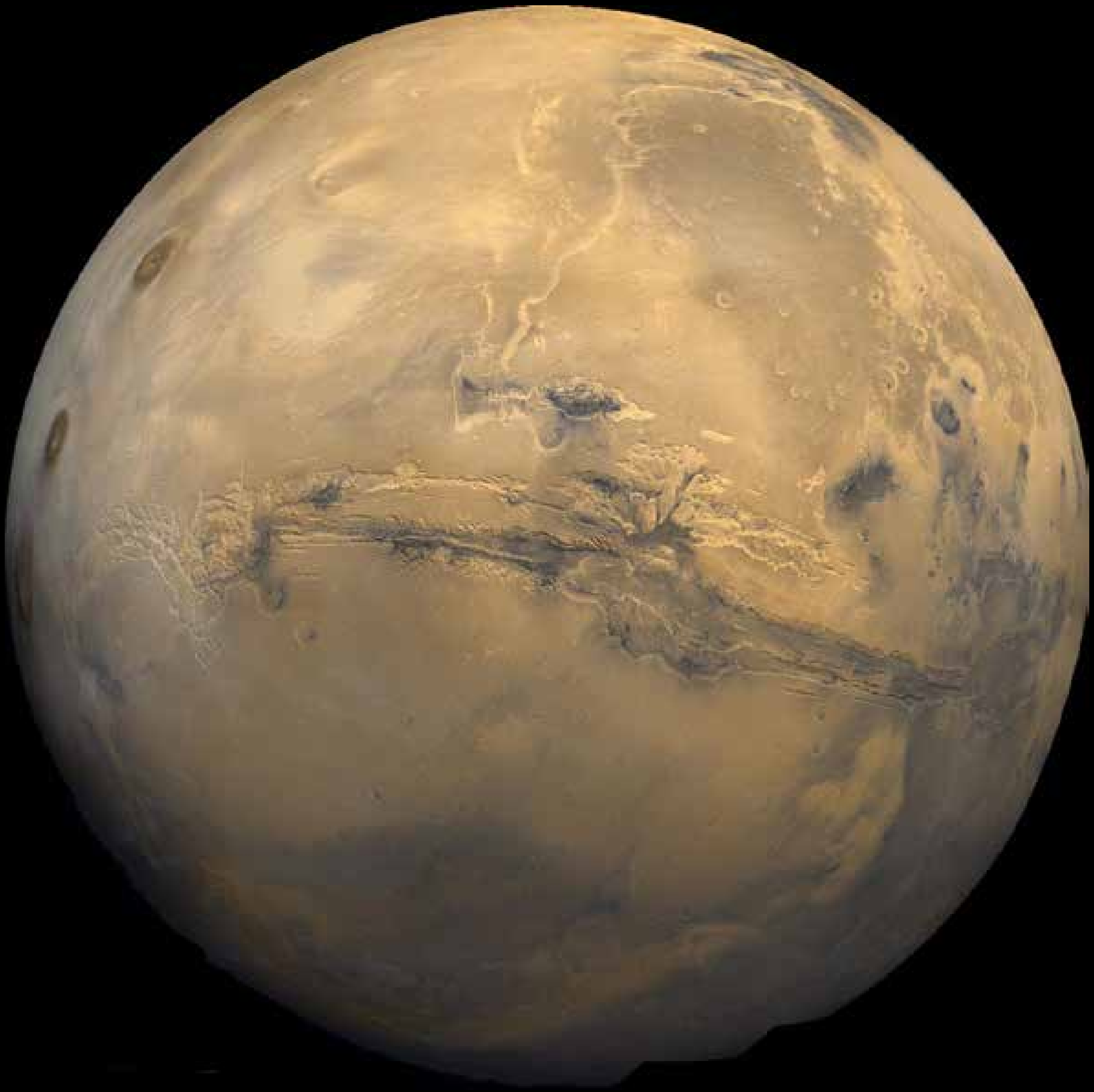
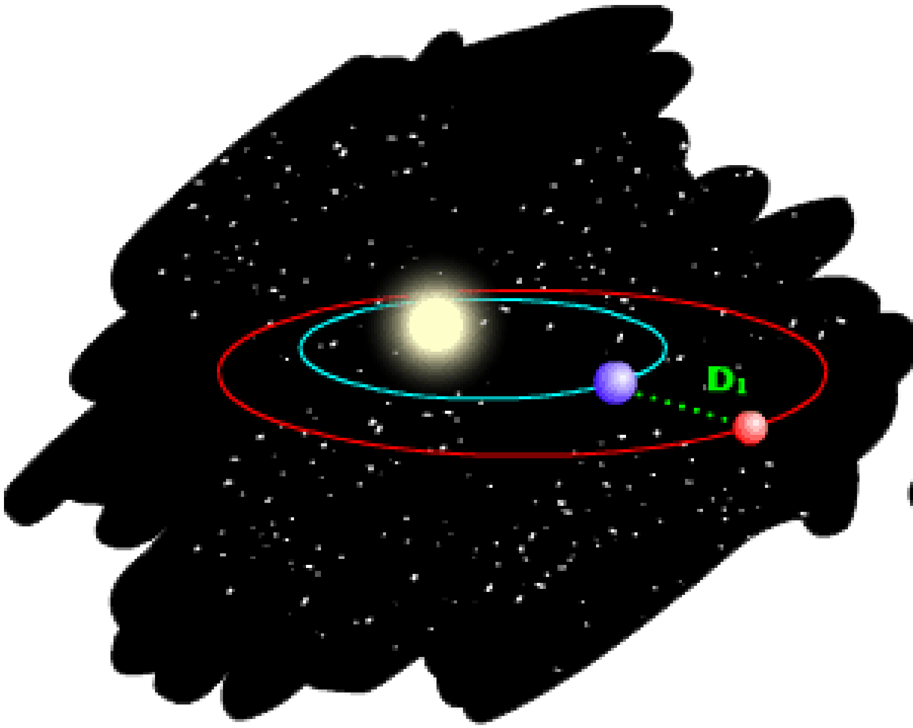
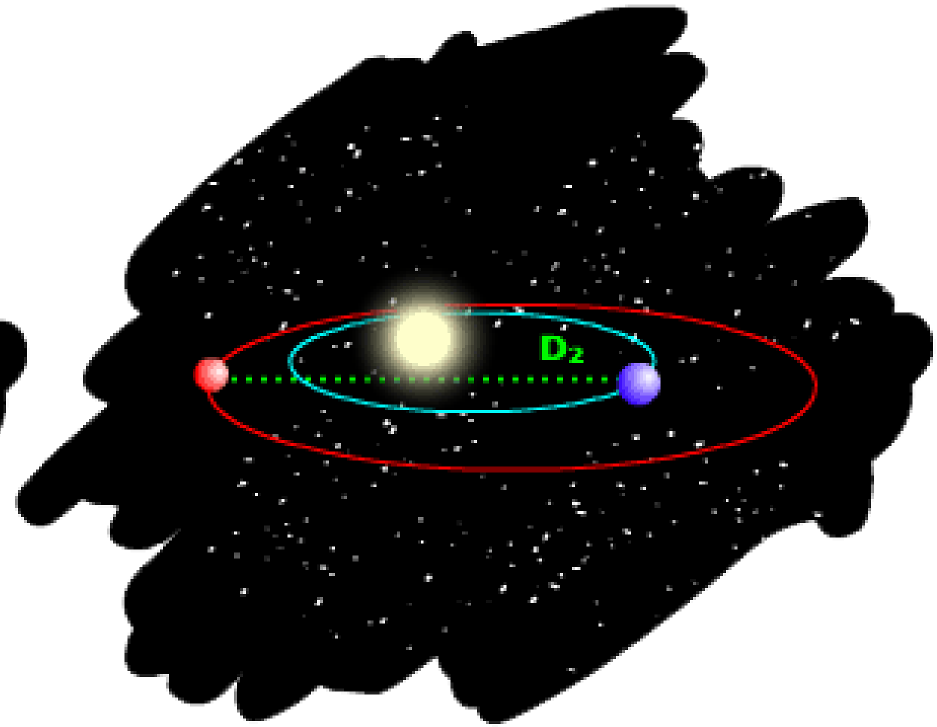
Good evening, everyone!

Are you ready?



How Far Is it?





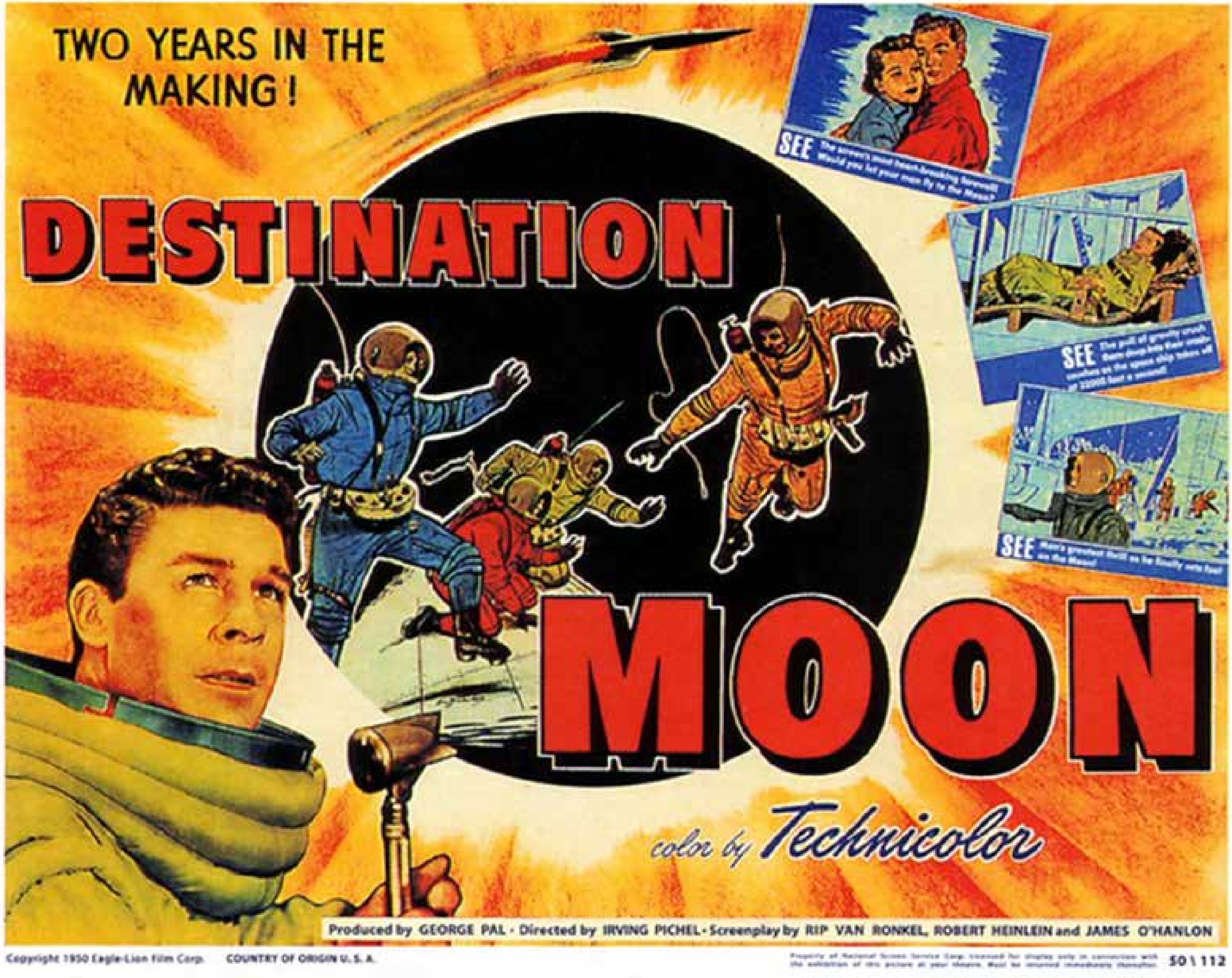
D1 = 60,000,000 miles

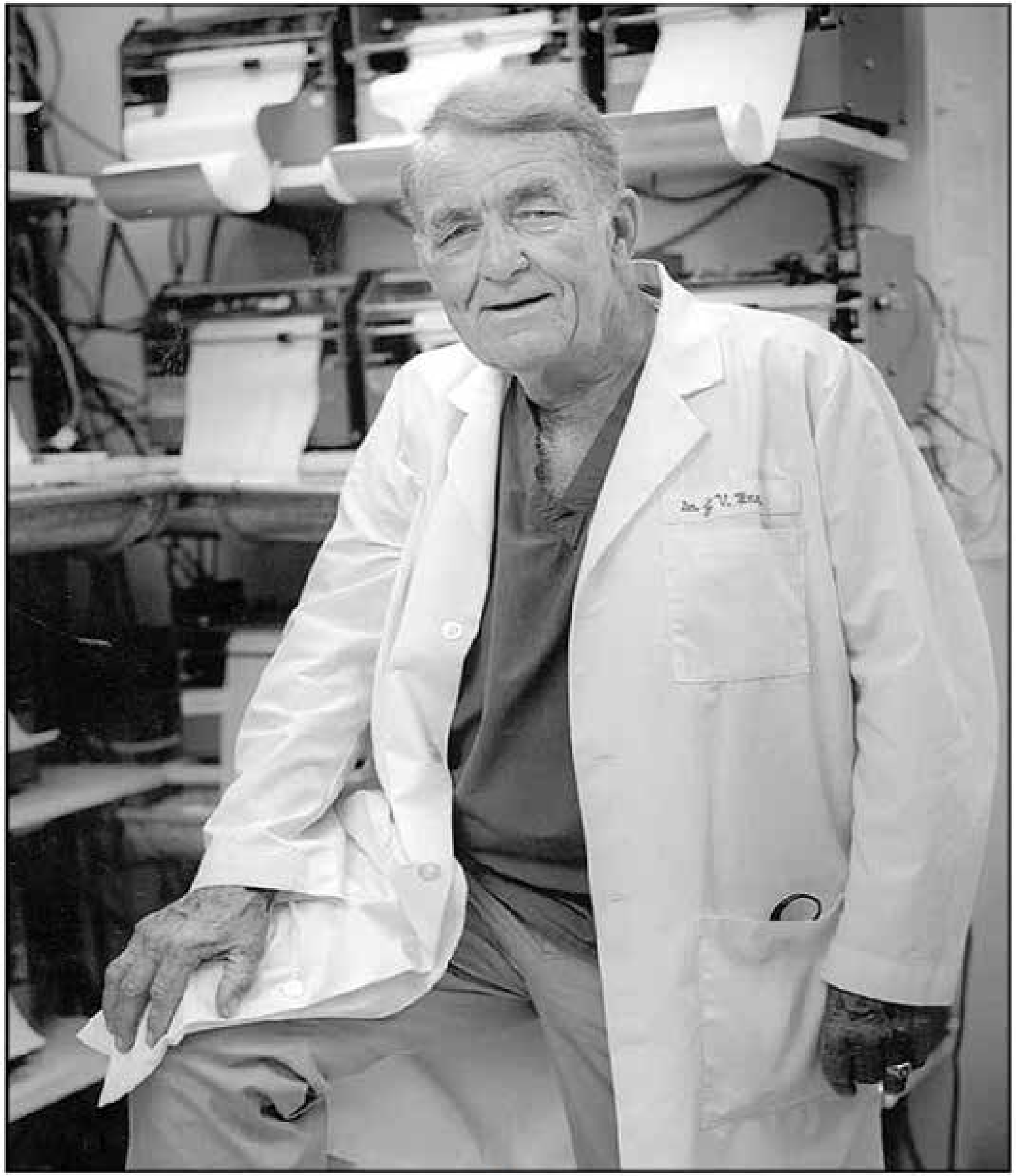
D2 = 400,000,000 miles

How Long Will It Take?

- **High energy trajectory**
  - Outbound flight of 160-250 days
  - 60 days on the Martian surface
  - Return flight of 160-250 days
- **Low energy trajectory (Mars Direct Plan)**
  - Outbound flight of 200-300 days
  - 400-500 days on the Martian surface
  - Return flight of 200-300 days

Manzey, D. (2004). Human missions to Mars: new psychological challenges and research issues. *Acta Astronautica*, *55*, 781-790.


TWO YEARS IN THE MAKING!
SEE
SEE
SEE
DESTINATION
MOON
color by Technicolor
Produced by GEORGE PAL · Directed by IRVING PICHEL · Screenplay by RIP VAN RONKEL, ROBERT HEINLEIN and JAMES O'HANLON
Copyright 1950 Eagle-Lion Film Corp.
COUNTRY OF ORIGIN U. S. A.
50\112



Joseph V. Brady

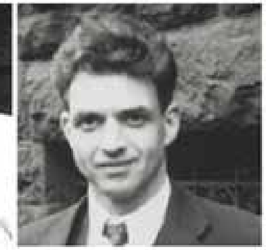
100 Years of the Henry Phipps Psychiatric Clinic

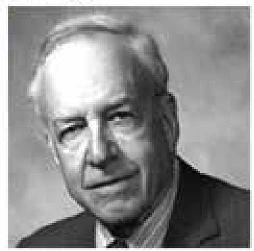
Celebrating Psychiatry's Stars

In the century since the dedication of the Phipps Psychiatric Clinic with its founding director, Adolf Meyer, the Department of Psychiatry has produced countless scholars and leaders. Dean MacKinnon, M.D. introduces you to a select few who represent the range of contributions that Johns Hopkins faculty have made to the field of modern psychiatry. Click on each photo below to read more.

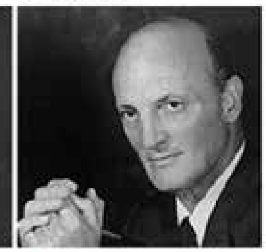

Adolf Meyer

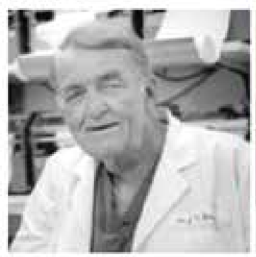

Curt Richter

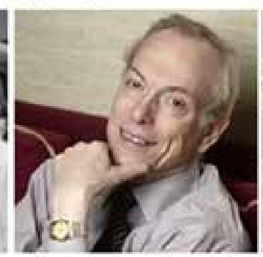

W. Horsley Gantt


Jerome Frank


Leo Kanner


Eugene Meyer


Joseph Brady


Solomon Snyder


Paul McHugh


Marshal and Susan Folstein


Kay Redfield Jamison


John Money

First PERC Presentation

Bigelow, G.E., Emurian, H.H., and Brady, J.V. **A Programmed Environment for the Experimental Analysis of Individual and Small Group Behavior**, Symposium: Controlled Environment Research and Its Potential Relevance to the Study of Behavioral Economics and Social Policy. Addiction Research Foundation, Toronto, Canada, **1973**.

Programmed Environment Management of Confined Microsocieties: Mission to Mars

Henry H. Emurian
College of Engineering and Information Technology
UMBC

&

Joseph V. Brady
The Johns Hopkins University School of Medicine

At Dinner in Philadelphia

Behavioral Systems Management of Confined Microsocieties: An Agenda for Research and Applications

Henry H. Emurian & Kip Canfield
UMBC

Peter G. Roma, Eric D. Gasior, & Zabecca S. Brinson
Institutes for Behavior Resources

Robert D. Hienz, Steven R. Hursh, & Joseph V. Brady
Johns Hopkins University School of Medicine

UMBC
AN HONORS UNIVERSITY IN MARYLAND

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JOHNS HOPKINS
MEDICINE

1 2009-01-2423

Behavior Analysis of Team Performance: A Case Study of Membership Replacement

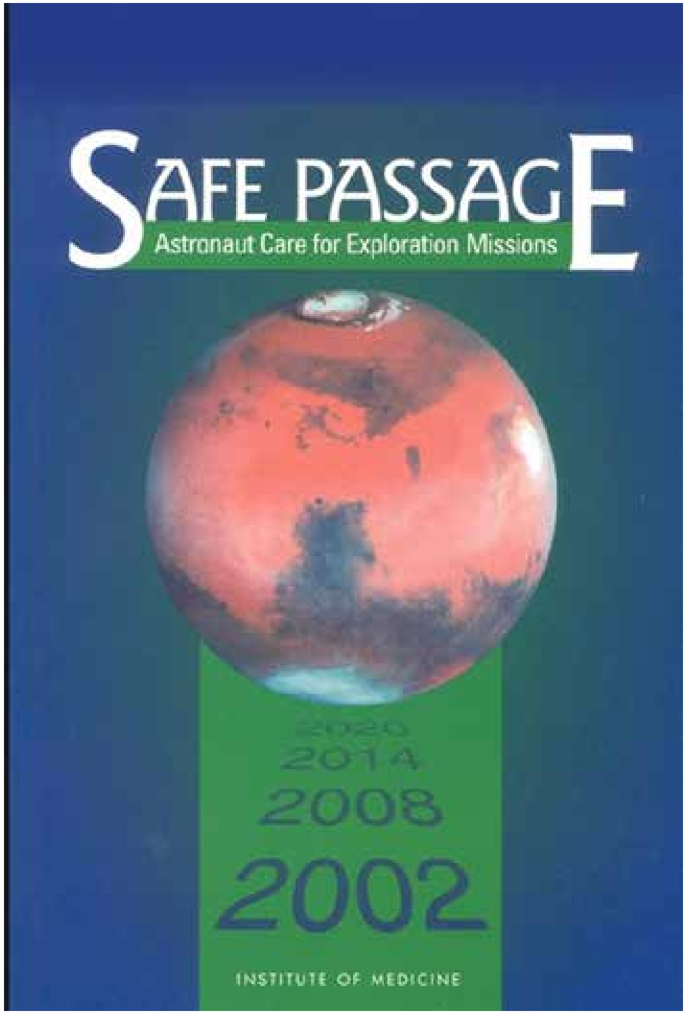
Henry H. Emurian & Kip Canfield
UMBC
&
Joseph V. Brady
Behavioral Biology Research Center
Johns Hopkins University School of Medicine

Précis

- **Anticipate extended stays in space**
- **Management of crew behavioral health**

Two Influential Reports

Safe Passage: Astronaut Care for Exploration-Missions (2001)



Institute of Medicine (US) Committee on Creating a Vision for Space Medicine During Travel Beyond Earth Orbit; Ball, JR & Evans, CH Jr. (Eds.), Washington (DC): National Academies Press (US); 2001.

