abilities during space flight, comparing them with the astronauts' usual Earth- based scores or to population norms. For example, before going to work on a difficult task-- perhaps repairing malfunctioning equipment on the spacecraft's hull-- an astronaut might use MiniCog to see whether his or her spatial relations are up to snuff. If an astronaut performs poorly at mentally rotating three dimensional objects-- a task adapted from the 1970s work of Stanford psychologists Roger Shepard, PhD, and Jacqueline Metzler, PhD-- a nap or a cup of coffee might be in order, Kosslyn notes. In addition to tests of spatial ability, MiniCog can evaluate an astronaut's level of attention, motor control, working memory and problem- solving, say its developers.

**So, a group of NSBRI- funded researchers headed by James Carter, PhD, a clinical psychologist at Harvard Medical School, and including former astronaut Jay Buckey, MD, of Dartmouth Medical School, is developing a computer program to assist astronauts dealing with depression or interpersonal conflicts-- the two most likely problems to appear during extended space travel, say the scientists.**

