Mars Analog Station
Cognitive Testing (MASCOT):
Results of First Field Season

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Outline

- Introduction
  - Analog research program objectives
  - Station design, location and operations
- The MASCOT experiment
  - Objective
  - Software and procedures
  - Participants
- Results and Discussion
- Conclusions
Mars Analog Stations Program

- The Mars Society has built a number of Mars-analog stations in remote environments:
  - Flashline Mars Arctic Research Station, FMARS (2001)
  - Mars Desert Research Station, MDRS (2002)
  - European Mars Analog Research Station, EuroMARS (2005?)
- These stations will be operating for several more years
- Crews are volunteers with suitable professional and personal backgrounds
- “Mission Control” is performed by volunteers at Mars Society headquarters or Mars Society state chapters
Mars Analog Stations Research Objective

- To provide an integrated simulation environment for testing and improving all human-related elements of a future Mars surface base:
  - Habitat external and internal design
  - Life support and communications technology
  - Mission support
  - Operational guidelines and organization

- Lessons learned by the crews living and working at those stations have the potential to benefit the first astronauts on Mars
FMARS Location

Greenland

Devon

Ellesmere

Resolute Bay (YRB)

Baffin
Floor Plan: Lower Deck

- Primary Airlock
- Secondary Airlock
- EVA Prep Room
- Shower
- Lab Fridge
- Biology Lab
- Main Work Table
- Utility Cabinet

Scale (approximate) 0 1m 2m
Floor Plan: Upper Deck
FMARS 2003 Mission Objectives

- **Operations:**
  - How can the crew maximize exploration and science accomplishments given limited resources?
  - How can the crew best use the expensive and limited satellite communications services?

- **Human Factors:**
  - How does station design influence crew productivity? How can it be improved?
  - How does the crew’s cognitive ability develop?

- **Biology:**
  - What local organisms can be cultured from the soil? Can they be used to produce new antibiotics?

- **Outreach**
  - Generate newspaper and web reports and pictures
  - Establish Ham Radio contacts (call sign: KI4AGQ/VE8)
  - Do interviews with TV and radio stations
FMARS 2003 Mission Timeline

- July 4: Crew arrives in Ottawa, Canada
- July 5: Crew travels to Resolute Bay
- July 6: Crew starts transfer to FMARS
- July 9 to 30: Full-scale simulation (crew “in sim”)
- July 30: Crew transfers back to Resolute Bay
- August 2: Crew travels back to Ottawa
- August 3: Crew arrives home
**FMARS 2003 Daily Life (Typical)**

- **Full crew:**
  - 0700 – 0800: wake, wash, breakfast
  - 0800 – 0900: planning, briefing
  - 0900 – 1800: EVA or IVA
  - 1800 – 1900: post-EVA, debriefing
  - 1900 – 2030: dinner & cleanup
  - 2030 – 2200: report writing, research
  - 2200 – 2300: pre-sleep, maintenance
  - 2300 – 0700: sleep

- **EVA team:**
  - 0900 – 1000: EVA prep
  - 1000 – 1800: EVA

- **IVA team:**
  - 0900 – 1100: Hab maintenance
  - 1100 – 1200: lunch prep
  - 1200 – 1300: lunch & cleanup
  - 1300 – 1700: research, report writing
  - 1700 – 1800: Hab maintenance, dinner prep

- **Lunch and particularly dinner were welcome group activities**

- **Housekeeping chores were rotated:**
  - Generator/water team, 2 crew (weekly)
  - Galley operations, 2 crew (daily)
  - General housekeeping, 1 crew (daily)
FMARS 2003 Exploration Accomplishments

Furthest North:
UTM 16 X
E 424446
N 8387350

Furthest South:
UTM 16 X
E 422933
N 8358961

Furthest West:
UTM 15 X
E 578507
N 8373883

Furthest East:
UTM 16 X
E 435035
N 8377633

FMARS 75° N, 90° W

10 km

FMARS 2002 “furthest” waypoints

MASCOT: Results of First Field Season
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Objective: Track cognitive performance of crewmembers on board simulated planetary exploration facilities

Software: WinSCAT®
- Developed for and used on ISS
- PC-based, self-administered, minimal training needed
- One run takes about 15 to 20 minutes to complete
- Four subtests:
  - Code substitution and memory (CSM; sustained attention and concentration, visual search, verbal learning and recall)
  - Math (MTH; basic computational skills, concentration, working memory)
  - Match-to-Sample (MTS; spatial processing, visuo-spatial working memory)
  - Running memory and continuous performance (CPT; attention/concentration, working memory, lapses in attention)
WinSCAT® Screenshots

**Match-to-Sample**

**Code Substitution**

7 + 5 - 8 = 

Math
MASCOT Participants and Procedures

- 5 of 7 FMARS 2003 crewmembers participated
- Pre-mission instructions and familiarization via e-mail and phone
- Daily test-taking by each participant was encouraged
- Participants kept MASCOT feedback log
- Post-mission test
MASCOT FMARS 2003 Results