***Safe Passage: Astronaut Care for Exploration-Missions* (2001)**

- **Not enough is yet known about the risks.**
- **Everything *reasonable* should be done to understand and mitigate those risks.**

Behavioral Health and Performance

Approved for Public Release: April 11, 2016

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

A. Risk statement

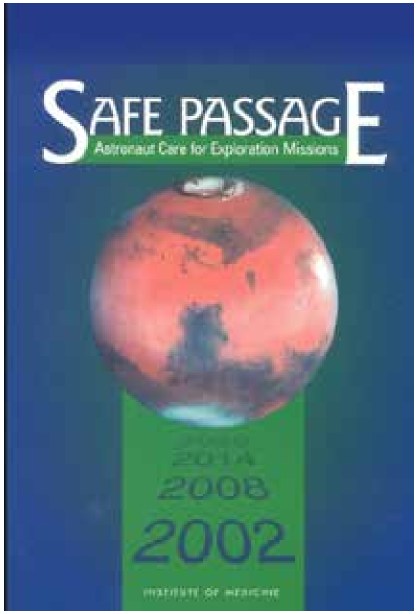
Taken verbatim from the Human Research Program Roadmap, the risk statement for Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders ("Risk", 2015) states:

> Given the extended duration of current and future missions and the isolated, confined and extreme environments, there is a possibility that (a) adverse cognitive or behavioral conditions will occur affecting crew health and performance; and (b) mental disorders could develop should adverse behavioral conditions be undetected and unmitigated.

Behavioral Health and Performance

Approved for Public Release: April 11, 2016

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas



Conclusion?

A Mars Mission Will Not Be Easy!

Sex in Space?

Astronauts in space live in extremely close quarters. A long term deep space mission would present the issue of romantic and sexual relationships between crewmates. – Credits: NASA

http://www.spacesafetymagazine.com/space-exploration/analog/sex-romance-mars

TECH 08/28/2010 05:12 am ET | **Updated** Feb 02, 2015

Sex Banned Aboard International Space Station: NASA Commander

You can forget joining the 200-mile high club.

NASA commander Alan Poindexter told a reporter who asked about "the consequences if astronauts boldly went where probably no others have been" that sexual intercourse is not permitted aboard the International Space Station.

"We are professionals," Poindexter said.

"We treat each other with respect and we have a great working relationship. Personal relationships are not [...] an issue," he explained. "We don't have them and we won't."

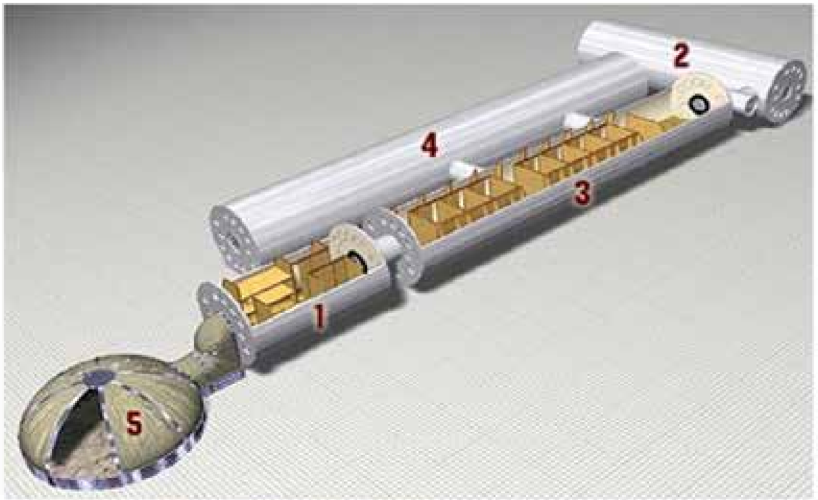
http://www.huffingtonpost.com/2010/06/28/international-space-stati_1_n_627447.html

If you want to get a few guys to Mars and back,
you'll have to talk to us about human engineering.

My off-the-cuff comment to a reporter in 1983 still stands. (*Psychology Today*, 1983)

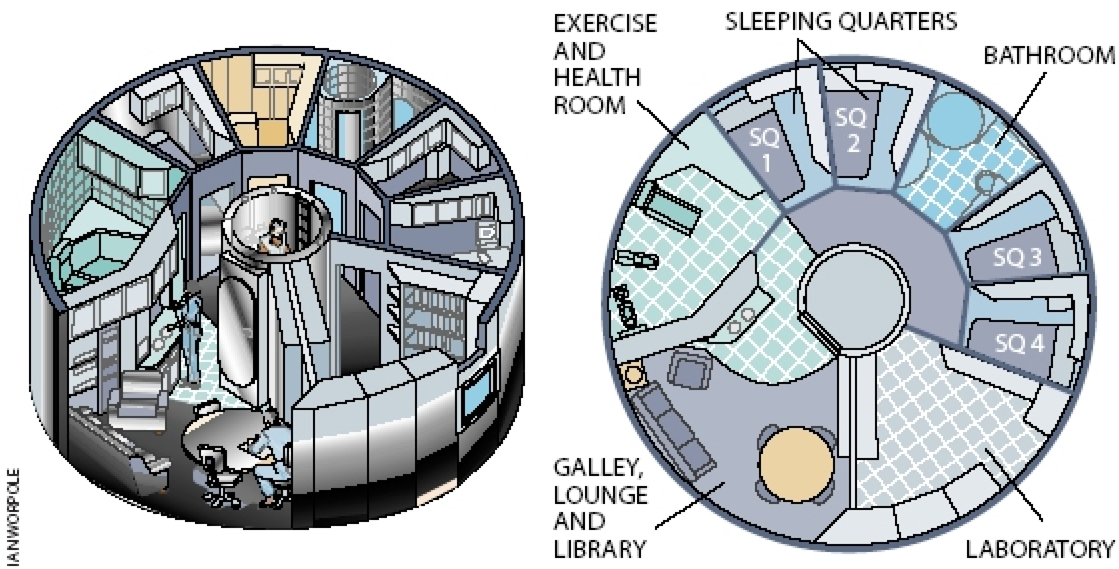

MARS 500
«Mars-500» project
Simulation of a manned flight to Mars
14-day isolation
105-day isolation
520-day isolation
Satellite experiments
Home
News
About 'Mars-500' project
Administration
Partners
The project is being spoken about
History
Experimental facility
14-day isolation
105-day isolation
520-day isolation
Publications in mass media
Photogallery
Downloads
Links
Contacts
520-day isolation completed November 4, 2011 at 14:00 (GMT)
Blogger
Livejournal
Youtube
Twitter
About "Mars-500" project
"Mars-500" project is being conducted by the State scientific center of the Russian Federation – Institute for Bio-Medical Problems of RAS under the aegis of Roscosmos and Russian Academy of Sciences. It includes a series of experiments simulating these or those aspects of an interplanetary manned flight. The main part is a series of experiments on long-term isolation of the crew in conditions of the specially built ground-based experiment facility. This part includes:
14-day isolation (it was completed in November 2007)
105-day isolation (it was completed in July 2009)
520-day isolation (it was completed in November 2011)
News
20.05.2012
The electronic version of abstracts book of International symposium on the results of the experiments, simulating manned mission to Mars (Mars-500) – Mars500 symposium - Abstracts book (rus+eng).pdf.
08.11.2011
New press-kit – "Finishing of 520-day isolation".
04.11.2011
End of 520-day isolation. Picture story
Virtual tour of the Mars500
Photogallery

2009: MARS 500



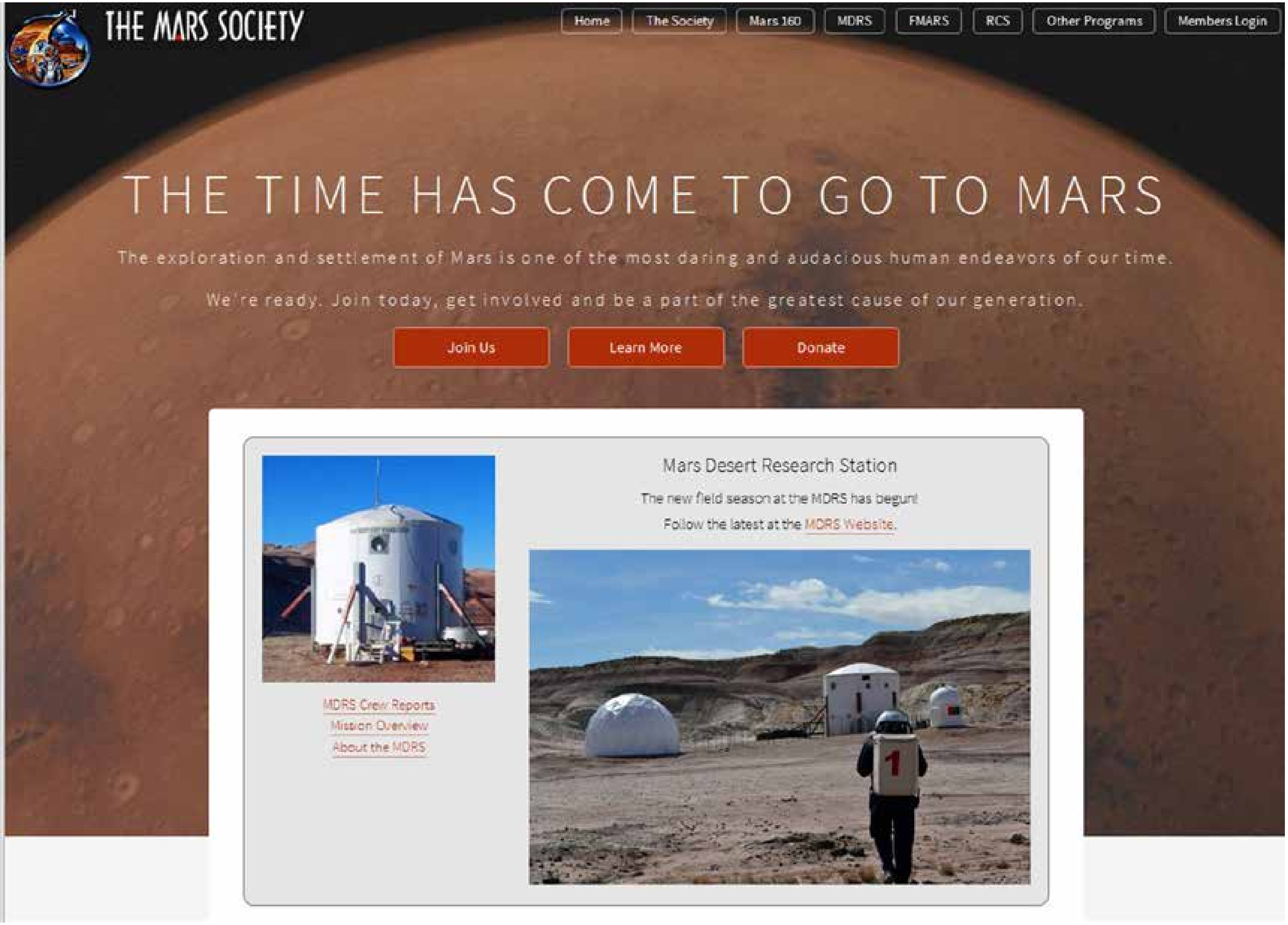
THE MARS DIRECT PLAN

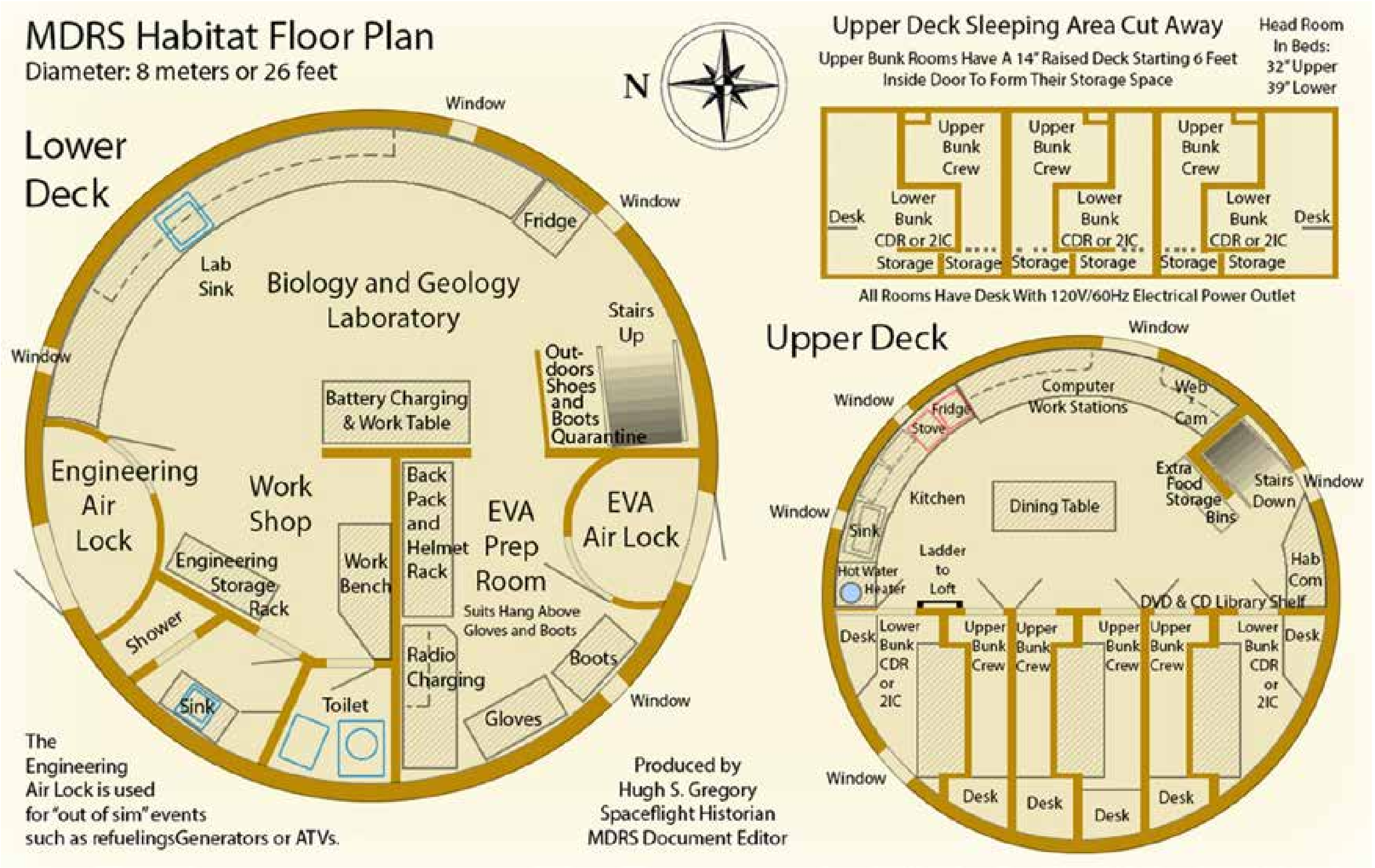
A leading advocate of manned missions to Mars, Robert Zubrin, outlines his relatively inexpensive plan to send astronauts to the Red Planet within a decade



HOME SWEET HOME in interplanetary space and on Mars might look like this. The upper deck of the habitat, shown here, would have sleeping quarters for four people as well as a laboratory, library, galley and gym. A solar-flare storm shelter would be located in the center. The lower deck (*not shown*) would serve as a garage, workshop and storage area. During the trip to Mars, a tether system could produce artificial gravity.

Zubrin, R. (2000). The Mars direct plan. *Scientific American*, *282*, 34-37.


THE MARS SOCIETY
Home
The Society
Mars 160
MDRS
FMARS
RCS
Other Programs
Members Login
THE TIME HAS COME TO GO TO MARS
The exploration and settlement of Mars is one of the most daring and audacious human endeavors of our time.
We're ready. Join today, get involved and be a part of the greatest cause of our generation.
Join Us
Learn More
Donate
Mars Desert Research Station
The new field season at the MDRS has begun!
Follow the latest at the MDRS Website.
MDRS Crew Reports
Mission Overview
About the MDRS


MDRS Habitat Floor Plan
Diameter: 8 meters or 26 feet
N
Lower Deck
Window
Window
Window
Fridge
Lab Sink
Biology and Geology Laboratory
Stairs Up
Out-doors Shoes and Boots Quarantine
Battery Charging & Work Table
Engineering Air Lock
Work Shop
Engineering Storage Rack
Work Bench
Back Pack and Helmet Rack
EVA Prep Room
EVA Air Lock
Suits Hang Above Gloves and Boots
Shower
Sink
Toilet
Radio Charging
Gloves
Boots
Window
The Engineering Air Lock is used for "out of sim" events such as refuelingsGenerators or ATVs.
Produced by Hugh S. Gregory Spaceflight Historian MDRS Document Editor
Upper Deck Sleeping Area Cut Away
Upper Bunk Rooms Have A 14" Raised Deck Starting 6 Feet Inside Door To Form Their Storage Space
Head Room In Beds: 32" Upper 39" Lower
Upper Bunk Crew
Upper Bunk Crew
Upper Bunk Crew
Desk
Lower Bunk CDR or 2IC
Lower Bunk CDR or 2IC
Lower Bunk CDR or 2IC
Desk
Storage
Storage
Storage
Storage
Storage
Storage
All Rooms Have Desk With 120V/60Hz Electrical Power Outlet
Upper Deck
Window
Window
Computer Work Stations
Web Cam
Fridge
Stove
Kitchen
Dining Table
Extra Food Storage Bins
Stairs Down
Window
Window
Sink
Hot Water Heater
Ladder to Loft
Hab Com
DVD & CD Library Shelf
Desk
Lower Bunk CDR or 2IC
Upper Bunk Crew
Upper Bunk Crew
Upper Bunk Crew
Upper Bunk Crew
Lower Bunk CDR or 2IC
Desk
Window
Desk
Desk
Desk
Desk

Journey to Mars Overview | NA...

https://www.nasa.gov/content/journey-to-mars-overview

NASA TV

Journey to Mars

Journey to Mars | Overview | Images | Videos | Media Resources

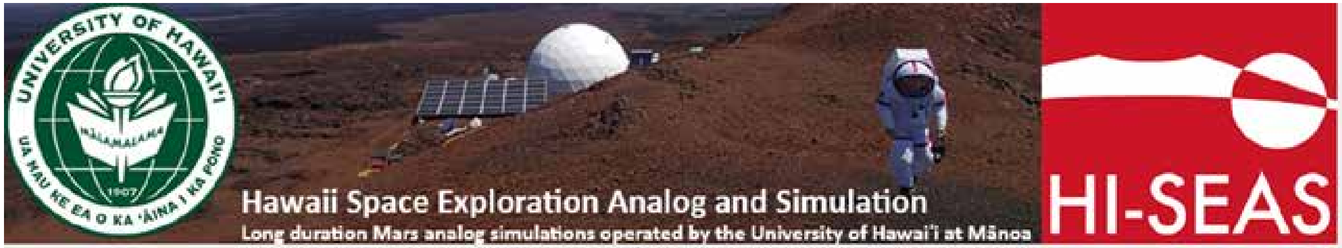
Journey to Mars Overview

NASA is on a journey to Mars, with a goal of sending humans to the Red Planet in the 2030s. That journey is already well under way.

For decades, the agency and its partners have sent orbiters, landers and rovers, dramatically increasing our knowledge about the Red Planet and paving the way for future human explorers. The Curiosity rover has gathered radiation data to help us protect future astronauts, and the upcoming Mars 2020 rover will study the availability of Martian resources, including oxygen.

There is more to learn as we expand humanity's presence into the solar system: Was Mars once home to microbial life or is it today? Can it be a safe home for humans? What can the Red Planet teach us about our own planet's past, present and future?

Building on the robotic legacy, the human exploration of Mars crosses three thresholds, each with increasing challenges as humans move farther from Earth: Earth Reliant, the Proving Ground, and Earth Independent.



HOME MEDIA ARCHIVES ANNOUNCING HI-SEAS V CREW MEMBERS!

