Simulating Mars on Earth: Georgia Tech's Crew 47 at the Mars Desert Research Station
Outline

- On to Mars
  - Why?
  - How?
  - The Mars Society’s analog stations program

- Crew 47 - The 2006 Georgia Tech Expedition to MDRS
  - Meet the Crew
  - Training
  - Mission Timeline

- Research

- Engineering

- Outreach

http://www.solarviews.com/cap/mars/vmars3.htm
Why Send Humans to Mars?

➔ To find out more about Mars, leading to a better understanding of
  ◦ The origins of life
  ◦ Earth's ecosystem and how to protect it

➔ To open up a "new frontier" for human civilization
  ◦ Presenting opportunities and challenges
  ◦ Providing a worthy objective for the best and brightest
  ◦ Advancing culture and technology
  ◦ Inspiring the human spirit
  ◦ Following the Imperative of Life

Painting by Alan Bean
How to Send Humans to Mars

Earth to Mars Trajectory

Mars at Launch

Mars at Landing

Earth at Launch

Earth at Landing

Earth at Return

Mars at Return

Mars to Earth Trajectory

Earth at Return

Mars at Launch

Earth at Launch
Mars Direct Mission Sequence 1

Year 1

Year 3

Year 5

Zubrin 1996
Mars Direct Mission Sequence 2

Year 1

Year 3

Year 5

Zubrin 1996
Mars Direct Mission Sequence 3

Year 1

Year 3

Year 5

Zubrin 1996

800 km
Mars Direct Mission Overview

Year 1

Year 3

Year 5

800 km

Zubrin 1996
First Human Base on Mars, 2025 (?)

- Habitation Module
- Earth Return Vehicle
- Unpressurized Rover
- Power Plant
- Pressurized Rover
- Experimental Greenhouse
- EVA
Mars Analog Stations Program Overview

- The Mars Society is an international organization of engineers, scientists, artists and others interested in promoting the manned exploration and settlement of Mars.

- It has started building and operating a number of Mars-analog stations in remote environments:
  - Flashline Mars Arctic Research Station, FMARS
  - **Mars Desert Research Station, MDRS**
  - European Mars Analog Research Station, EuroMARS

- Crews are volunteers with suitable professional and personal backgrounds.
Mars Analog Stations Mission Objectives

- To develop requirements for the design of the first Mars surface bases:
  - Habitat layout
  - Life support systems
  - Communications technology
  - Mission support
  - Operational guidelines

- To engage in public outreach in support of manned space exploration

- To provide hands-on exploration experience to scientists, engineers and students
Floor Plan: Lower Deck
Floor Plan: Upper Deck
Meet Crew 47

➡️ Dr. Jan Osburg: Commander, Radio, Navigation, Human Factors
➡️ Emily Colvin: Executive Officer, IT Engineering
➡️ Anne Campeau: Station Engineer, Materials and Tools Research
➡️ Meryl Mims: Biology, Geology, Health and Safety Officer
➡️ Jennifer Rome: Astronomy, Logistics
➡️ Jason Sherwin: Radiation Research, Public Affairs Officer
➡️ Elizabeth Tang: Mission Support Lead, Outreach
➡️ Gregory Lantoine: Mission Support, Mars In-Situ Construction
➡️ Jonathan Sharma: Mission Support
Training Hike, January 2006

Hiking Track Visualization in Google Earth

Hiking Track Visualization in GPS TrackMaker
Daily Life at MDRS

➡️ Typical daily schedule:
- 08:00h: wake/wash/breakfast
- 09:30h: start of IVA work
- 12:30h: lunch
- 14:00h: EVA (3 crew), continue IVA work (3 crew)
- 18:00h: report writing
- 19:00h: dinner
- 20:00h: continue reports, additional IVA work
- 22:00h: movie, homework, etc.
- 00:00h: sleep

➡️ Chores/housekeeping were rotated:
- Generator team, 2 crew (daily)
- Galley operations, 2 crew (daily)
- General housekeeping, 1 crew (daily)
Crew 47 Mission Objectives

- Navigation, communication and data transmission research
- Testing polymer fiber materials and tools
- Developing construction techniques based on in-situ resources utilization
- Making astronomical observations
- Testing celestial navigation procedures
- Characterization of the radiation field around the station
- Human Factors research
- Biological research
- Monitoring the station’s power consumption
- Providing general engineering upgrades
- Outreach activities
  - High school involvement
  - Newspaper, TV and web reports
Crew 47 Navigation/Communication Experiments