Overall results:

- Test data from all five participants
- Average 13.4 test runs per participant, at varying times due to busy schedules
- Log entries with suggestions and comments from all five participants
- One participant scored low due to non-standard PC configuration

Trends:

- Improvements over time (learning effects)
- Noticeable individual performance variations
- Taking MASCOT became part of crew routine
CODESUB Response Times

Dot/Lines show Medians

<table>
<thead>
<tr>
<th>Participant</th>
<th>Code</th>
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<tr>
<td>1</td>
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<td>2</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
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CODESUB RT (msec)

Session
CODESUB Correct Responses

Session

CODESUB % Correct

Participant

1

2

3

4

5

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## Impact of External Factors

<table>
<thead>
<tr>
<th>CATEGORY OF LOG COMMENT</th>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
<th>Participant 4</th>
<th>Participant 5</th>
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</thead>
<tbody>
<tr>
<td><strong>Distractions</strong></td>
<td>CODESUB% Math%</td>
<td>CODESUB% Math%</td>
<td>CODESUB% CPT RT CPT% Math% M2S%</td>
<td>CODESUB% Coding RT Math% M2S%</td>
<td>CODESUB%</td>
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<tr>
<td>Music, conversations, being asked questions</td>
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<td><strong>Illness</strong></td>
<td>CODESUB%</td>
<td>CODESUB%</td>
<td>CODESUB% Math%</td>
<td>CODESUB% Math%</td>
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<tr>
<td>Sore throat, head cold, sniffles</td>
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<tr>
<td><strong>Fatigue</strong></td>
<td>CODESUB%</td>
<td>CODESUB%</td>
<td>CODESUB% Math%</td>
<td>Math%</td>
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<td>Reported being tired</td>
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<tr>
<td><strong>EVA day</strong></td>
<td>CODESUB% M2S% Math%</td>
<td>CODESUB%</td>
<td>CODESUB%</td>
<td>CODESUB% M2S%</td>
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<tr>
<td>At the end of an long EVA day</td>
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Lessons Learned

- Supervised trial runs are necessary to catch peculiarities of individual test participant’s hardware.
- Better explanation of some test aspects is needed.
- Participants should be encouraged to take test in distraction-free environment.
- Meaningful statistical analysis will be possible after additional field data has been gathered from future crews, using comparable experimental procedures.
Conclusions

- Integrated analog simulation facilities enable low-cost, rapid-turnaround, field-level Human Factors research
- Cognitive performance tracking can be achieved through standalone testing software
- Results demonstrate impact of external factors (fatigue, distractions, etc.) on cognitive performance
- Research continues on board FMARS (Crew 9 there now), MDRS and next-generation simulation facilities
Additional Slides
MATH Response Times

Dot/lines show Medians

Math RT (msec)

Session

Participant

1

2

3

4

5

Dot/Lines show Medians
MATH Correct Responses

![Graph showing Math % Correct versus Session for different participants.

1. Participant 1
2. Participant 2
3. Participant 3
4. Participant 4
5. Participant 5

The graph illustrates the percentage of correct responses for each participant across 17 sessions. The data shows variability in performance, with some participants maintaining a high percentage of correct responses throughout the sessions.
FMARS 2003 Crew

CDR/BIO

XO/GEO

ENG

LOG/PAO

BIO/MED

HF/COM/NAV/ENG

IT/ENG
FMARS Interior (1)
# Human Factors Research Questionnaire

**Planetary Habitat Analog Design Efficiency Survey (PHADES)**

Please list the 5 environmental or architectural features of a structure that contribute the most to efficient living and working:

For each of the statements below, please indicate the extent of your agreement or disagreement by placing a tick in the appropriate column.

<table>
<thead>
<tr>
<th>Environment/Architecture</th>
<th>Lighting</th>
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<tbody>
<tr>
<td></td>
<td>The lighting is not bright enough</td>
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<td>The lights are located accurately</td>
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<td>Lighting is good</td>
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<td>Lighting is pleasant</td>
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<td>The color of the illumination is poor</td>
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<td>The level of illumination can be easily changed</td>
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<td>There are enough lights</td>
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<td>Acoustics</td>
<td>The noise is too loud</td>
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<td>The acoustics are acceptable</td>
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<td>The noise level is pleasant</td>
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<td>Sound is contained well</td>
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<td>Noise does not impact sleep and rest</td>
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<td>Noise does not impact work</td>
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<td>Noise level can be easily controlled or mediated</td>
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<td>Temperature</td>
<td>Temperature is good</td>
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<td>The air is too hot</td>
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<td>Temperature can be easily modified</td>
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**PIs:**
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Jennifer Blume, jennifer.l.blume@msfc.nasa.gov

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MASCOT: Results of First Field Season

Jan.Osburg@gmx.net
EVA Glove Actuator
Inside vs. Outside
Midnight Sun
Sampling
Onwards – Upwards!
Rappelling
STS-107 Columbia Memorial