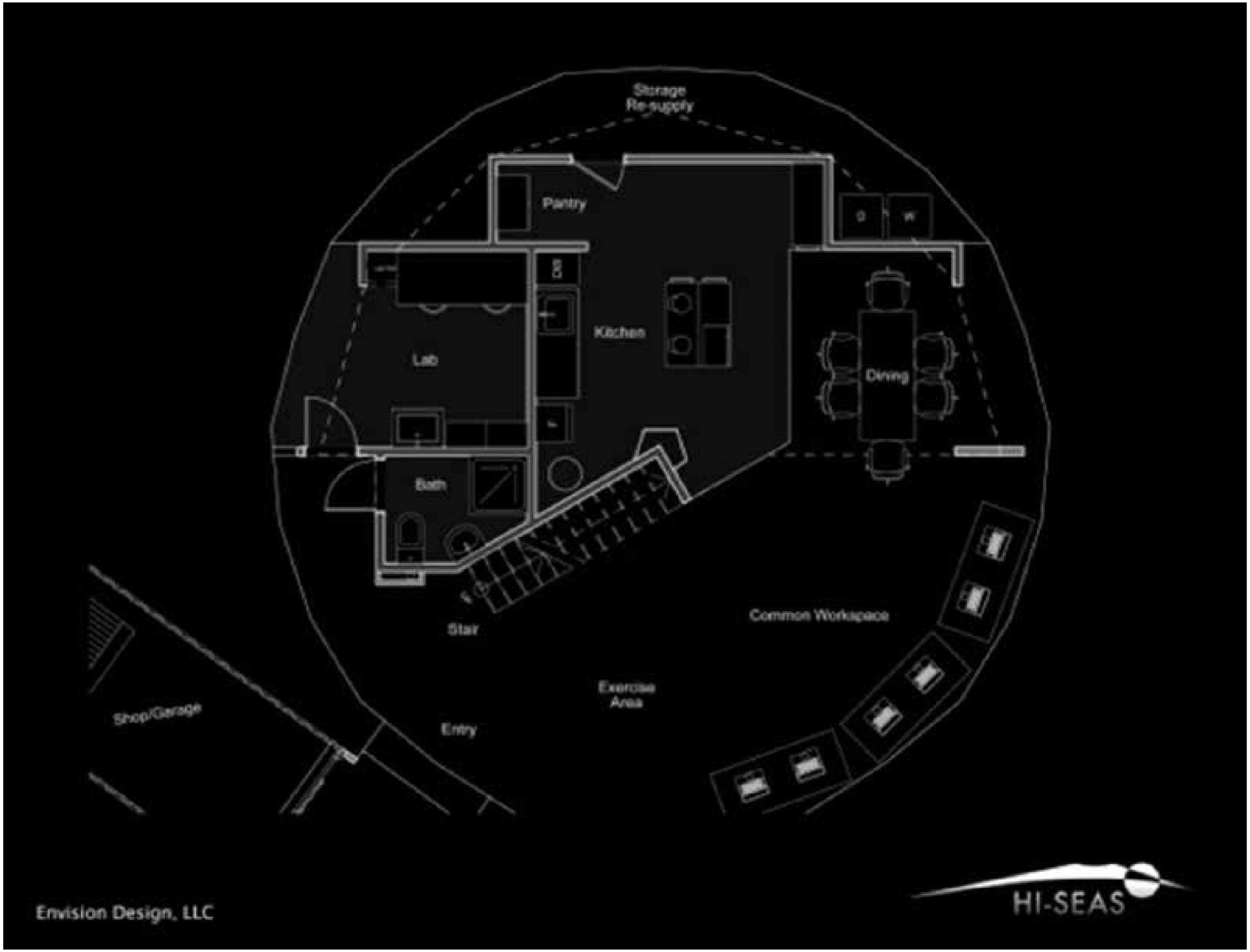
Hawai'i Space Exploration Analog and Simulation

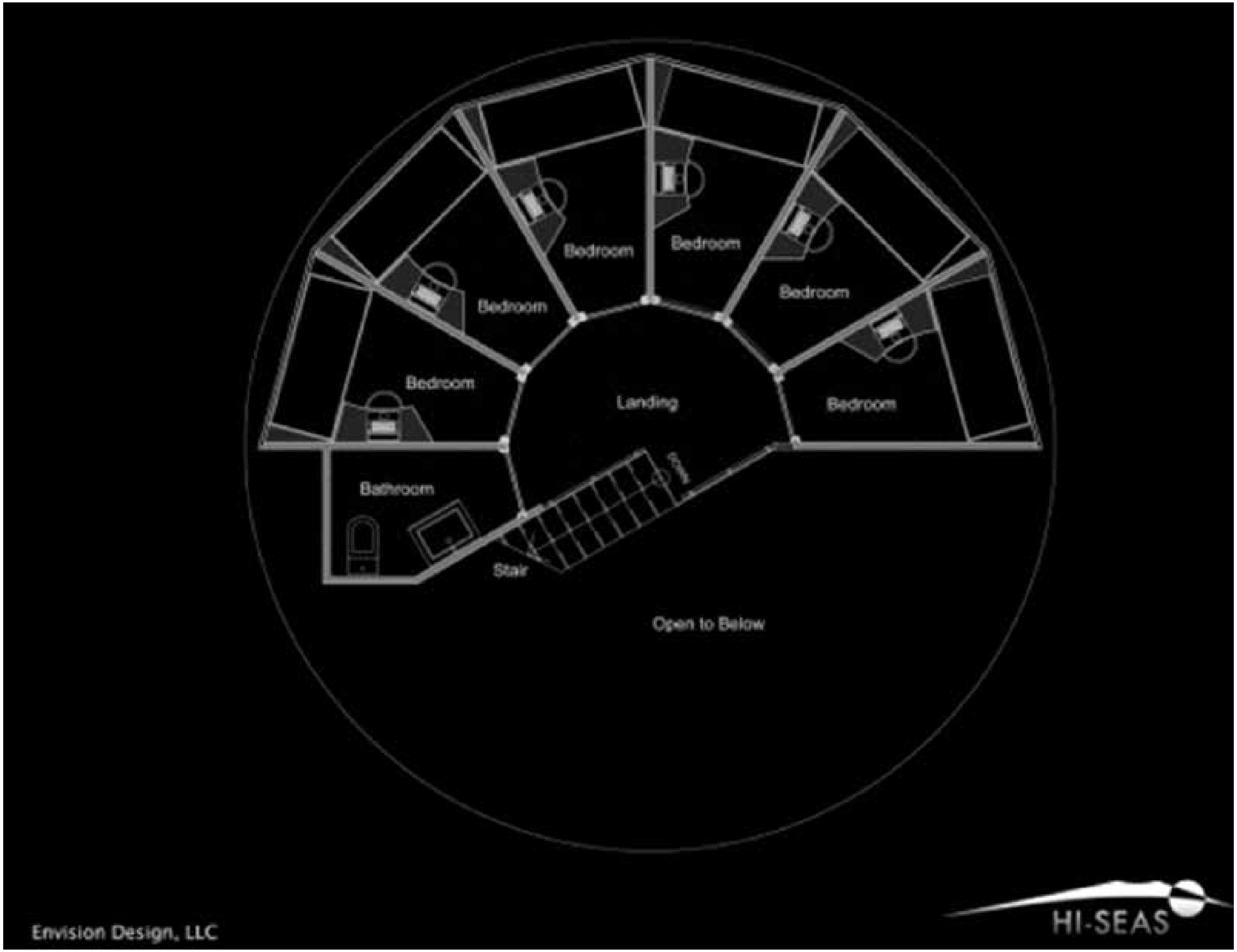
HI-SEAS (Hawai'i Space Exploration Analog and Simulation) is a Habitat on an isolated Mars-like site on the Mauna Loa side of the saddle area on the Big Island of Hawaii at approximately 8200 feet above sea level. HI-SEAS is unique, in addition to its setting in a distinctive analog environment, as:

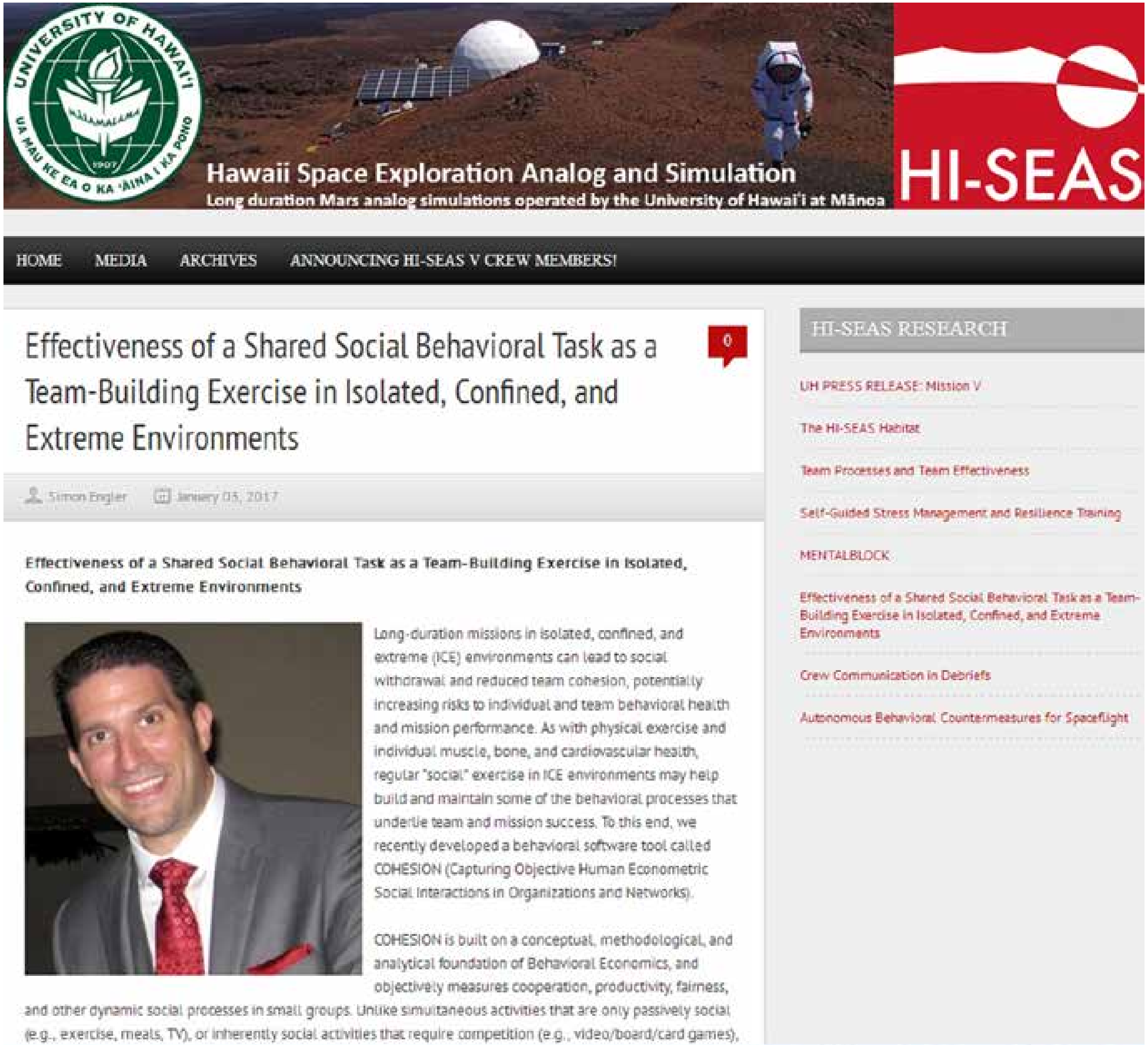
1. we select the crew to meet our research needs (in serendipitous analogs, such as Antarctic stations, crew selection criteria are not controlled by researchers);
2. the conditions (Habitat, mission, communications, etc.) are explicitly designed to be similar to those of a planetary exploration mission;
3. the site is accessible year round, and has very little variation in weather, allowing longer-duration isolated and confined environment studies than at other locations;
4. the Mars-like environment provides for high-fidelity analog tasks, such as geological field work carried out by human explorers and/or robots.

HI-SEAS RESEARCH

- UH PRESS RELEASE: Mission V
- The HI-SEAS Habitat
- Team Processes and Team Effectiveness
- Self-Guided Stress Management and Resilience Training
- MENTALBLOCK
- Effectiveness of a Shared Social Behavioral Task as a Team-Building Exercise in Isolated, Confined, and Extreme Environments
- Crew Communication in Debriefs
- Autonomous Behavioral Countermeasures for Spaceflight


Storage
Re-supply
Pantry
Lab
Kitchen
Dining
Bath
Stair
Common Workspace
Exercise
Area
Entry
Shop/Garage
Envision Design, LLC
HI-SEAS


Bedroom
Bedroom
Bedroom
Bedroom
Bedroom
Bedroom
Landing
Bedroom
Bathroom
Stair
Open to Below
Envision Design, LLC
HI-SEAS



UNIVERSITY OF HAWAI'I

Hawaii Space Exploration Analog and Simulation

Long duration Mars analog simulations operated by the University of Hawai'i at Mānoa

HI-SEAS

HOME MEDIA ARCHIVES ANNOUNCING HI-SEAS V CREW MEMBERS!

Effectiveness of a Shared Social Behavioral Task as a Team-Building Exercise in Isolated, Confined, and Extreme Environments

0

Simon Engler January 03, 2017

Effectiveness of a Shared Social Behavioral Task as a Team-Building Exercise in Isolated, Confined, and Extreme Environments

Long-duration missions in isolated, confined, and extreme (ICE) environments can lead to social withdrawal and reduced team cohesion, potentially increasing risks to individual and team behavioral health and mission performance. As with physical exercise and individual muscle, bone, and cardiovascular health, regular "social" exercise in ICE environments may help build and maintain some of the behavioral processes that underlie team and mission success. To this end, we recently developed a behavioral software tool called COHESION (Capturing Objective Human Econometric Social Interactions in Organizations and Networks).

COHESION is built on a conceptual, methodological, and analytical foundation of Behavioral Economics, and objectively measures cooperation, productivity, fairness, and other dynamic social processes in small groups. Unlike simultaneous activities that are only passively social (e.g., exercise, meals, TV), or inherently social activities that require competition (e.g., video/board/card games),

HI-SEAS RESEARCH

UH PRESS RELEASE: Mission V

The HI-SEAS Habitat

Team Processes and Team Effectiveness

Self-Guided Stress Management and Resilience Training

MENTALBLOCK

Effectiveness of a Shared Social Behavioral Task as a Team-Building Exercise in Isolated, Confined, and Extreme Environments

Crew Communication in Debriefs

Autonomous Behavioral Countermeasures for Spaceflight

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NEEMO

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- Journey to Mars
- Living in Space
- Technology
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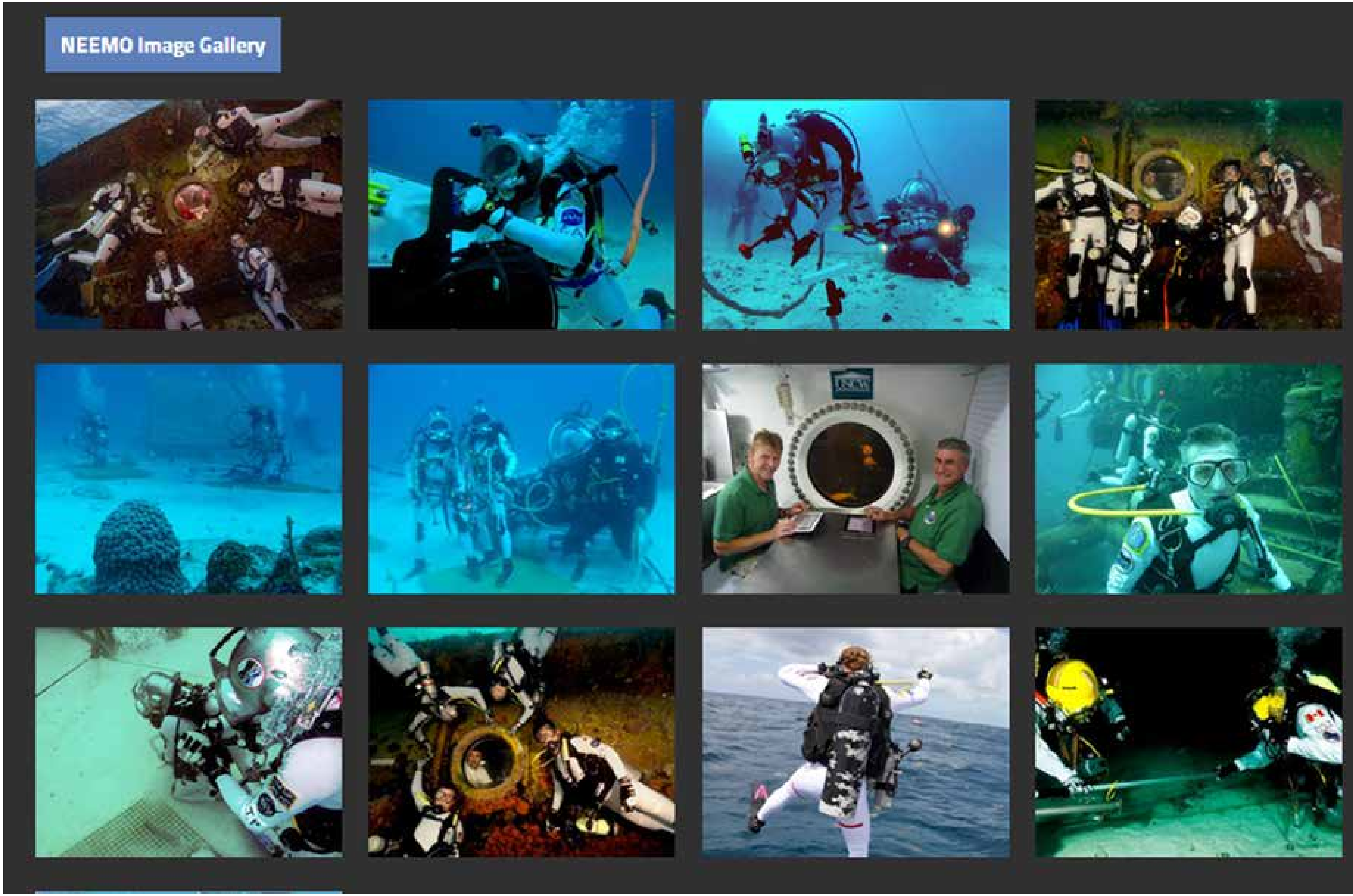
About NEEMO (NASA Extreme Environment Mission Operations)

NEEMO - the NASA Extreme Environment Mission Operations project - is a NASA analog mission that sends groups of astronauts, engineers and scientists to live in Aquarius, the world's only undersea research station, for up to three weeks at a time. Operated by Florida International University (FIU), Aquarius is located 5.6 kilometers (3.5 miles) off Key Largo in the Florida Keys National Marine Sanctuary. It is deployed next to deep coral reefs 62 feet (19 meters) below the surface.

A NEEMO 14 aquanaut practices shoveling underwater, just as an astronaut would shovel to collect soil samples on another planet. *Credits: NASA*

The Aquarius habitat and its surroundings provide a convincing analog for space exploration. Much like space, the undersea world is a hostile, alien place for


NEEMO Image Gallery

AIAA 2006-7445

Spaceship Discovery –Vehicle Architecture for Human Exploration of Moon, Mars, and Beyond

Mark G. Benton, Sr.*
Boeing Space and Intelligence Systems, Los Angeles, CA 90009-2919

American Institute of Aeronautics and Astronautics (AIAA)

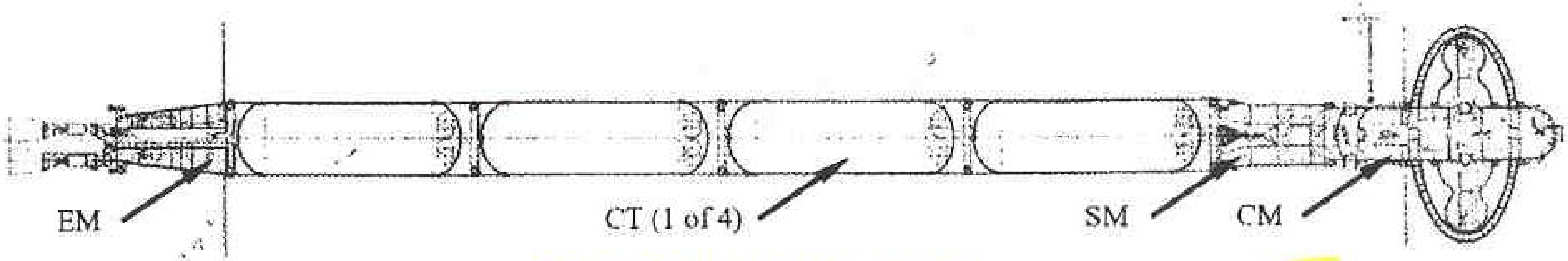


FIGURE 2. Side View – Spaceship Discovery "Main Ship": EM, 4 CTs, SM, and CM.

Dec. 22, 2016

The Next Generation of NASA's Space Launch System

< Backto Gallery

The next generation of NASA's Space Launch System will be 364 feet tall in the crew configuration, will deliver a 105-metric-ton (115-ton) lift capacity and feature a powerful exploration upper stage. On SLS's second flight with Orion, the newer rocket will carry up to four astronauts on a mission around the moon, in the deep-space proving ground for the technologies and capabilities needed on NASA's Journey to Mars.

Record Duration: Space Station Mir

- **Longest Stay:** Cosmonaut Valery Polyakov holds the record for the longest stay in orbit, **438 days**, 1994-1995. (n = 1)

http://www.space.com/11337-human-spaceflight-records-50th-anniversary.html

Why a Mars Mission Is Different

- **Distance of travel**
- **Automated life-support systems**
- **Degree of isolation and confinement**
- **No rescue**

Kanas, N., & Manzey, D. (2003). *Space Psychology and Psychiatry*. Boston, MA: Kluwer Academic Publishers.

Countermeasures

Countermeasures

- **Proactive**
  - Crew screening, selection, and training
  - Overcoming effects of radiation and microgravity
  - Work and habitat design

Williams, R.S., & Davis, J.R. (2005). *Aviation, Space, and Environmental Medicine*, *76*(6), Section II, B1-B2.

NASA's Bioastronautics Roadmap: http://bioastroroadmap.nasa.gov/User/risk.jsp

Countermeasures

- **Reactive**
  - Medical emergencies
  - Depression and related emotional problems
  - Circadian desynchronization
  - Crew autonomy from mission control (“Groupthink”)
  - Group fragmentation and interpersonal hostility
  - Loss of skilled performance

Rationale for a New Approach

- Our **current psychological knowledge** derived from orbital spaceflight and analogue environments is **not sufficient** to assess the specific risks of missions into outer space.

Manzey, D. (2004). Human missions to Mars: new psychological challenges and research issues. *Acta Astronautica*, *55*, 781-790.

Rationale for a New Approach

- The most severe **stressors** involve **social monotony** and **boredom** related to hypoactivity and hypostimulation, isolation of family and friends, and the restricted social contacts within a small crew.

Manzey, D. (2004). Human missions to Mars: new psychological challenges and research issues. *Acta Astronautica*, *55*, 781-790.

Rationale for a New Approach

- Data from space analogue settings and from long-duration mission spaceflight suggest that **neither astronaut selection nor crewmember professionalism** will prevent all problems due to the psychosocial stressors that will arise in space crews. (Recent "biomarker" research)

Flynn, C.F. (2005). An operational approach to long-duration mission behavioral health and performance factors. *Aviation, Space, and Environmental Medicine*, *76*(6), Section II, B42-B51.