- Based on off-the-shelf amateur radio equipment
- Features:
  - Each EVA suit has its own GPS receiver and amateur radio beacon (“Automatic Position Reporting System”, APRS)
  - Voice and APRS repeaters (ground- and balloon-based) expand coverage
  - Near-real-time position tracking and display of EVA positions on web site
- Scope:
  - Evaluate practicality and determine fielding issues
  - Standardize/document to encourage adaptation by other crews
  - Characterize RF coverage, determine good repeater locations
  - Gather additional data for MDRS waypoint/track database
Radio System Overview

- Voice repeater (cross-band)
- Digipeater
Real-Time EVA Position Tracking with Amateur Radio
EVA Track Visualization and Live Data on the Web

findu.com
aprsworld.net

National Geographic Topo!
(c/o Frank Crossman)

GPS Track Maker
www.gpstm.com
Navigation Database Updates and GPS Route Survey

MARS Mars Waypoint Database

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<tr>
<th>Crew</th>
<th>EVA</th>
<th>Waypoint Name</th>
<th>Latitude</th>
<th>Longitude</th>
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SET GPS COORDINATES TO UTM:

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ELEVATION UNITS:

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SET UTM Zone 12S:

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<tr>
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</table>
Polymer Fiber Materials and Tools Research

- Design and build a shovel out of carbon fiber
- Compare strength and weight against regular metal shovel
- Investigate compatibility with EVA suits
- Support other research (ISRU, radiation)
Use of in-situ construction materials on Mars reduces launch mass:
- Radiation shielding
- Pressurized structures

Objective:
- Use sandbags as building blocks for small structures
- Examine compatibility of sandbag filling and placement with EVA suits
- Evaluate the effectiveness of a radiation shield made of filled sand bags
Mapping Radiation Levels

➔ Equipment:
   ✷ Handheld GammaScout radiation meter
   ✷ Global Positioning System (GPS) receivers

➔ Approach:
   ✷ Match timestamps of radiation and position data
   ✷ Plot radiation data (counts per minute) on map
Celestial Navigation Experiment

➤ Background
  ❖ Backup navigation in case of electronic positioning system failure
  ❖ Celestial navigation is time-honored method

➤ Objective: evaluate the feasibility of celestial navigation as a contingency navigation technique on Mars
  ❖ Is the equipment reasonably portable?
  ❖ Can the equipment be used in a spacesuit?
  ❖ Is the technique accurate?
  ❖ Can the techniques that work on Earth be applied to the Martian sky?
Human Factors Research

**MASCOT cognitive performance test**

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

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<tr>
<th>Environment/Architecture</th>
<th>Lighting</th>
<th>level</th>
<th>The lighting is not bright enough</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Not Applicable</th>
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<td></td>
<td></td>
<td>location</td>
<td>The lights are located accurately</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td></td>
<td></td>
<td>general acceptability</td>
<td>Lighting is good</td>
<td>X</td>
<td>X</td>
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<tr>
<td></td>
<td></td>
<td>aesthetics</td>
<td>Lighting is pleasant</td>
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<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>color</td>
<td>The color of the illumination is poor</td>
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<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>control</td>
<td>The level of illumination can be easily changed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>quantity</td>
<td>There are enough lights</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<table>
<thead>
<tr>
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<th>level generally</th>
<th>The noise is too loud</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Not Applicable</th>
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<tbody>
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<td>The acoustics are acceptable</td>
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<td>X</td>
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<tr>
<td></td>
<td>aesthetics</td>
<td>The noise level is pleasant</td>
<td>X</td>
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<td></td>
<td>privacy</td>
<td>Sound is contained well</td>
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<td>X</td>
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<td>sleep</td>
<td>Noise does not impact sleep and rest</td>
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<td>X</td>
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<td>Noise does not impact work</td>
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<td></td>
<td>control</td>
<td>Noise level can be easily controlled or mediated</td>
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<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**PHADES Habitability Survey**
Mars Literature as a Cabin Fever Countermeasure
The Backup Crew

Photos: imdb.com
Engineering and Emergencies
Exploration
Media Response (Crew 37 and Crew 47)

Additional Crew 47 coverage:
- The Chicago Tribune
- The Washington Times
- The Forward
- VIEW Magazine
On to Mars!

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