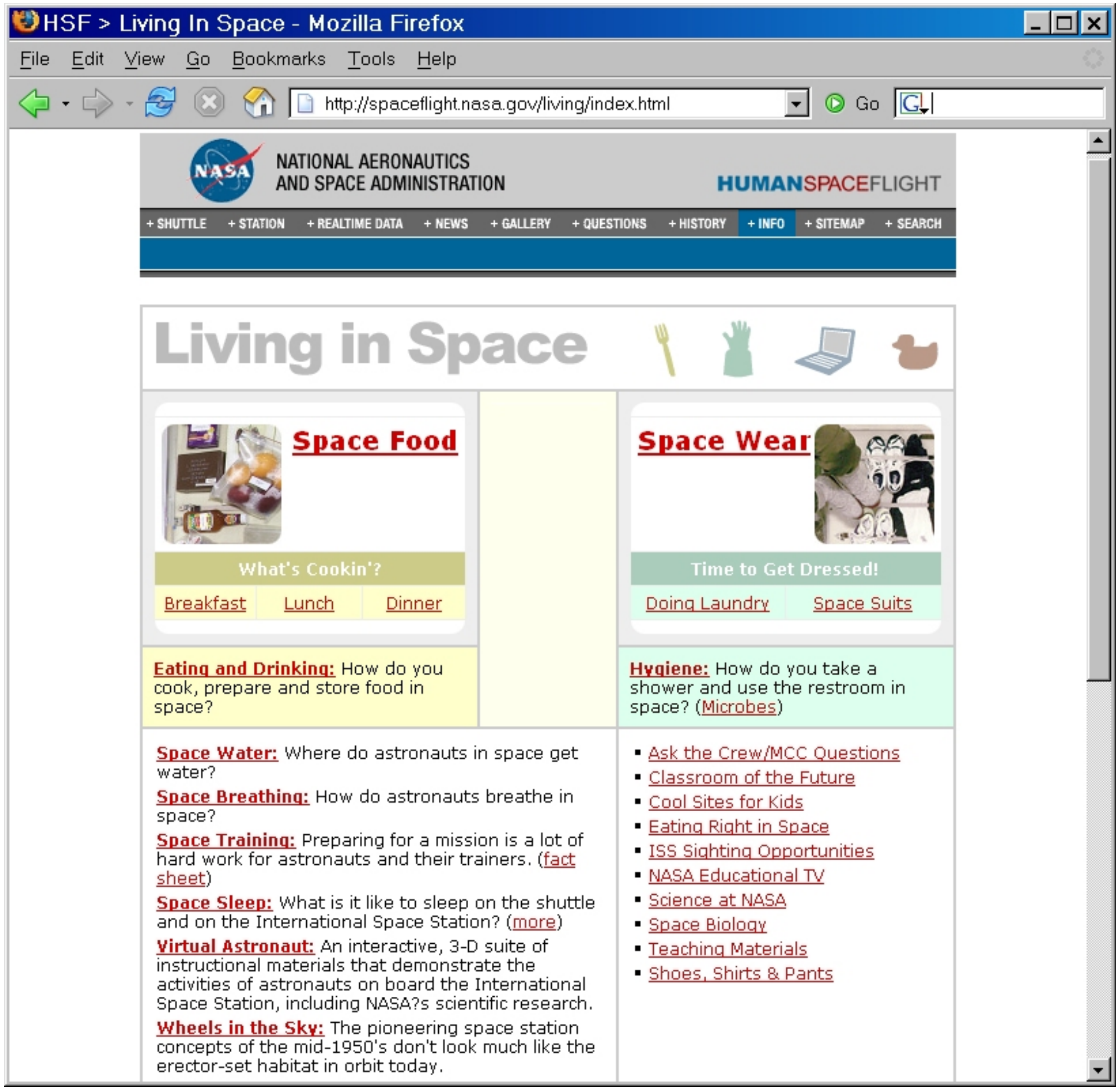
Spaceflight Stages

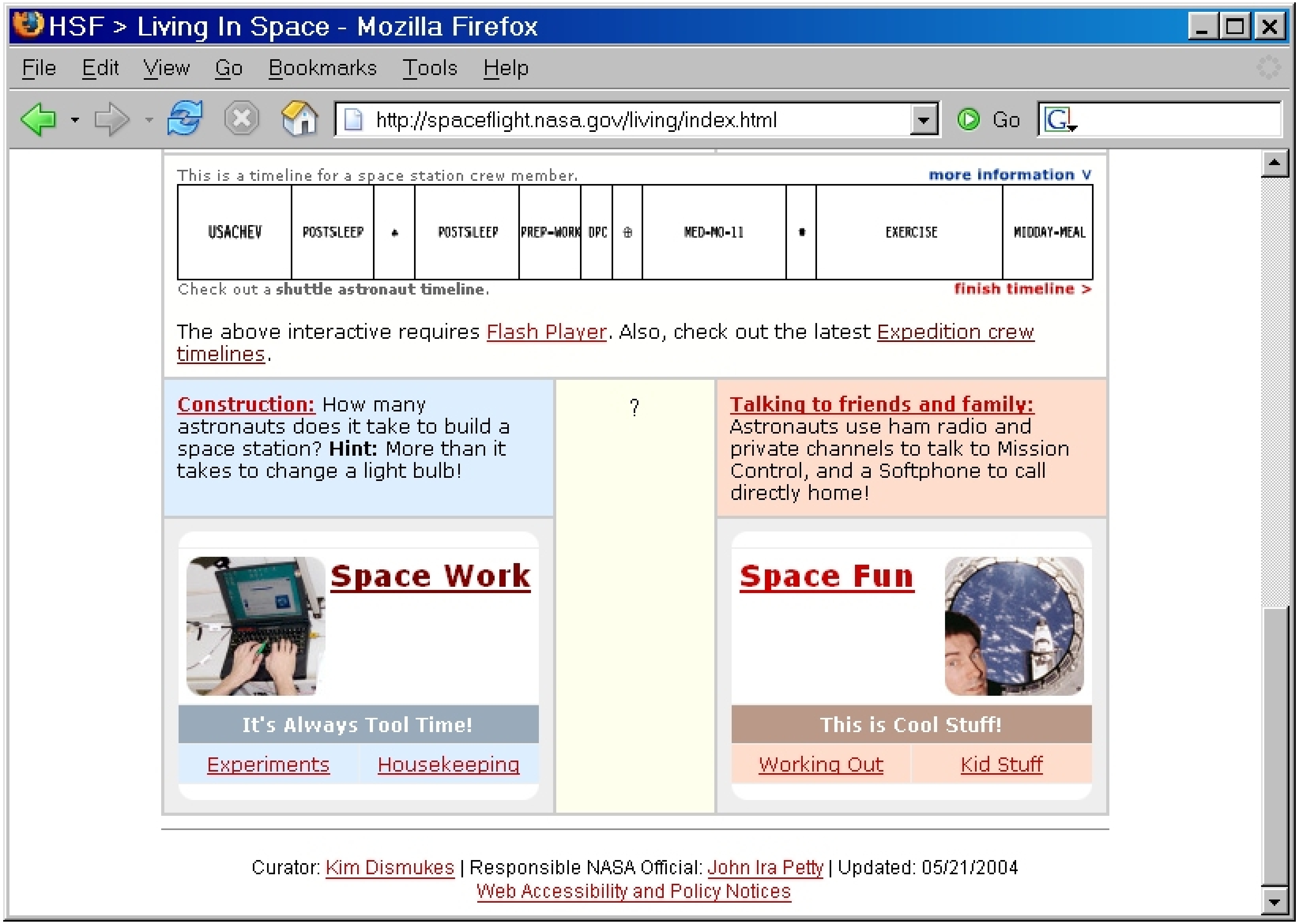
1. Physiological and psychological adaptation to microgravity and onboard schedules (**4-6 weeks**).
2. Steady-state adaptation (**6-12 weeks**).
3. Behavioral stress reactions (**12+ weeks**).
4. End-of-mission euphoria

Manzey, D. (2004). Human missions to Mars: new psychological challenges and research issues. *Acta Astronautica*, *55*, 781-790.

Current Approach to Spacelife Management

[Living in Space](#)




HSF > Living In Space - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://spaceflight.nasa.gov/living/index.html
Go
This is a timeline for a space station crew member.
more information v
USACHEV
POSTSLEEP
POSTSLEEP
PREP-WORK
DPC
MED-MO-11
EXERCISE
MIDDAY-MEAL
Check out a shuttle astronaut timeline.
finish timeline >
The above interactive requires Flash Player. Also, check out the latest Expedition crew timelines.
Construction: How many astronauts does it take to build a space station? Hint: More than it takes to change a light bulb!
?
Talking to friends and family: Astronauts use ham radio and private channels to talk to Mission Control, and a Softphone to call directly home!
Space Work
It's Always Tool Time!
Experiments
Housekeeping
Space Fun
This is Cool Stuff!
Working Out
Kid Stuff
Curator: Kim Dismukes | Responsible NASA Official: John Ira Petty | Updated: 05/21/2004
Web Accessibility and Policy Notices

"Behavioral Program"

Radiogram No. 8077u　　　　Form 24 for 01/01/2012

CREW OFF DUTY

GMT	CREW	ACTIVITY
06:00-06:10	CDR,**FE-1**, **FE-2**,FE-5	Moming Inspection
06:00-06:05	FE-6	Urine Spot Test
06:00-06:05	**FE-4**	PLAZMENNYI KRISTALL. Pressure Check
06:05-06:10	**FE-4**	Moming Inspection
06:05-06:10	FE-6	ICV-MAKITA Battery Replacement
06:10-06:40	CDR,**FE-1**,**FE-2**, **FE-4**,FE-6	Post-sleep
06:10-06:30	FE-5	Post-sleep
06:30-06:50	FE-5	HRF Urine Sample Collection Subject
06:40-07:30	CDR,**FE-2**, **FE-4**,FE-6	BREAKFAST
06:40-07:30	**FE-1**	BREAKFAST. ***SM ПСС [Caution & Warning Panel] Test*** *(after breakfast)*
06:50-06:55	FE-5	Urine Spot Test
06:55-07:05	FE-5	HRF Urine Sample Insertion Into MELFI
07:05-08:05	FE-5	BREAKFAST
09:00-10:30	FE-5	Physical Exercise (ARED)
09:30-11:00	**FE-4**	Physical Exercise (TVIS), Day 4
09:30-10:30	CDR	Physical Exercise (CEVIS)
10:30-10:35	FE-6	ICV-MAKITA Battery Replacement
10:30-12:00	CDR	Physical Exercise (ARED)
10:35-10:55	FE-5	HRF Urine Sample Collection Subject
10:35-11:35	FE-6	Physical Exercise (CEVIS)
10:55-11:00	FE-5	MELFI Urine Sample Insertion

16:50-17:10	FE-6	Integrated Cardiovascular (ICV) Ambulatory Monitoring Midpoint
17:10-18:40	FE-6	Physical Exercise (ARED)
17:40-18:40	**FE-4**	Physical Exercise (VELO), Day 4
17:45-18:45	FE-5	Physical Exercise (CEVIS)
18:45-18:55	FE-5	HRF Blood Collection Hardware Setup
19:30-21:25	**FE-4**	Pre-sleep
19:30-20:10	CDR	Pre-sleep
19:30-21:30	**FE-1**,**FE-2**, FE-5,FE-6	Pre-sleep
20:10-20:25	CDR	Private Family Conference
20:25-21:30	CDR	Pre-sleep
21:25-21:30	**FE-4**	PLAZMENNYI KRISTALL. Pressure Check
21:30-06:00	.	SLEEP
Task List	**FE-1**,**FE-2**, **FE-4**	Preparation of reports for Roskosmos site
		URAGAN. Observations and Photography
		SEINER Ocean Observations
		ECON. Observations and Photography

Notes:
1. SM Window #9 shutter opening is at crew discretion with **Report to MCC**
2. See OSTP for references to US activities.
3. Pre-sleep ops: dinner, daily food prep, evening toilet
End of Radiogram

https://www.nasa.gov/pdf/613794main_010112_tl.pdf

Background to a New Approach

BEHAVIORAL HEALTH REQUIREMENTS—BRADY

Fig. 4. Chimpanzee training device for animal pretest flights of Project Mercury. Personal collection of the author.

Brady, J.V. (2005). Behavioral health: the propaedeutic requirement. *Aviation, Space, and Environmental Medicine*, *76*(6), Section II, B13-B24.

AN EXPERIMENTAL OUTLINE FOR BUILDING AND EXPLORING MULTI-OPERANT BEHAVIOR REPERTOIRES

JACK D. FINDLEY[1, 2]

LABORATORY OF PSYCHOPHARMACOLOGY AND INSTITUTE FOR BEHAVIORAL RESEARCH

UNIVERSITY OF MARYLAND

Although theorists may be found in frequent controversy, experimenters differ in their approach to behavior, and data are sometimes ambiguous or subject to debate, the experimental organism is always right. His behavior is real, lawful, and always appropriate to the instantaneous conditions of his internal and external environments. It is basically the experimenter's job to gain control over those environmental conditions.

In the laboratory, the experimenter emits a variety of behavior and then attempts to relate changes in his behavior with changes in the behavior of the organism under study. The ideal result of such interactions is the statement of definitive relationships which ultimately give rise to what is called "understanding of behavior." Unfortunately, however, we do not have definitive statements or relationships giving us an understanding of what behavior on the part of the experimenter most effectively generates relationships acceptable to the body of behavioral science. Although they are not observed under controlled conditions, variations in behavior from one experimenter to another, or within a given experimenter, suggest that he can state definitive relationships between himself and his organism only insofar as he is able to control and manipulate the relevant environmental conditions. Yet, only occasionally is the experimenter's primary effort to gain control and to manipulate. To do so, in fact, is often punished by other experimenters and theorists. The occasion for punishment would seem particularly strong when the gains in control are substantial and when the interaction between the experimenter and his organism does not immediately result in definitive relationships, but only suggests feasible ones in terms inadequate for conventional language and conceptual analysis. In spite of the occasional punishment for efforts primarily directed at bringing more of an organism's behavior under experimental control and subject to manipulation, we know that such efforts always set the occasion for the obtaining of definitive relationships; and, moreover, that somehow this behavior is maintained.

The material to follow represents, in part, the results of several years of laboratory effort in which the pursuit of behavioral control progressively took precedence over the statement of problems and answers, and in which it was often pursued in their absence. The major result of this effort has been a demonstration that it is feasible to build, describe, and manipulate complex samples of behavior under controlled conditions, on a scale limited only by our individual laboratory behavior. It has been the argument of this section that to do so is in many ways basic to the building of a science of behavior. The following sections are concerned with: first, the nature of multi-operant behavior and general problems of its establishment and analysis; second, the conceptual and notational description of multi-operant behavior; and, finally, the reporting of the laboratory story which largely generated the notions and points of view presented below.

PART I: THE NATURE OF MULTI-OPERANT BEHAVIOR AND PROBLEMS OF ITS ESTABLISHMENT AND ANALYSIS

The continuous nature of an organism's behavior has long been recognized; yet, equally well acknowledged is the argument that behavior can not be studied experimentally in its entirety, but must be broken into units of special attention. These analytical activities are ultimately justified in that the process occasionally results in useful suggestions relevant to the control of particular behaviors, and, also, that it aids in the formulation of a more sophisticated picture of the entire behavioral process.

Current experimental analyses of operant behavior suggest a view of the behavior process in which specific operants under the control of numerous classes of variables are emitted one after another. Thus, one sort of behavior is followed by another in a continuous and flowing manner due to the consequences of each segment giving rise to the special conditions controlling the next. A more specific picture of the overall behavioral process is, for the most part, unavailable. This "conceptual vacuum" is perhaps most readily accounted for by our failure to establish larger samples of behavior in the laboratory under well-controlled conditions. Thus, our history of behavioral science reflects, on the one hand, rather casual observation of extensive and naturalistic samples of behavior, and, on the other, the careful experimental analysis of limited and specific operants. Fortunately,

[1]Supported in part by Grant MY-1604 from the National Institute of Mental Health to the University of Maryland.

[2]The author would like to express his appreciation for the generous encouragement of Dr. J. V. Brady.

Findley, J.D. (1962). An experimental outline for building and exploring multi-operant behavior repertoires. *Journal of the Experimental Analysis of Behavior*, *5*, 113-166.

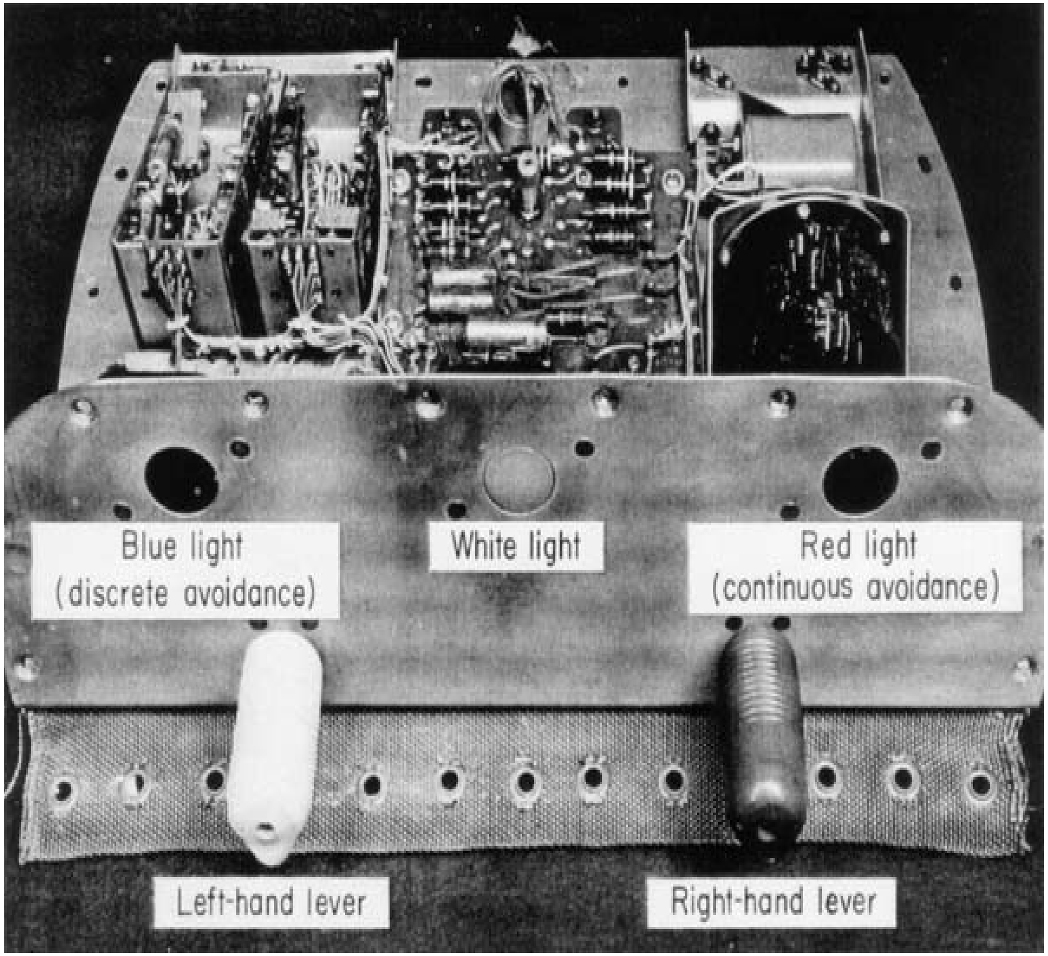
Ham

Holloman **A**erospace **M**edical Center, located at Holloman Air Force Base in New Mexico.

- **Image Name: Chimpanzee Ham** in the Flight Couch for the Mercury-Redstone 2 (MR-2) flight Image
- **Description:** Chimpanzee Ham in his Flight Couch for the Mercury-Redstone 2 (MR-2) suborbital test flight.
- **On January 31, 1961**, a Mercury-Redstone launch from Cape Canaveral carried Ham over 640 kilometers down range in an arching trajectory that reached a peak of 254 kilometers above Earth.
- Mission:+ Mercury 2
- Experiment Title:+ Project Mercury Ballistic and Orbital Chimpanzee Flights (CHIMP)

http://lsda.jsc.nasa.gov/scripts/photoGallery/detail_result.cfm?image_id=1813

Performance Test Apparatus



- **Image Name:** Mercury-Redstone 2 (MR-2) Performance Test Apparatus
- **Image Description:** Image of the Mercury-Redstone 2 (MR-2) ballistic flight Performance Test Apparatus.
- **Mission:** Mercury 2
- **Experiment Title:** Project Mercury Ballistic and Orbital Chimpanzee Flights (CHIMP)
- **Payload:** Mercury 2 (Mercury 2)
- **Research Area:** Behavior and performance
- **Keyword:** Animals in space Hardware
- **Hardware:** Performance Test Apparatus

http://lsda.jsc.nasa.gov/scripts/photoGallery/detail_result.cfm?image_id=1817

Some Effects of Short-Duration Spaceflight: Salutogenic Consequences

- **Image Name:** Chimpanzee Ham after the successful 17-min Mercury-Redstone 2 (MR-2) suborbital flight
- **Image Description:** Close-up view of the chimpanzee Ham, the live test subject for Mercury-Redstone 2 (MR-2) test flight, being fed an apple. This photo was taken after his successful recovery from the Atlantic Ocean.

http://lsda.jsc.nasa.gov/scripts/photoGallery/detail_result.cfm?image_id=1804

Rohles Trained the Chimps For Historic Space Flights

Editor's note: As we were going to press, The Topeka Capital-Journal published an article about our author's career. We decided we should share it with ASHRAE Journal readers.

By Jan Biles, The Topeka Capital-Journal

MANHATTAN, Kan.—In Fred Rohles' study in his Manhattan home hangs a large portrait of Ham, the chimpanzee who was strapped into a Mercury space capsule and launched into space on Jan. 31, 1961, four months before astronaut Alan Shepard made his historic space flight on May 5, 1961.

Rohles, 85, an emeritus professor at Kansas State University, was among the men who trained Ham at the Aeromedical Research Laboratory at Holloman Air Force Base in New Mexico prior to his flight.

"The Russians had put up a dog," he said, referring to Laika, who orbited the Earth aboard Sputnik II on Nov. 3, 1957. "I had worked with monkeys but never chimps. Ham was in a ballistic shot -- up and down -- that was weightless for a very short time."

Rohles also trained Enos, a chimp who was launched into space in a Mercury capsule on Sept. 13, 1961, to make the first U.S. orbital animal flight. Enos was supposed to make three orbits around the Earth but was brought back after the second orbit because the spacecraft was getting overheated, he said.

The Topeka Capital-Journal

Rohles holds a photograph of Ham, a chimpanzee he helped train for NASA.

Enos' trip was the precursor of the first U.S. manned orbital mission, which sent astronaut John Glenn into space on Feb. 20, 1962, to successfully make three orbits around the Earth.

At that time, the United States was entrenched in the "space race" to land a man on the moon, as directed by President Kennedy, who Rohles met during a briefing in June 1963 at Holloman. Also at the briefing was Vice President Lyndon Johnson.

"We opened up areas that had never been done before," Rohles said of the research he and others did in the early days of the space program.

Rohles, who was born in Chicago and grew up in nearby Evanston, Ill., earned a degree in personnel management in 1942 from Roosevelt University in Chicago. He enlisted in the U.S. Air Force that year and spent the next 22 years as an Air Force officer and psychologist doing research in aviation, engineering psychology and aerospace medicine at major aeromedical research laboratories throughout the United States, including the School of Aerospace Medicine at Randolph Air Force Base near San Antonio and the Arctic Aeromedical Laboratory in Fairbanks, Alaska.

He earned a master's degree in experimental psychology and a Ph.D. in experimental psychology from the University of Texas in 1950 and 1956, respectively. He returned to the School of Aerospace Medicine to lead its experimental psychology department and then was transferred to the U.S. Air Force Aeromedical Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio.

"This is where I got in the space business. I headed the unusual environment department," he said, explaining how he and his colleagues developed a model and equipment for measuring behavior of mice during space flight while there.

He was appointed to the Joint Armed Services Biosatellite Coordination Committee, and while with this group presented a paper in 1958 at the annual American Astronautical Society meeting that stressed both behavioral and physiological measurements needed to be documented when animals were sent into space to obtain a complete assessment of the effects of the space environment.

Shortly after this, he and his entire section were transferred to Holloman Air Force Base in New Mexico to set up a facility for measuring animal performance during space flight. The base had a sizable colony of chimpanzees.

He and his team developed performance programs and restraint systems for the animals, including feeders and watering devices that could be operated in weightlessness. He also compiled a much-needed topical bibliography on all aspects of the chimpanzee.

Rohles said he retired as a lieutenant colonel on Oct. 31, 1963, and the next day started working at K-State's Institute for Environmental Research with a joint faculty appointment in psychology and mechanical engineering. In 1973, he was named director for the Institute for Environmental Research at K-State.

"We had chimps here for a couple of years," he said. "We had two chimps here on loan from the Delta Regional Primate Center in New Orleans."

His research, he said, centered on the concept of "middleness" and whether chimps could determine what item was in the middle of a series of objects. One of his studies was filmed and is on deposit at the Psychological Film Institute at Pennsylvania State University.

"Then I got out of the monkey business because I didn't feel we could adequately take care of them," he said. "And I got into the people business."

The American Society of Heating, Refrigerating and Air Conditioning had donated an environmental chamber to the university, which became the heart of the Institute for Environmental Research.

"We worked to develop a standard for human thermal comfort," he said, adding that he also worked with the Ford Motor Co. to evaluate its automotive air conditioning system and did research on environmental ergonomics.

Rohles, who retired from K-State in 1986, has authored more than 150 technical papers and is the recipient of the Raymond F. Longacre Award for psychological and psychiatric aspects of aviation medicine and ASHRAE's Holladay Distinguished Fellow Award.

Behavior analysis provides the context for conceptualizing multi-operant performance repertoires. The extension, ultimately, to space dwelling microsocieties follows the method of "systematic replication" (Sidman, 1960). What is demonstrably effective in one setting is applied to another as a test of effectiveness and generality of process.

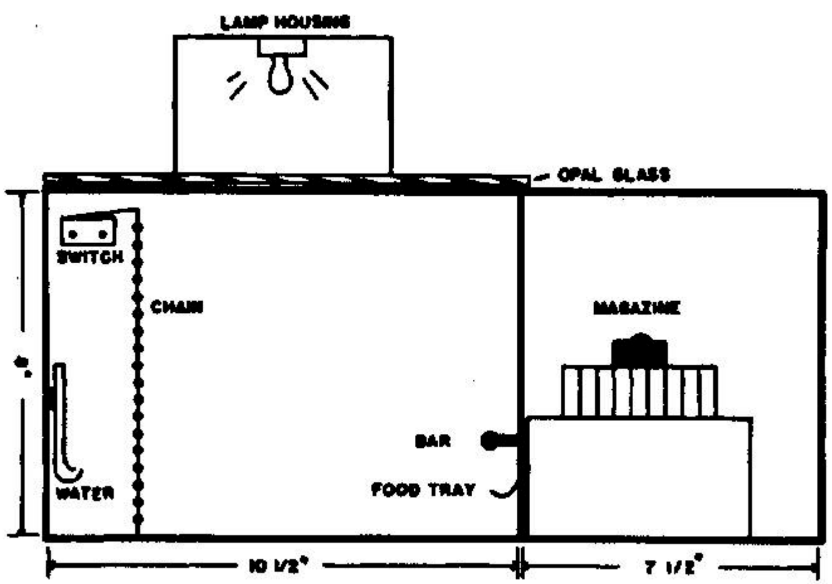


Fig. 1. Experimental chamber used with two-operant chaining procedure.

Sidman, M. (1960). *Tactics of Scientific Research*. New York: Basic Books.

for 1 (a). The failure of the organism to select the operant in each option which matches the stimulus properties of the operant producing the option leads to a timed-out condition and reinstatement of that part of the grove.

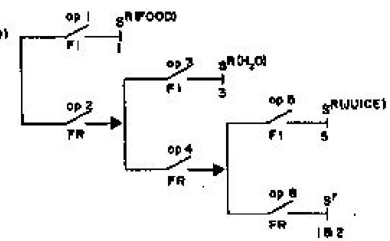
Grove (8) is composed of several trees and provides for the production of four different reinforcement conditions. The delivery of each reinforcement is followed by reinstatement of the conditions for operant 1. Numerous possibilities exist for different sequences by alteration of the reinforcement conditions. For example, if both operants 4 and 5 produced food, operant 4 could be arranged to reinstate operant 2 and operant 5 to reinstate operant 1. Such an arrangement could be used to compartmentalize the behavior associated with reinforcers of a given type and thus circumvent the necessity of going through the entire sequence for each primary reinforcement.

Behavior grove (9) is composed of trees in which one operant is common both to the preceding option and the subsequent tree. Thus, in this grove, operant 1 produces food and reinstates only itself. Operant 2 is concurrently in effect with operant 1, but its only function is the production of the subsequent option. Although this type of grove suggests some similarities with a multiple-schedule procedure, the translation of conditions from one reinforced operant to the next is under the organism's control via the specific operants 2, 4, and 6. It is also similar in some respects to the grove in example (5), but it allows the progression of operants to flow in only one direction.

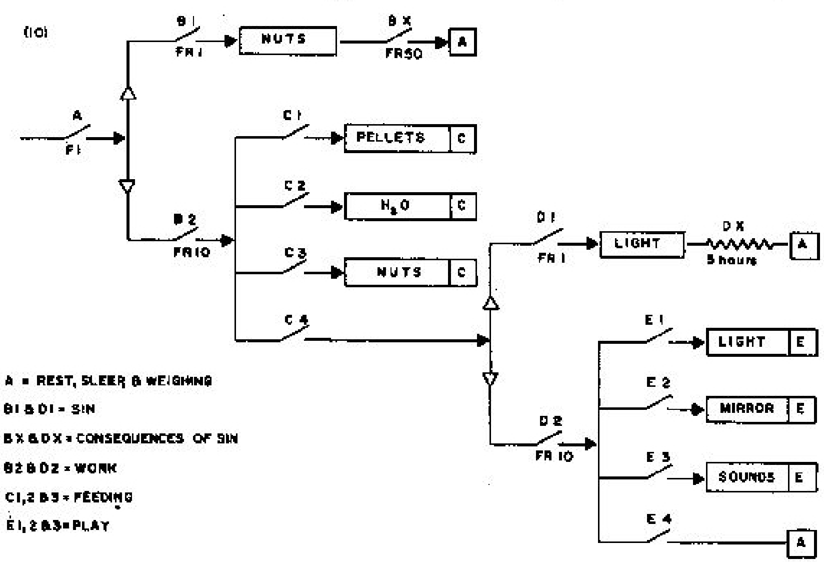
In most of the illustrations of the present system presented above, emphasis has been placed upon the more or less detailed description of behavior samples. The example grove (10) is included to illustrate an extension of the system to still larger repertoires of behavior. In this case, the meaning of the symbolization is more general. Capital letters designate not operants, but behaviors which might be composed of many operants and described in detail separately. Special reinforcement and reinstatement conditions are described with words or with letters and enclosed in boxes.

In this example, the behavior A is considered to be restricted to a special chamber where the organism

(9)



(10)



A LONG-TERM STUDY OF HUMAN PERFORMANCE IN A CONTINUOUSLY PROGRAMMED EXPERIMENTAL ENVIRONMENT

Jack D. Findley, Bernard M. Migler, and Joseph V. Brady

November, 1963

University of Maryland

Institute for Behavioral Research

and

Walter Reed Army Institute of Research

http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19640001916_1964001916.pdf

19

Programmed Environments for the Experimental Analysis of Human Behavior

Jack D. Findley

INTRODUCTION AND RATIONALE

Although a behavioral determinism would seem to be widely accepted in principle, its full expression is not readily found in laboratory research with humans. Indeed, experimental work with humans aimed at a basic behavioral analysis has long been constrained. Unfortunately, determinism as a system, and its resultant body of information, is severely limited without the support of good laboratory operations. Furthermore, a laboratory in which known relevant variables cannot be freely manipulated is not very likely to yield powerful information or uncover important new principles. All such constraints unduly impede the progress of a behavioral science. I would like to suggest that there is currently only a very limited experimental analysis of basic human behavior, and, furthermore, that its progress is unduly slow in view of the knowledge and technology at hand. Although the slow pace is no doubt due to several factors, I think they reduce in large measure to a new kind of entrenched secularism which overemphasizes an understanding of man in the world as we now know it. For example, in studying sleep behavior, it is usually assumed implicitly that man must function in an environment with 24-hour days. Not only is such an assumption erroneous, but it is not even drawn from information suggesting 24-hour days to be most desirable. In studying motivations, as another example, the concern is usually with the existing and familiar, rather than with an effort to devise experimental conditions which would establish new and quite different motivations for orderly dissection. Likewise, in studying marital relations, economic behaviors, and social interaction, the orientation is always toward the existing system and never toward an experimental one.

827

Findley, J.D. (1966). **Programmed environments for the experimental analysis of human behavior. In W.K. Honig (Ed.). *Operant Behavior: Areas of Research and Application* (pp. 827-848). Englewood Cliffs, NJ: Prentice-Hall, Inc.**

The Carrollton, 2017

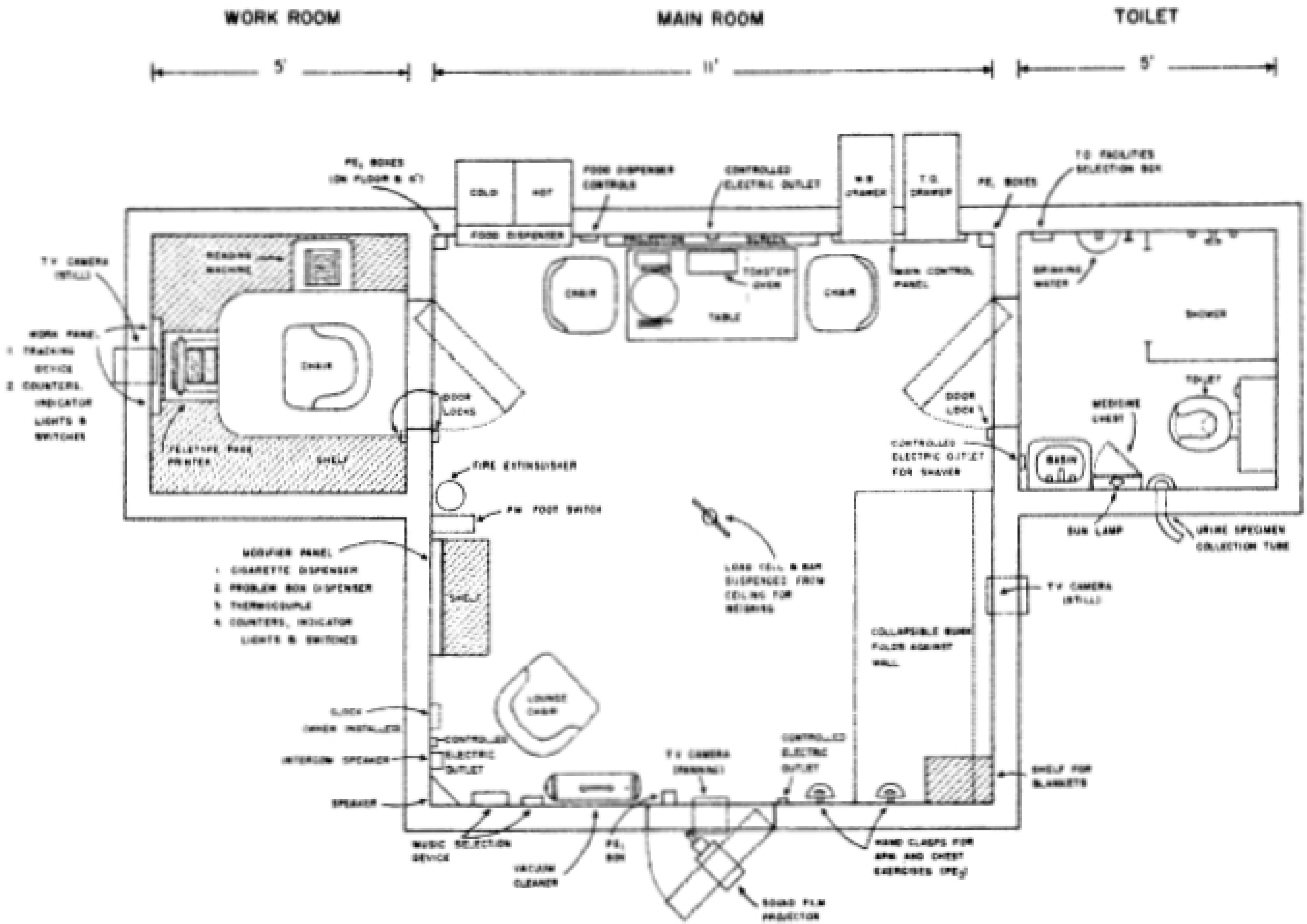
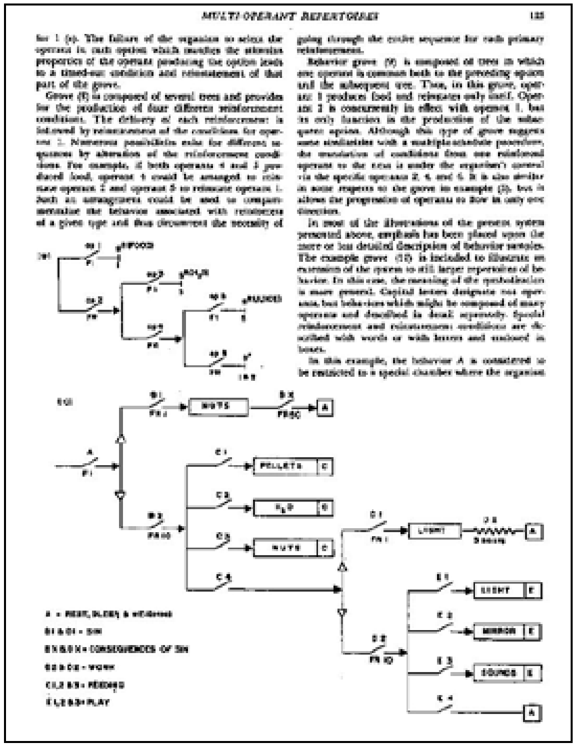


Fig 1. Diagram of experimental chamber showing furnishings and facilities in each room.

Findley, J.D., Migler, B.M., & Brady, J.V. (1963). A long-term study of human performance in a continuously programmed experimental environment. Technical Report NASA. p. 12.
http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19640001916_1964001916.pdf

Behavioral program supporting a single resident of a programmed environment for 152 days. The multi-operant features are determined by activity alternatives at the transition points.



Systematic Replication

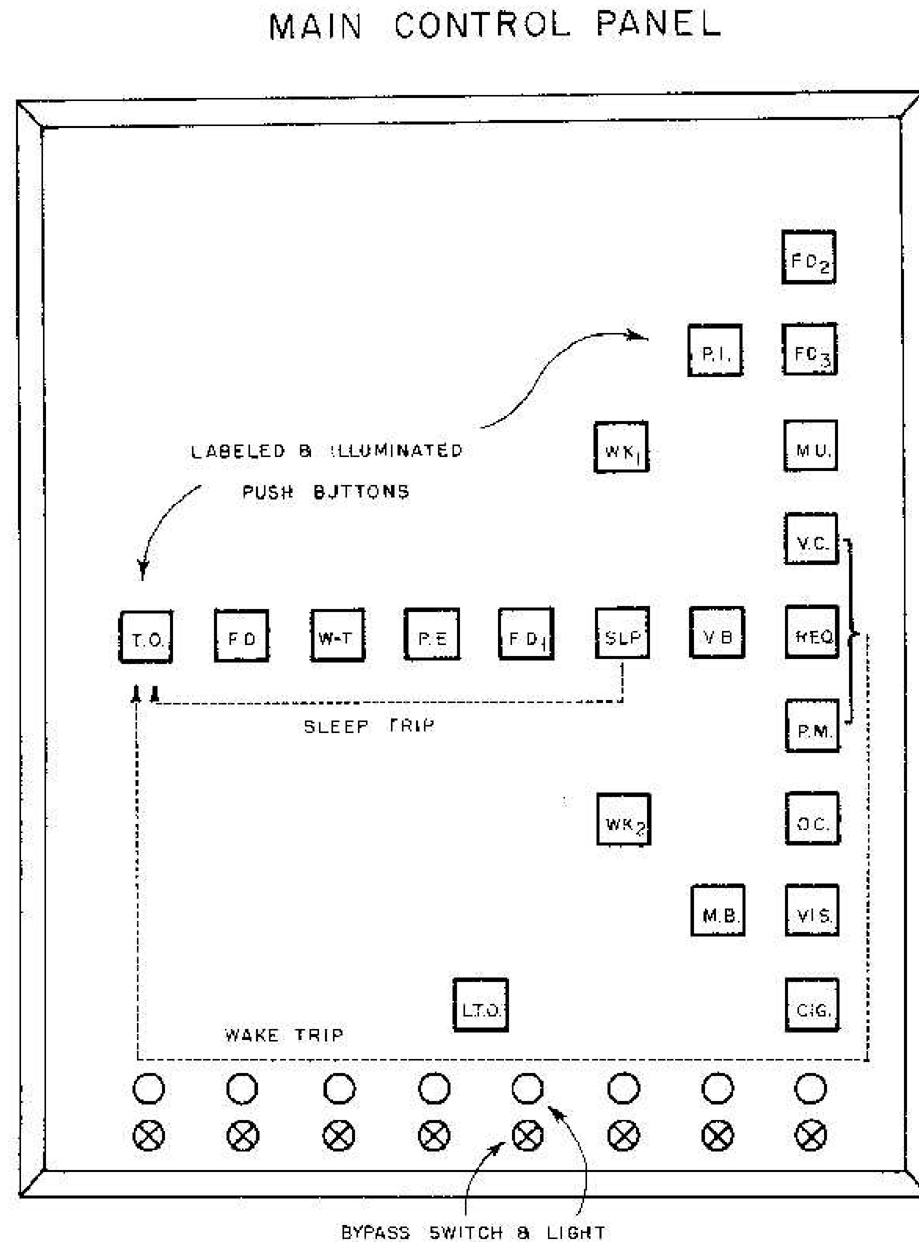
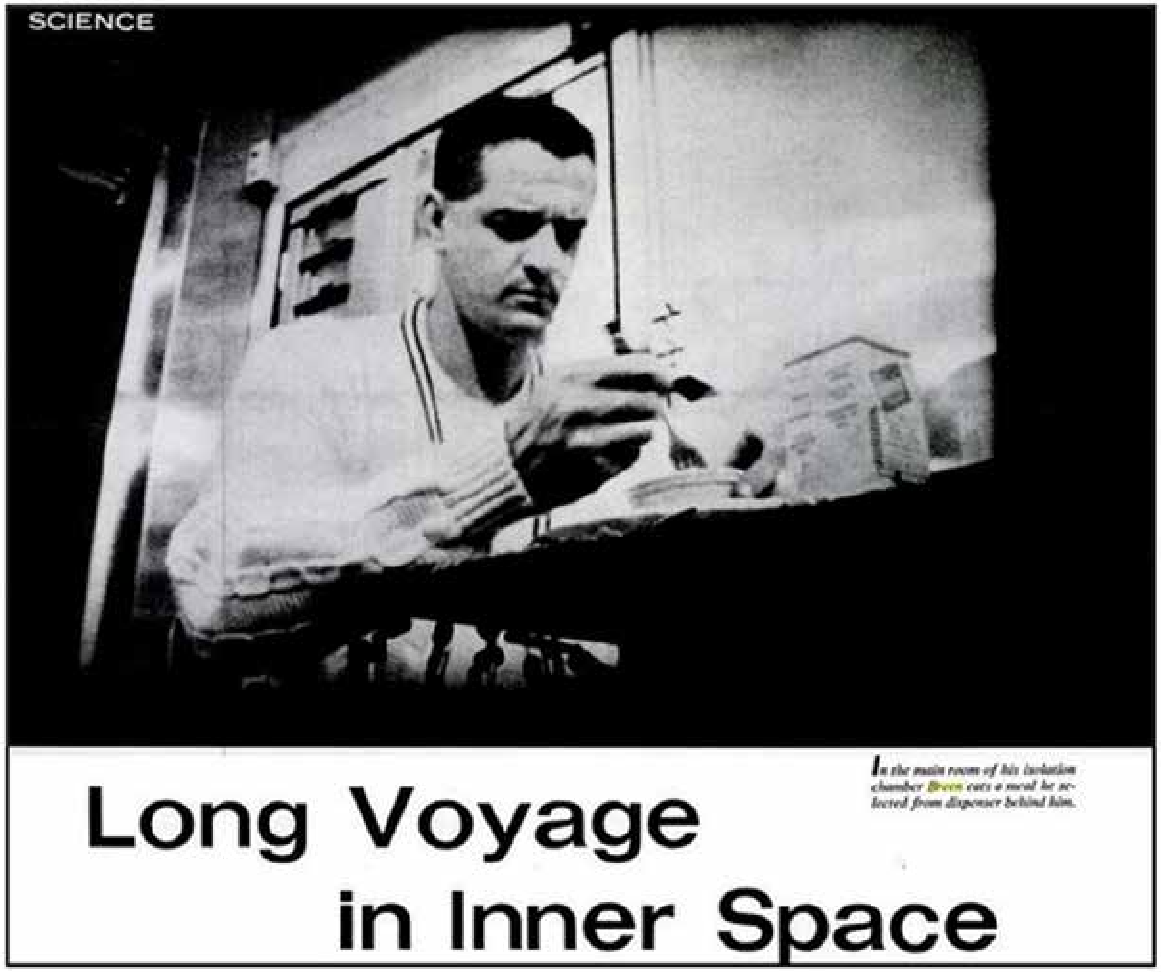


Figure 1. Main control panel containing push buttons that could be illuminated red or green. Each button is labeled with the abbreviations of the activity represented. "Wake Trips" and "Sleep Trips" are indicated by arrows.

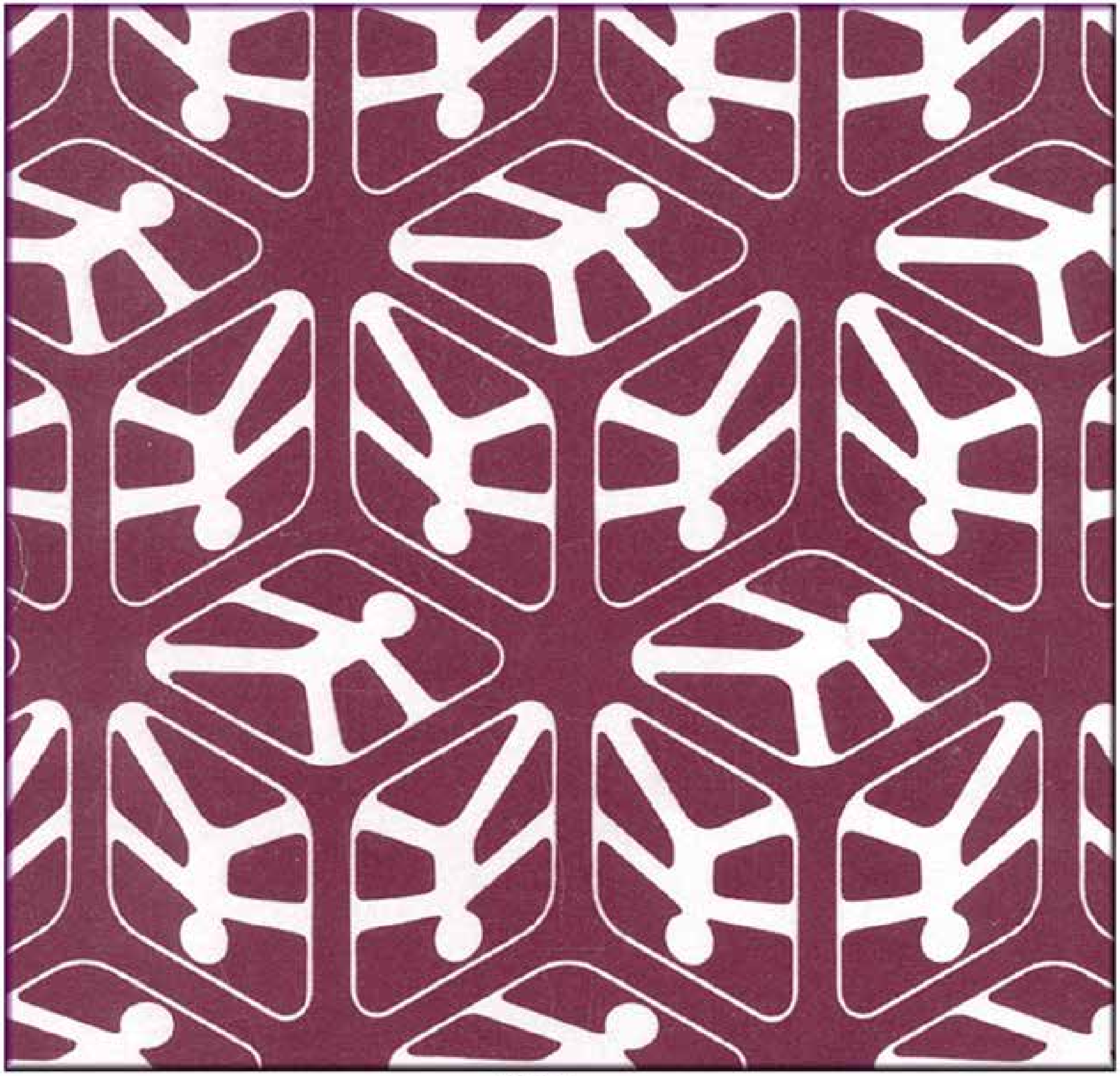


SCIENCE

In the main room of his isolation chamber Breen eats a meal he selected from dispenser behind him.

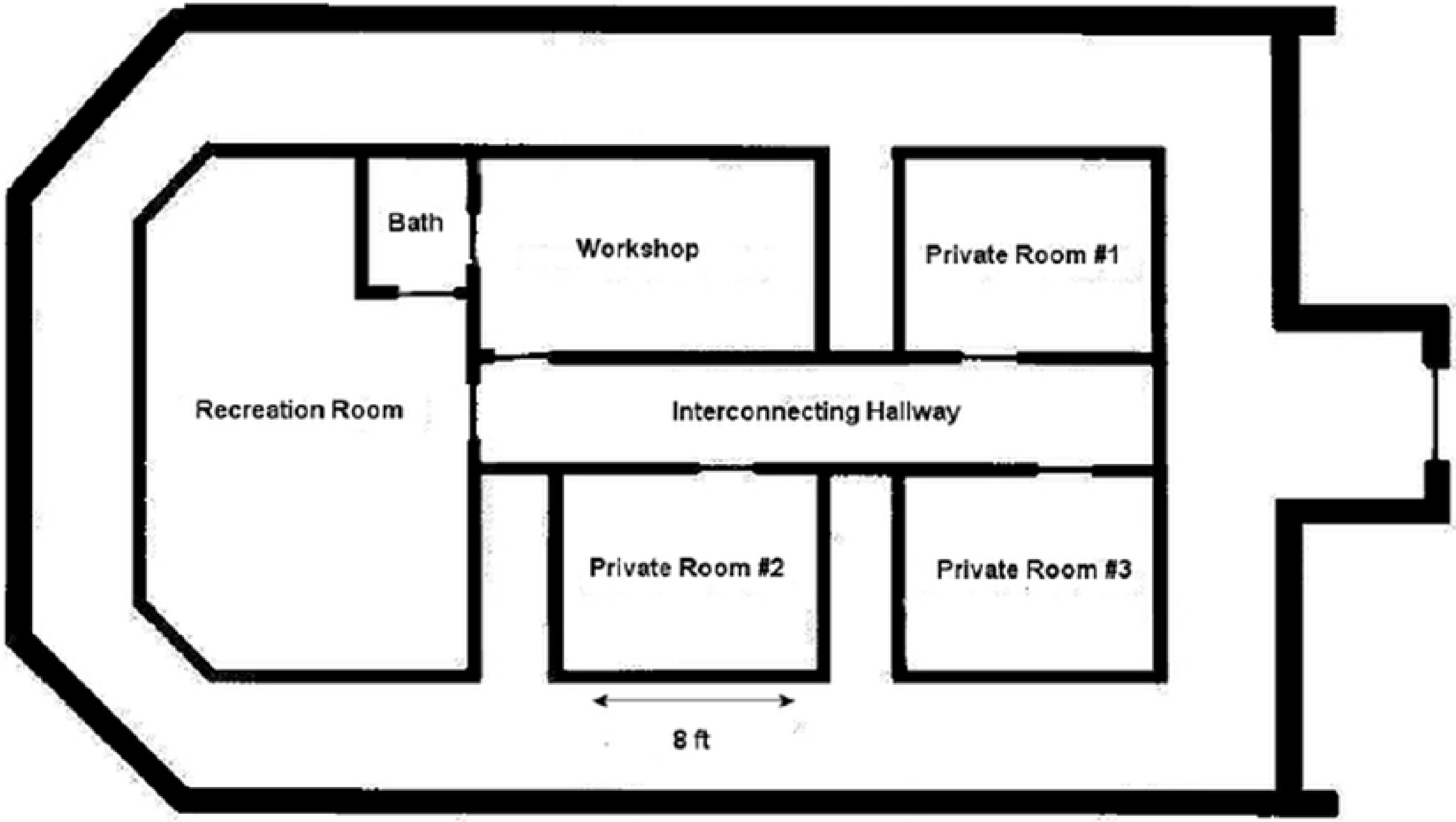
Long Voyage in Inner Space

The first resident of a programmed environment was Whilden P. Breen, Jr. That happened over 50 years ago. His experience was reported here in a 1963 issue of *Life Magazine*.



PERC Logo

Extending the Technology to Groups: Systematic Replication



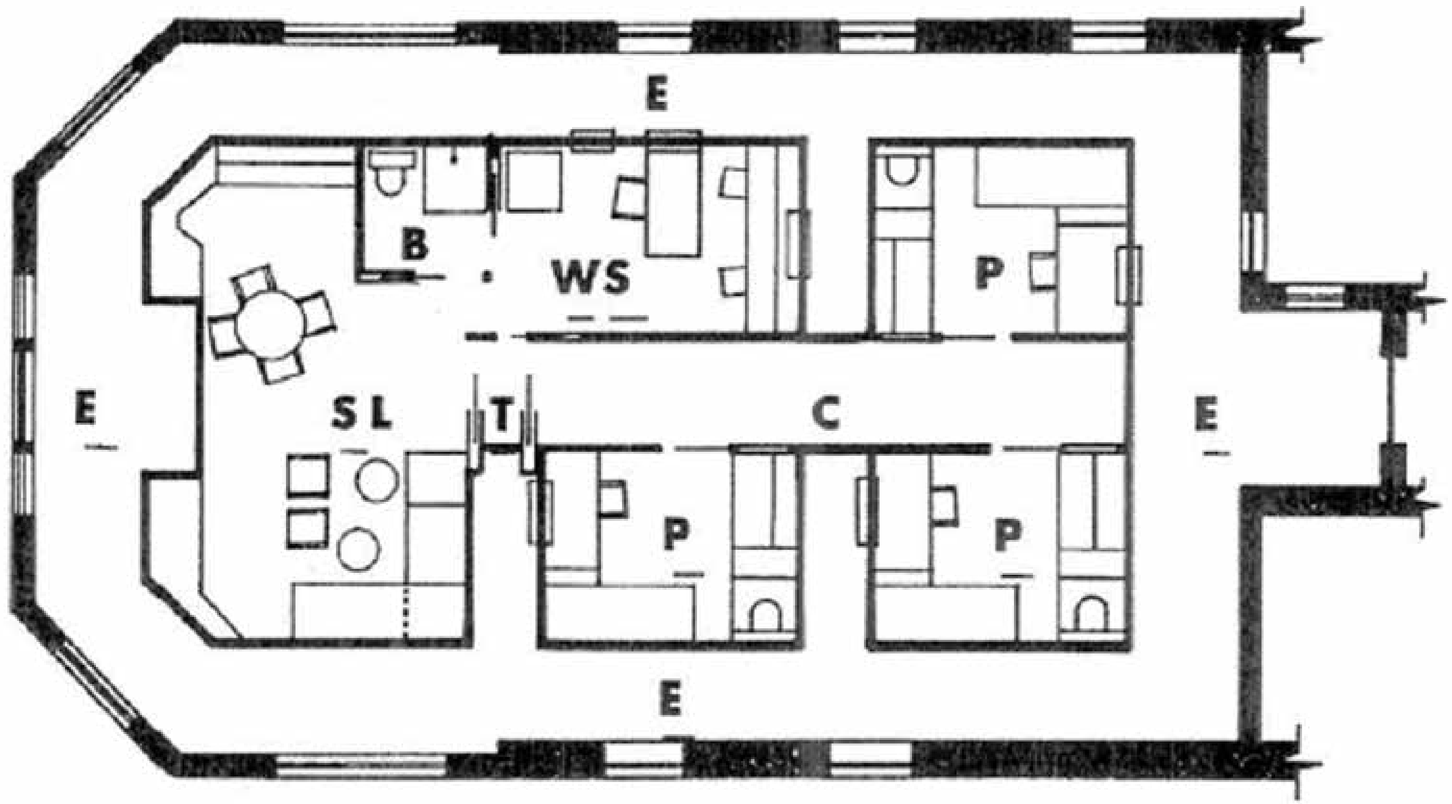
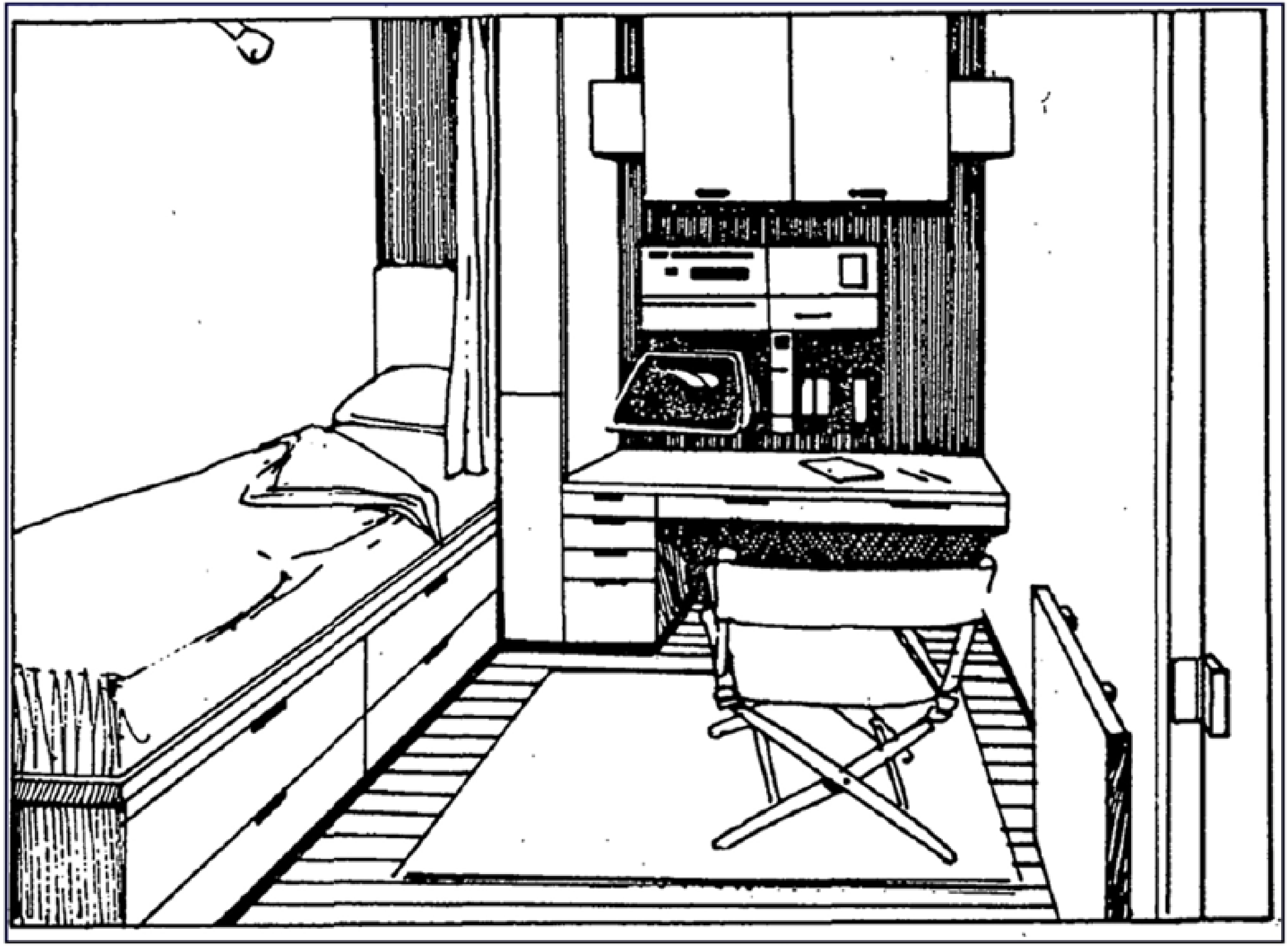
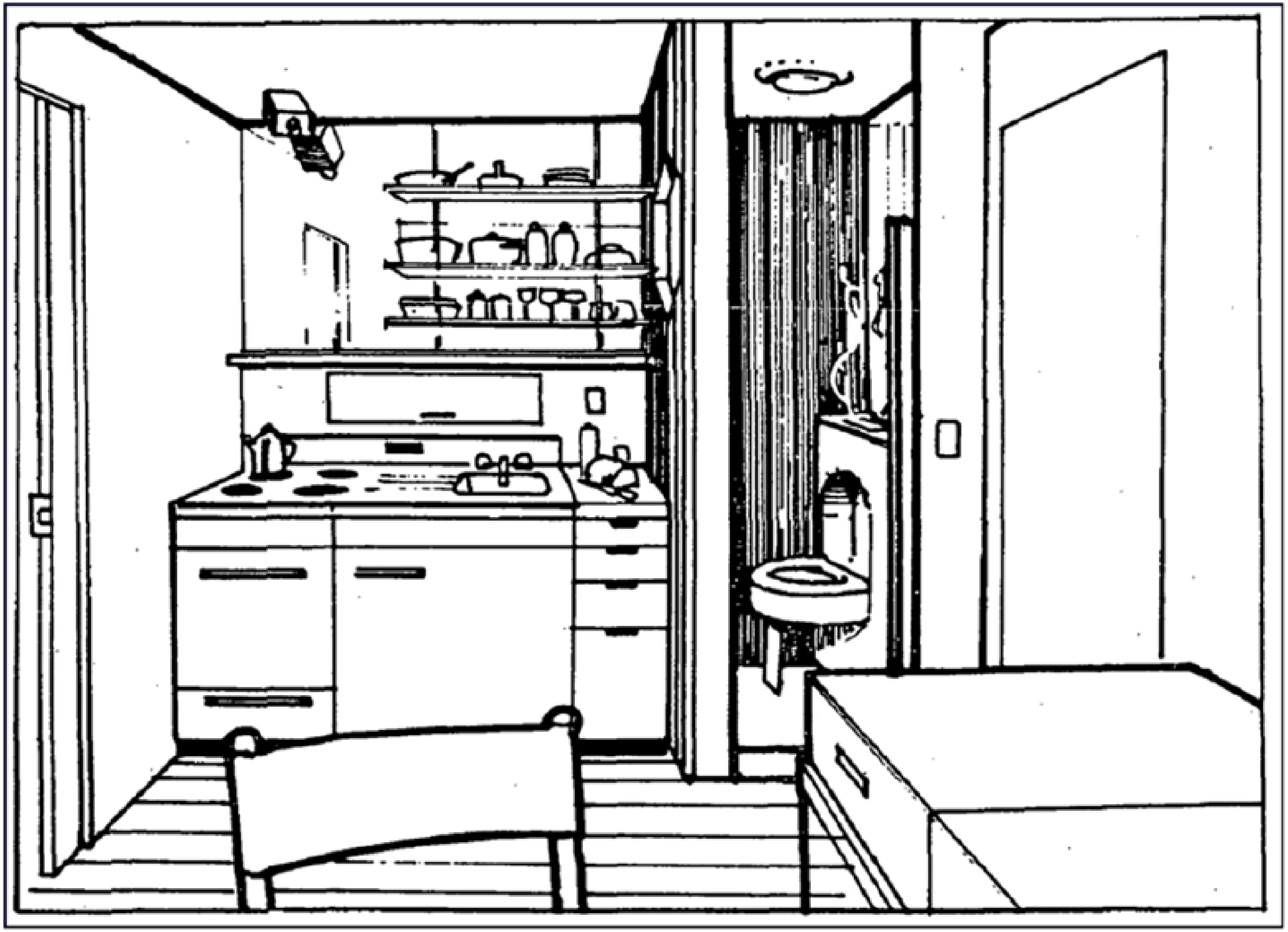


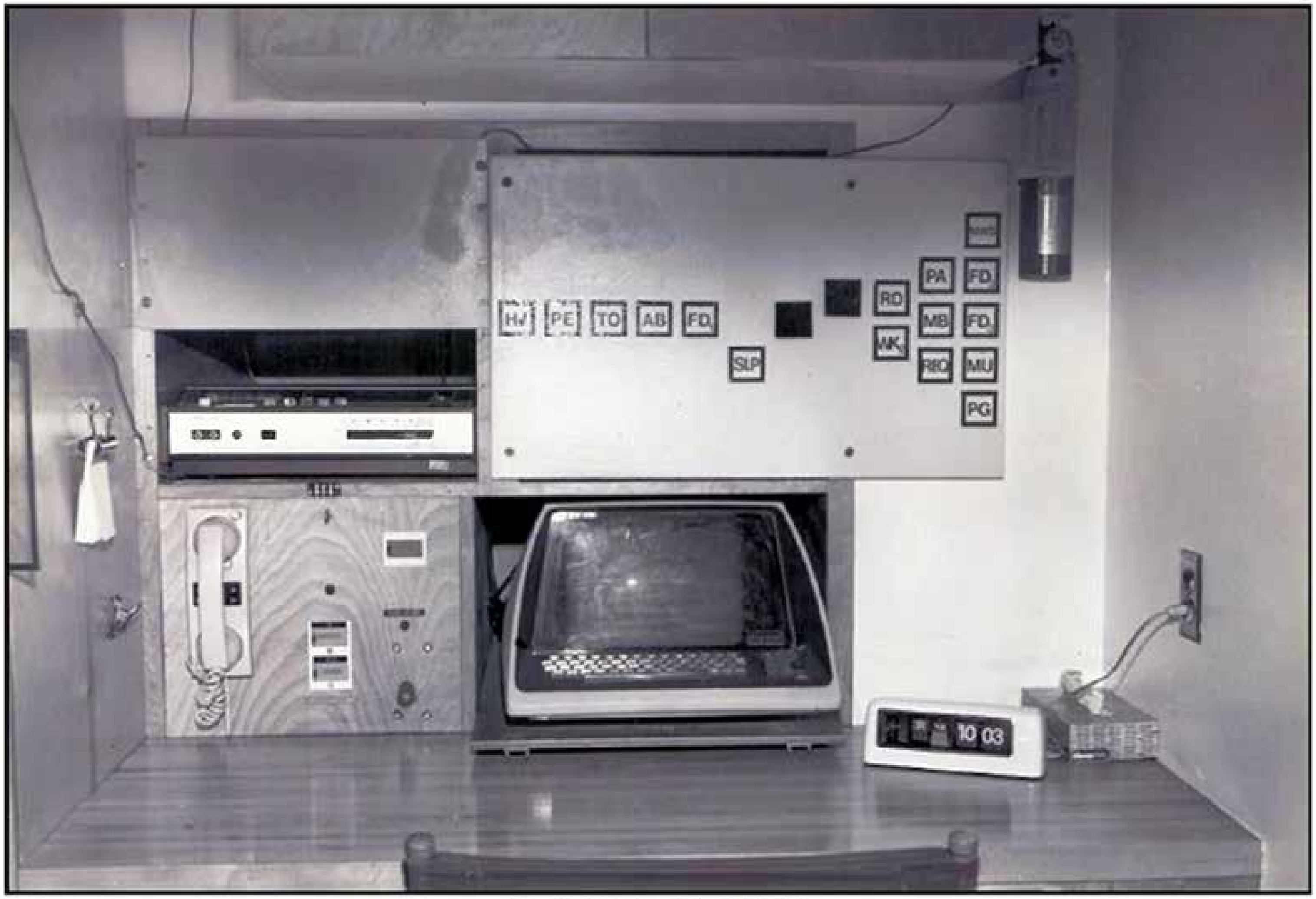
FIGURE 3. Diagrammatic representation of the overall floor plan of the laboratory and its arrangement within the external building shell.



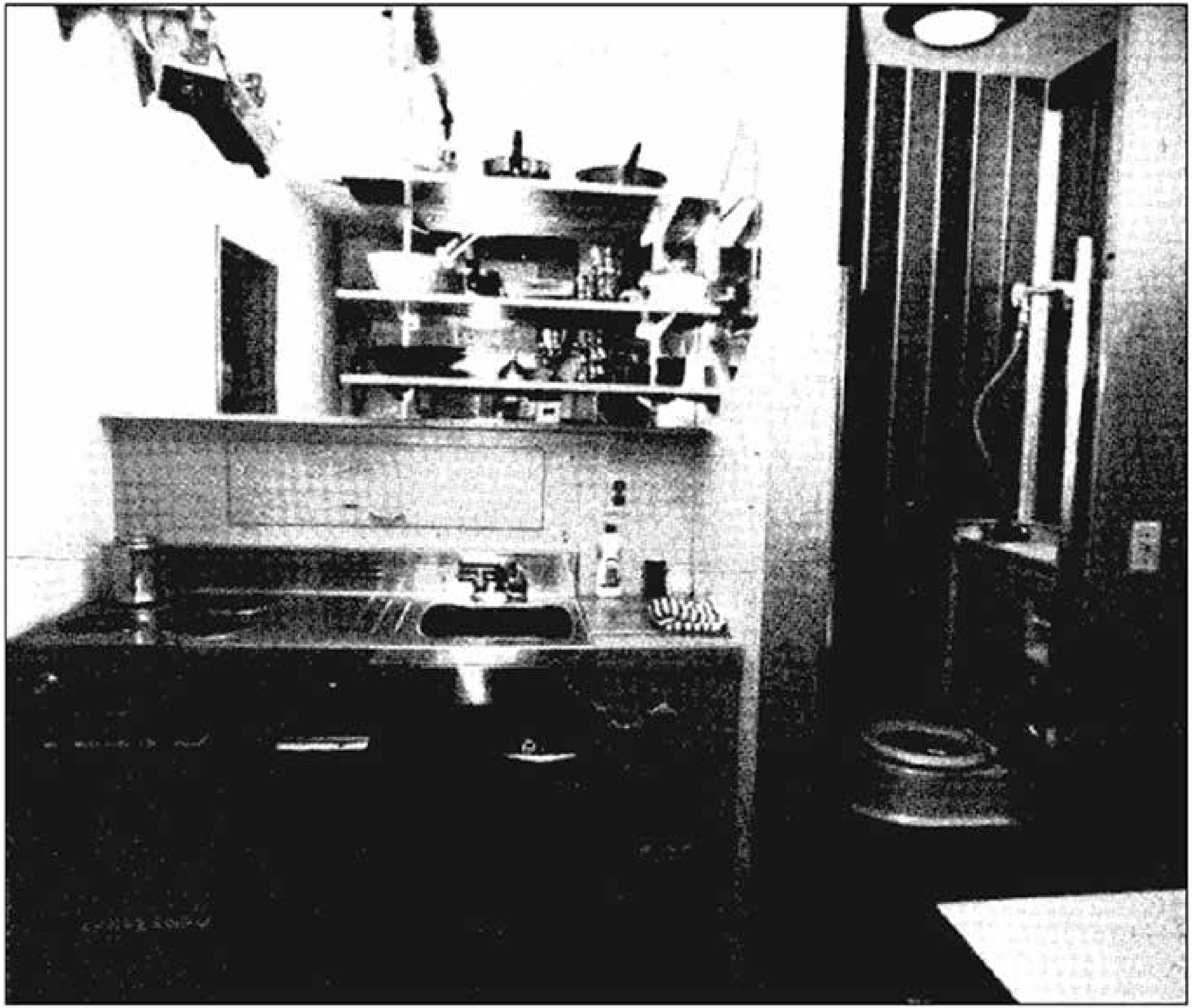
A Diagram of the Private Chamber



A Diagram of the Private Chamber



Private Chamber Work Station

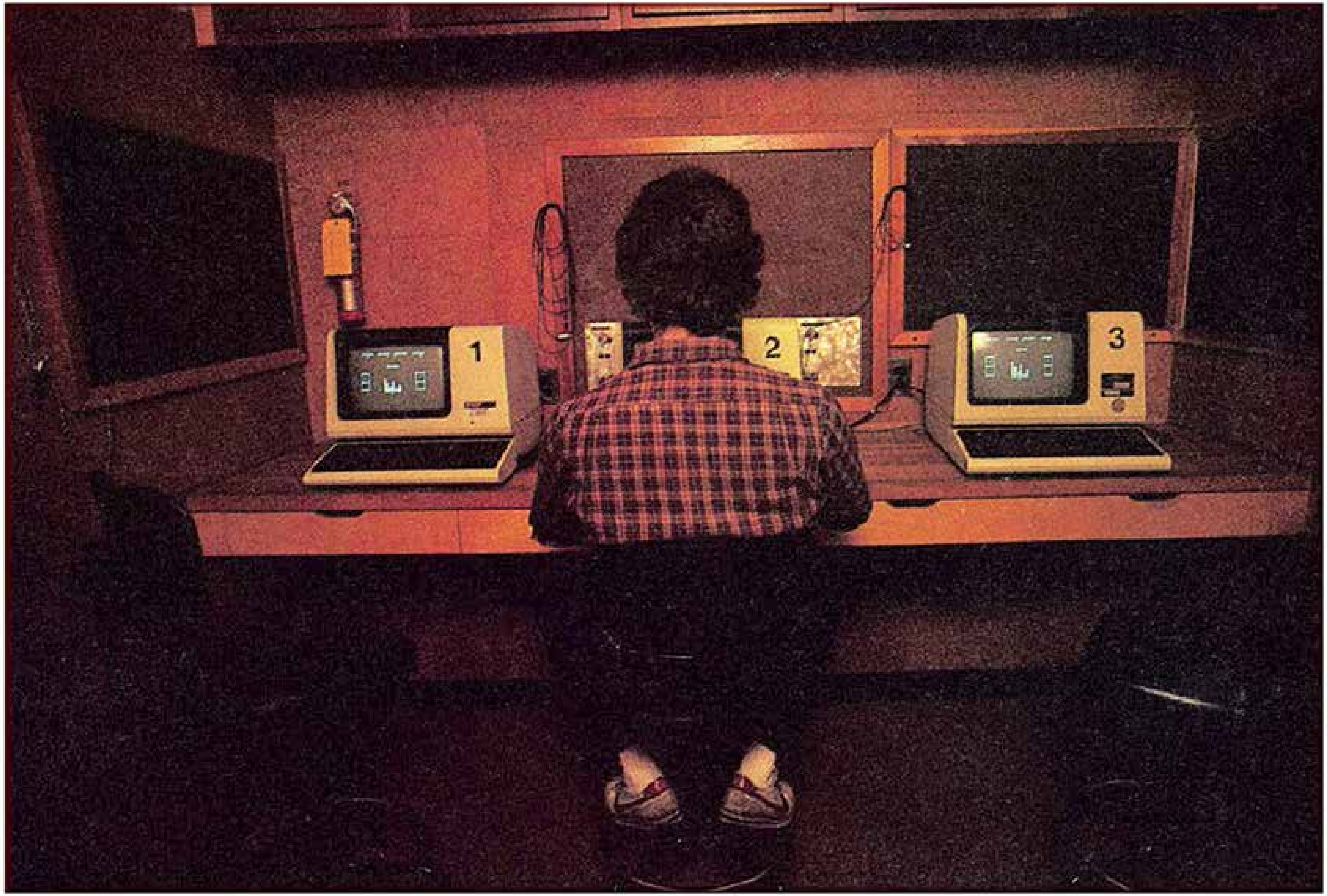


Private Chamber

Social Recreation Area

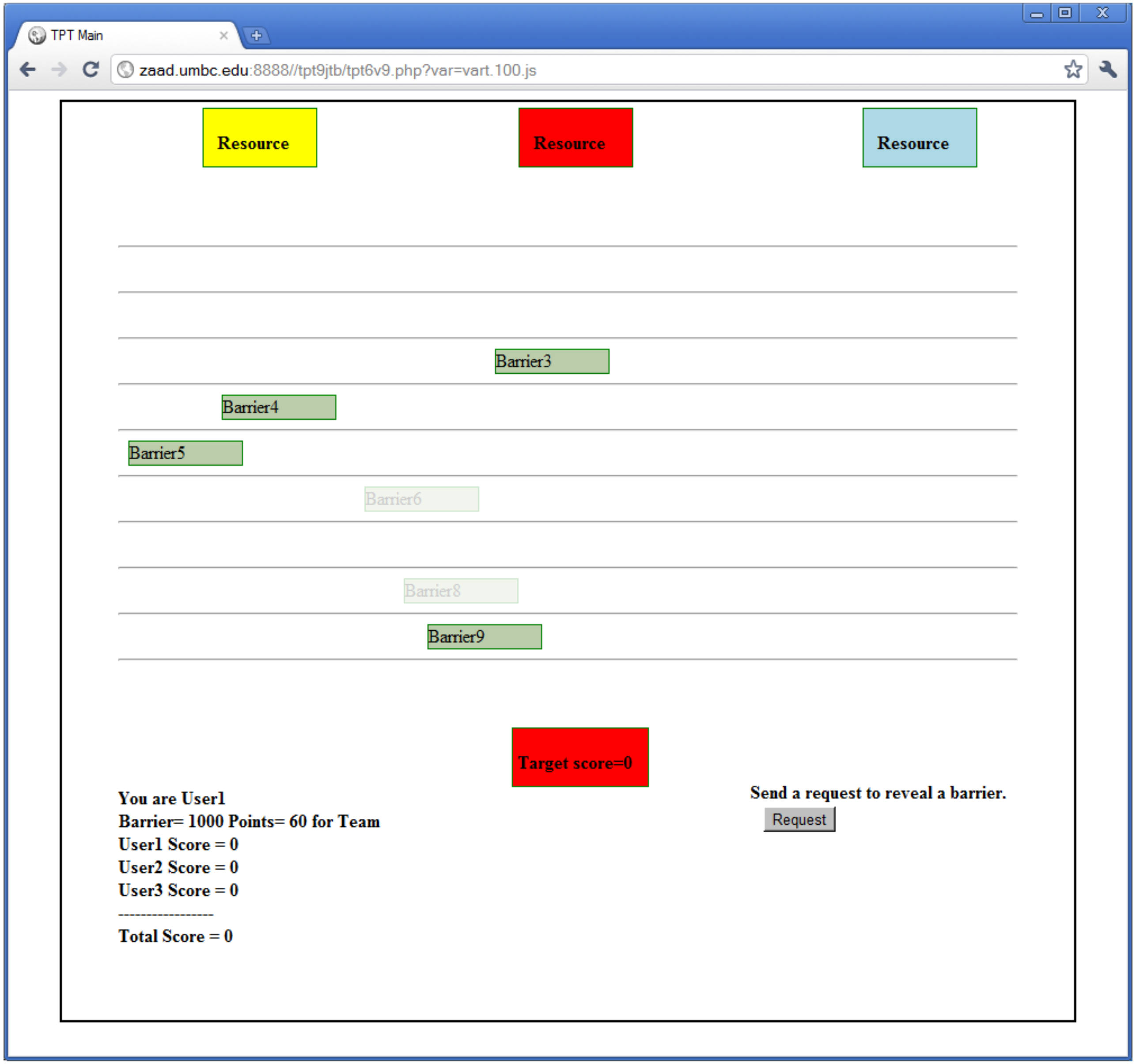
Control Station

The Alluisi Multiple Task Performance Battery (MTPB)



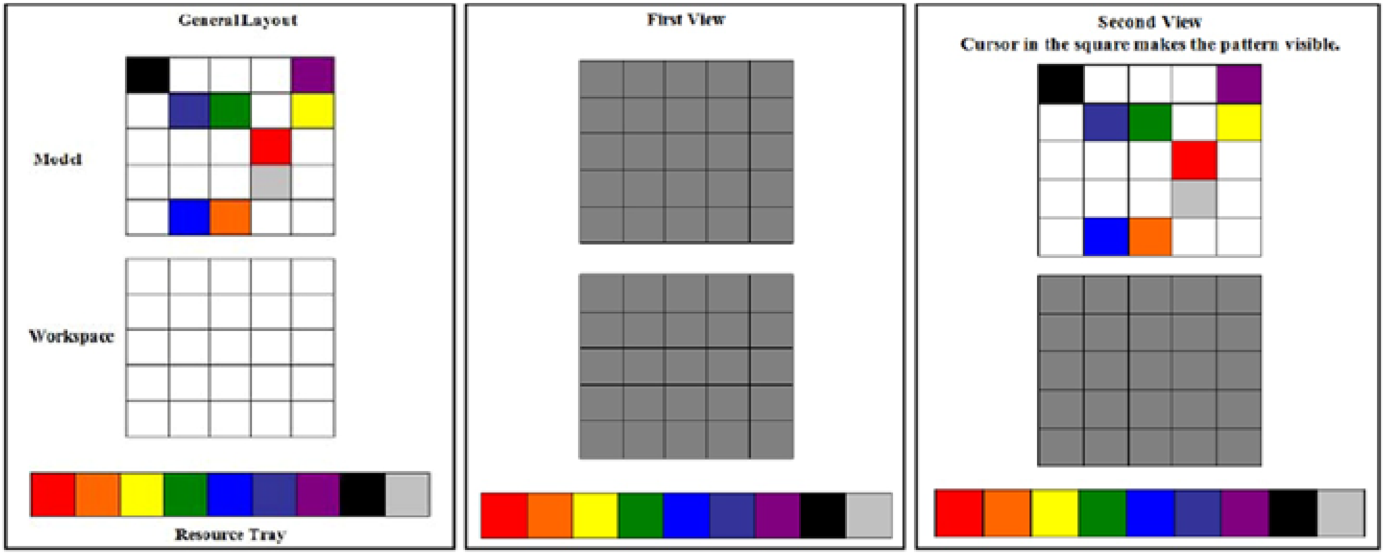
The Alluisi Team Performance Task (TPT) Circa 1982

TPT 2010

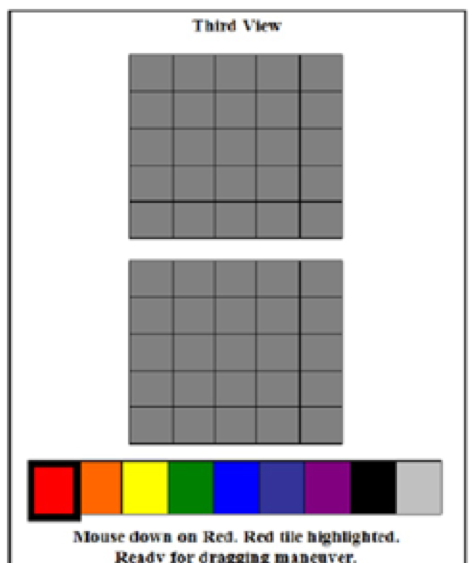

TPT Main
zaad.umbc.edu:8888//tpt9jtb/tpt6v9.php?var=vart.100.js
Resource
Resource
Resource
Barrier3
Barrier4
Barrier5
Barrier6
Barrier8
Barrier9
Target score=0
You are User1
Barrier= 1000 Points= 60 for Team
User1 Score = 0
User2 Score = 0
User3 Score = 0

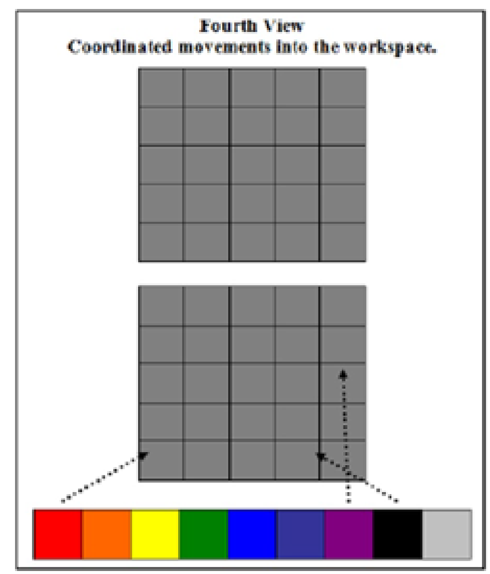
Total Score = 0
Send a request to reveal a barrier.
Request

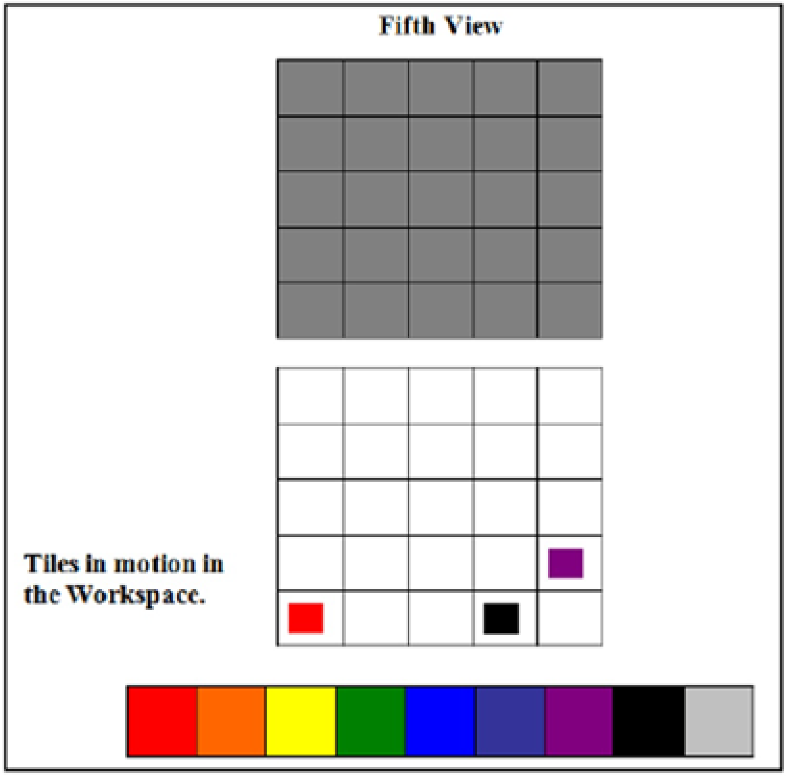
Networked Team Performance Task (N-TPT)

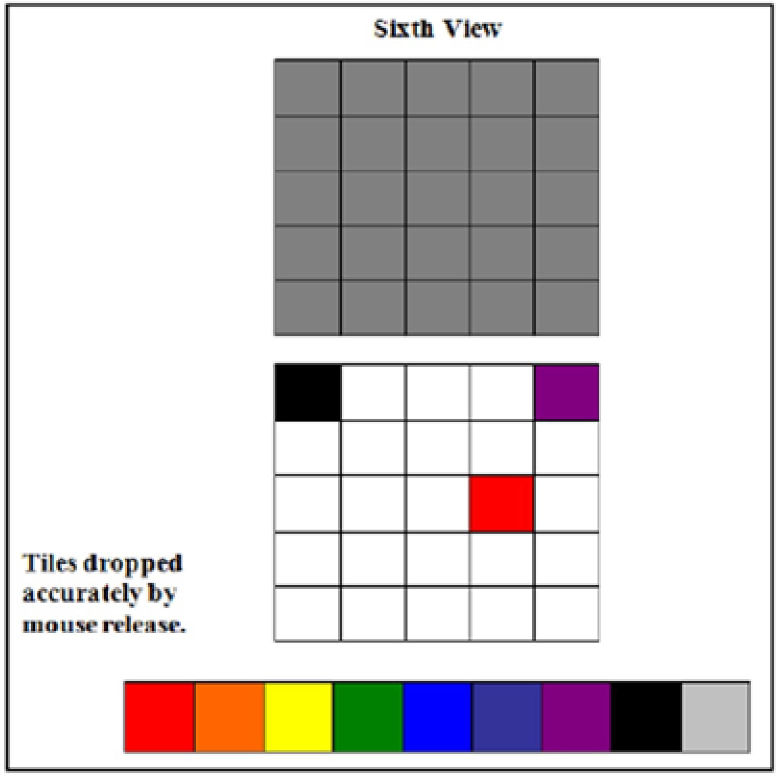


Presented here is the General Layout of one operator's console. The six views show the display as one operator engages the task from illuminating the model pattern (Second View) to three correct deposits in the Workspace by all three team members (Sixth View).

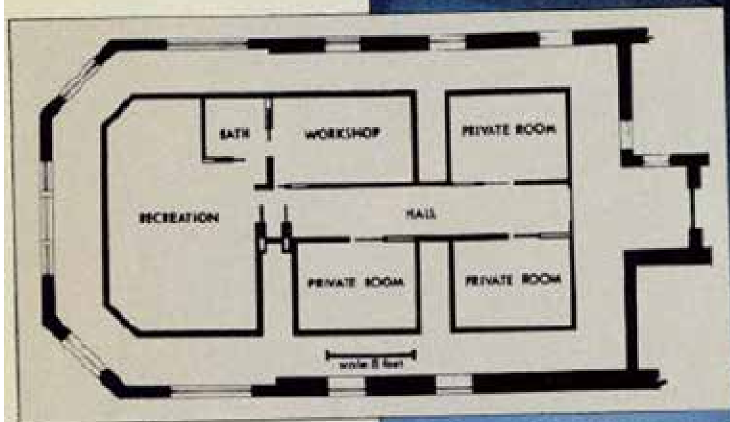


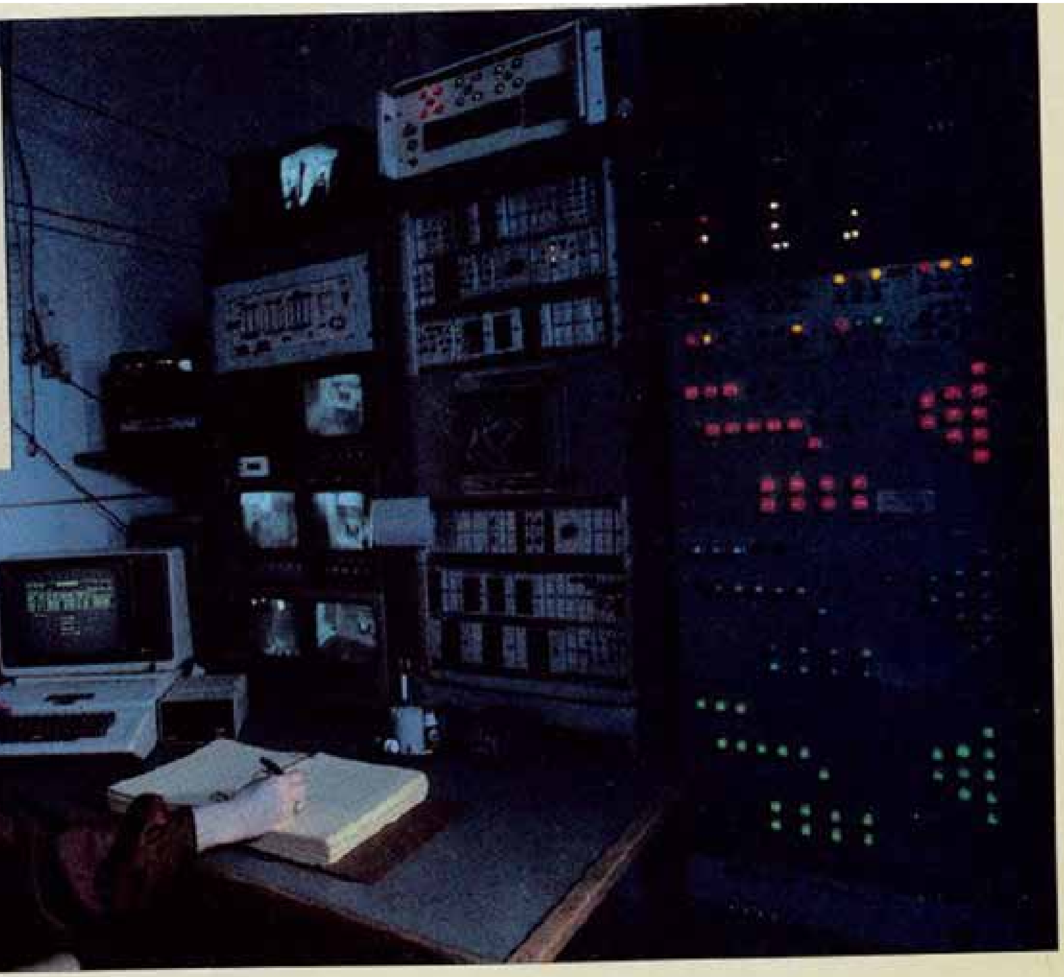



Fifth View
Tiles in motion in the Workspace.


Sixth View
Tiles dropped accurately by mouse release.

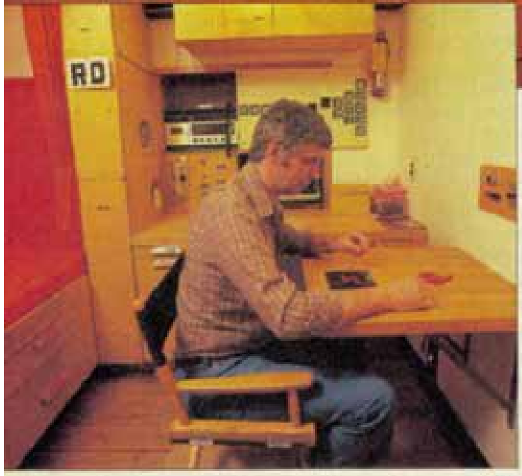
Monitors Deluxe! They All Made It Happen!





Above: The layout of the space lab. Right: Observers monitor participants via closed-circuit television. Far right: To perform successfully on the computerized exercise device, subjects must quickly reach to press flashing lights.

Duen Hsi Yen
Project Engineer



Above: In their private quarters, participants can send messages to and receive instructions from "mission control." Left: During their "free time," volunteers can choose to read, listen to music, or do puzzles.

competitive or cooperative group performance; then two more days of isolation while the replacement occurred; and finally three days of group performance with the novitiate. In some experiments, the researchers withdrew whoever had established himself as the group's natural leader; in other studies they replaced whoever had the lowest level of performance.

In recent years, the Johns Hopkins researchers have begun using women

Joe was an outstanding mentor to other faculty.
(Joe with Richard W. Foltin, Ph.D. PERC 1983-1992; photoshopped by Drew Gardner)

Look at that! Henry landed on Mars!
Eric Gasior, Joe Brady, & Kevin Spence

MAIN CONTROL PANEL

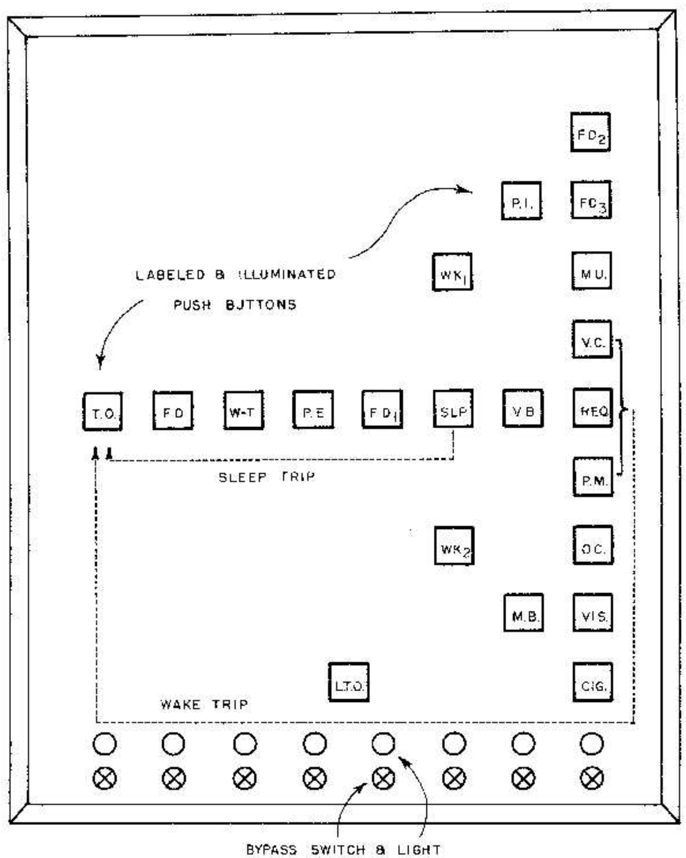
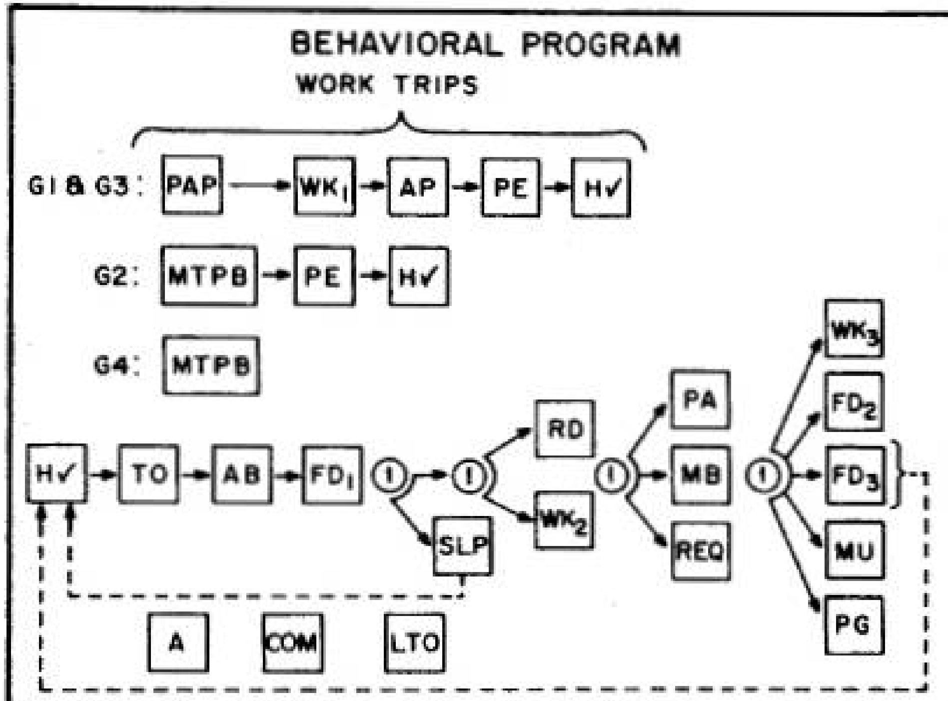


Figure 1. Main control panel containing push buttons that could be illuminated red or green. Each button is labeled with the abbreviations of the activity represented. "Wake Trips" and "Sleep Trips" are indicated by arrows.



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PE	PHYSICAL EXERCISE	500 CORRECT PRESSES ON AUTOMATED TASK
MTPB	MULTIPLE TASK PERFORMANCE BATTERY	G2: 800 CORRECT RESPONSES G4: NO RATIO
H✓	HEALTH CHECK	TEMPERATURE, PULSE, WEIGHT, STATUS REPORT
TO	TOILET OPERATIONS	USE OF PRIVATE BATHROOM AND CONTENTS OF DRAWER CONTAINING TOILETRIES
AB	AUTOGENIC BEHAVIOR	RELAXATION EXERCISES ON CASSETTE TAPE
FD1	FOOD ONE	TWO SELECTIONS FROM A LIST OF FOODS
SLP	SLEEP	USE OF BED AND PRIVACY CURTAIN
RD	READING	ACCESS TO BOOK
WK2	WORK TWO	PROBLEMS, EXPERIMENTS, ASSEMBLY PROJECTS
PA	PUZZLE ASSEMBLY	ASSEMBLE A PUZZLE
MB	MANUAL BEHAVIOR	ACCESS TO ART MATERIALS
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WK3	WORK THREE	ACCESS TO WORKSHOP
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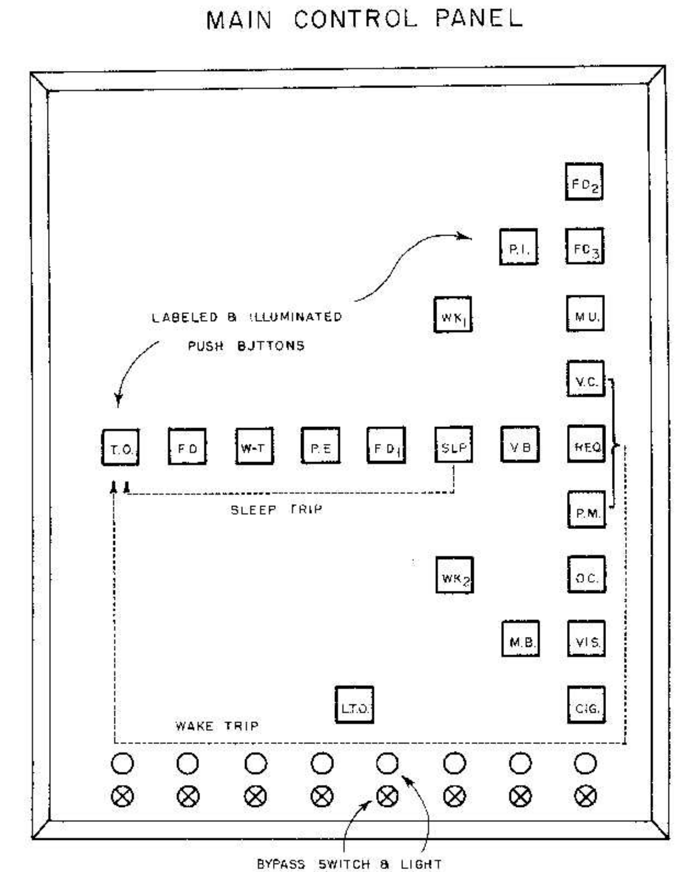
MU	MUSIC	EARN A CASSETTE TAPE
PG	PRIVATE GAMES	ACCESS TO SOLITARY GAMES
A	AUDIT	RECEIVE WORK SCORES FOR ALL SUBJECTS
COM	COMMUNICATION	ACCESS TO INTERCOM
LTO	LIMITED TOILET OPERATIONS	ACCESS TO ESSENTIAL TOILET FACILITIES



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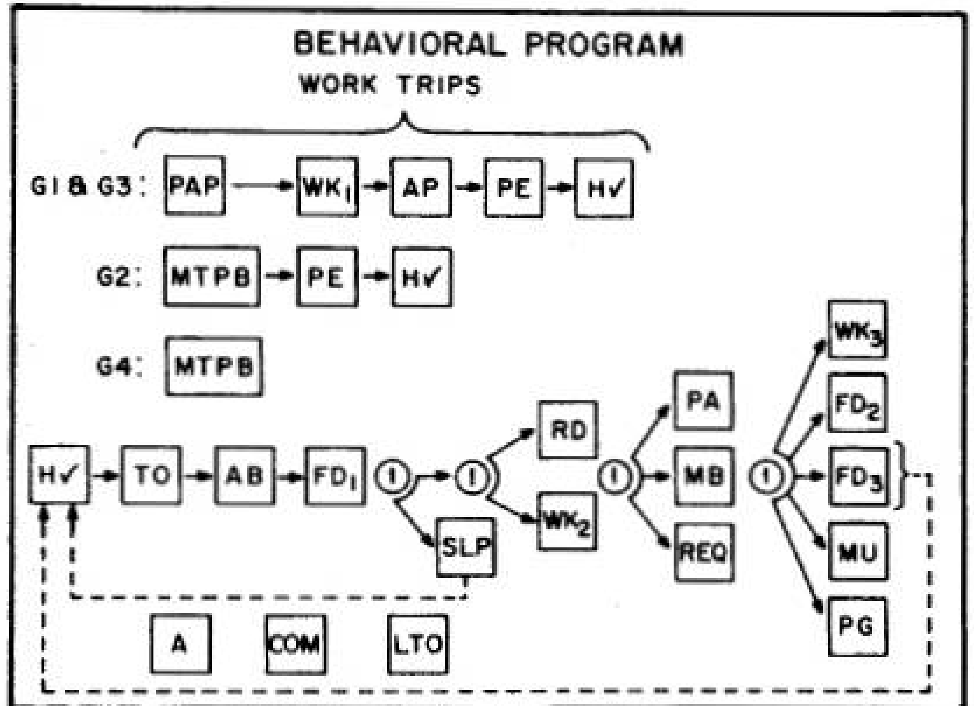
Systematic Replication



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Why Programmed Environments?

- Journeying in a spacecraft to Mars does **not** constitute an **ecological setting** into which familiar pre-flight routines of living are easily applied.

Why Programmed Environments?

- The setting is a **unique ecology** requiring a technology applied to that inherently unfamiliar setting.

Why a Behavioral Program?

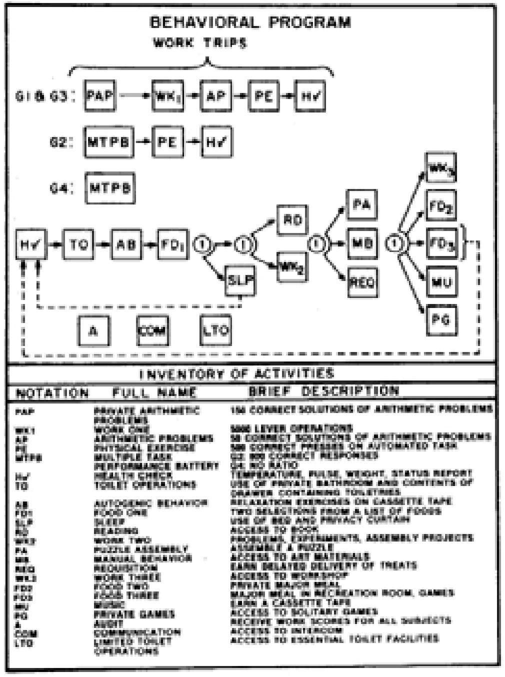
- **Manages scarce environmental resources**
- **Motivational "force" is intrinsic to the programmatic design**
- **Comprehensive status-assessment**
- **Spacelife systems integration**

Research Approach

- **Designed-based research**
- **Accept demonstrably effective interventions**
- **Systematic replication**
- **Spacelife engineering solutions**

Augmented Stages for a Mission to Mars

1. Physiological and psychological adaptation to microgravity and onboard schedules (4-6 weeks).
2. Steady-state adaptation (6-12 weeks).
3. Behavioral program “countermeasure” (12+ weeks)

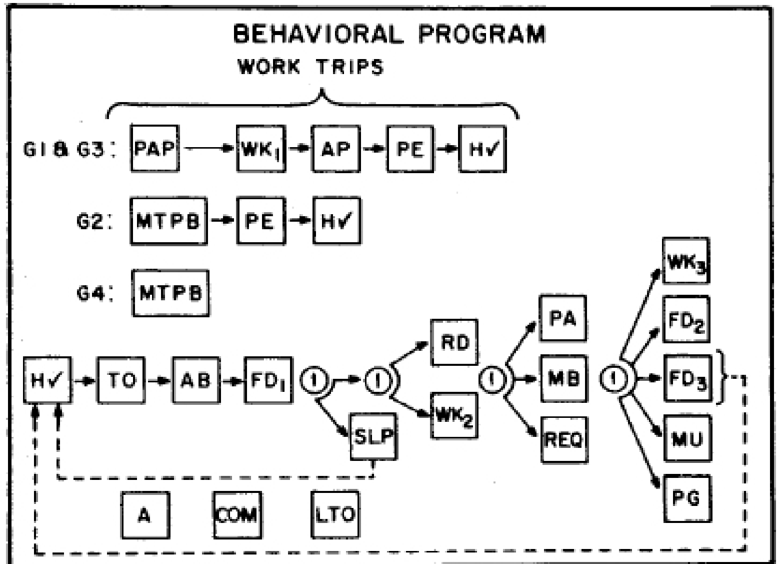


Which Approach?

Radiogram No. 4441u Form 24 for 01/03/07

SETTING UP BKЮ1,2 FAN CONTROL CONFIGURATION WITH БРУС (MANUAL FAN SPEED CONTROL UNIT)

GMT	CREW	ACTIVITY
08:00-06:10		Morning Inspection
06:10-06:40		Post-sleep
06:40-07:30		BREAKFAST
07:30-08:00	CDR, FE-2	Prep for Work
07:30-07:55	FE-1	
07:55-08:05		Switch VOZDUKH to the automatic control mode
08:05-08:20		Daily Planning Conference *(S-band)*
08:30-09:10	FE-1	Filling EDV [KOB] for Elektron
08:40-09:10	CDR, FE-2	OGS Rack rotation to install OGS equipment
09:10-10:25		OGS H2/N2 Vent Hose Installation
09:10-09:40	FE-1	СОЖ Maintenance. *Verification of ИП-1 sensor position*
09:40-10:40		METEOROID. Dismantle MMK-2 Electronic Unit
10:25-10:40	CDR, FE-2	LAB1D1 (AV-2) rack rotation to install OGS equipment
10:40-11:10		LAB1P1 waste water hose connection



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Both approaches have value at different occasions in a mission to Mars.

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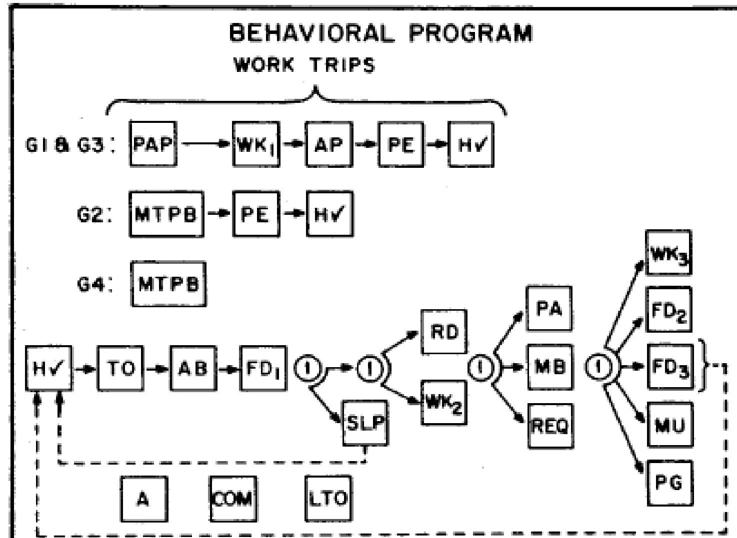

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Increasing Crew Autonomy for Long Duration Exploration Missions: Self-Scheduling

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(281) 244-7489

***Abstract*—Over the last three years, we have been investigating the operational concept of crew self-scheduling as a method of increasing crew autonomy for future exploration missions. Through Playbook, a planning and scheduling software tool, we have incrementally enabled the capability for Earth analog mission crews to modify their schedules at various levels of complexity. Playbook allows the crew to create new activities from scratch, add activities or groups of activities from a Task List, and reschedule or reassign flexible activities. The crew is also able to identify if plan modifications create violations, i.e., plan constraints not being met. This paper summarizes our observations with qualitative evidence from four NASA Extreme Environment Mission Operations (NEEMO) analog missions that supported self-scheduling as a feasible operational concept.**

in which they may not be able to communicate to ground in a timely manner. One key factor in allowing astronauts to work under these conditions is to provide aids that allow them to dynamically execute assigned tasks without depending on continual instruction from Earth. However, achieving this model requires a complex process. Removing the assistance that ground teams provide will likely result in an overwhelmed crew with a higher workload - ground teams have a vast amount of information and expertise, essential to working and living in space, which cannot be neatly codified.

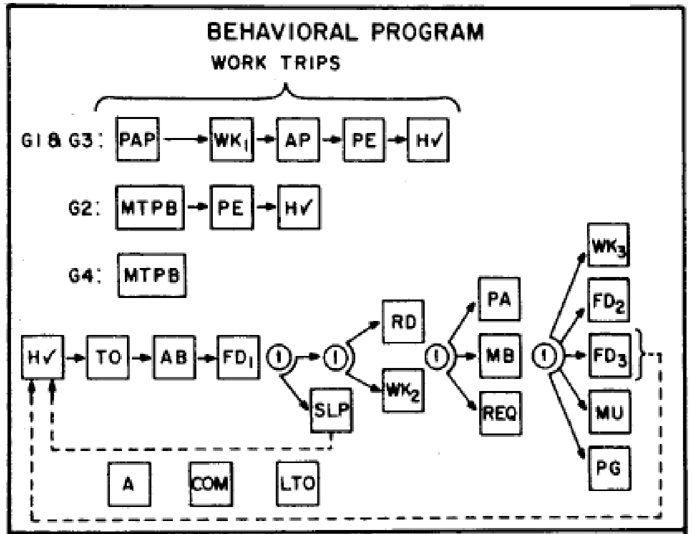
This inevitable shift from the current spaceflight operation model points to the need to support and enable more

March 4, 2017: https://ntrs.nasa.gov/search.jsp?R=20170002006

Timeline control à Behavioral program à Timeline control

Recommendations

- **Supportive of individual and crew performance during long-duration expeditionary missions.**
- **Warrants evaluation in ground-based simulations.**



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Gerald Soffen, NASA's current director of life sciences, admits that in terms of psychological research on crew selection, training, and accommodation, "The Soviets are way out in front of us." In the United States, until now, says Soffen, "We've poured everything into success and safety. Now we can focus on efficiency and performance." That may mean good news for the space lab at Johns Hopkins. If they can come up with enough money, Brady and Emurian would like to extend their missions from 10 days to a month or more. Any volunteers?

JOHN JOSEPH BOSLEY

1935 – 2014 Obituary Condolences

BALTIMORE, Md. - John Joseph Bosley, 77 years, died suddenly on March 13, 2014, in Baltimore, Md.

Mr. Bosley was born on Armistice Day, Nov. 11, 1935, in New Creek , W.Va., the fifth of seven children of Bess Dale (Corey) Bosley and Thomas Richard Bosley.

John Bosley, Ph.D., was lead for Mars Mission Human Support System Planning at Booz Allen.

Final Notes

We must finally rely, as have the older sciences, on replication.

➢**Cohen, 1994, p. 1002**

Cited in Cumming, G. (2008). Replication and *p* Intervals: *p* Values Predict the Future Only Vaguely, but Confidence Intervals Do Much Better. *Psychological Science*, *3*(4), 286-300.

Keep making responses.

➢**Brady, 2009**

BehvWiki interview with Joseph V. Brady:
http://web3.unt.edu/behvh/wiki/index.php/Joseph_V._Brady

Challenge

"The short-term nature of funded research and the **expectation of producing meaningful results in the near-term** is a result of the culture of experimental scientific research. Such an approach, however, does **not** seem to suit such settings as human spaceflight..." (Musson & Helmreich, 2005).

Musson, D.M., & Helmreich, R.L. (2005). Long-term personality data collection in support of spaceflight and analogue research. *Aviation, Space, and Environmental Medicine*, *76*(6), Section II, B119 – B125.


Thank You!

I retired from UMBC at the end of the Spring 2015 semester. I was truly blessed to know and work with so many outstanding students and colleagues over the years.