Human Factors and Life Support in Apollo

Engineering Apollo

16.395/ESD.30/STS.471

Prof. Laurence R. Young

1958 NACA Space Technology

Study Chaired by Guy Stever of MIT

Human Factors and Training Group chaired by Randy Lovelace, MD

15 Technical Areas

Wiesner and Abelson wanted NASA out of the science

Need for a basic biomedical research program

1958 HF and Life Science Issues

1. Program administration
2. Acceleration
3. Hi-intensity space radiation
4. Cosmic radiation
5. Nuclear propulsion
6. Ionization effects
7. Human info processing/comm.

1958 HF and Life Science Issues (cont)

8. Displays
9. Closed-cycle living
10. Balloon simulators
12. Space capsules
13. Crew selection and training
14. Research Centers
15. Launch sites

Major Life Science Issues

Astronaut Selection

Medical Requirements

Skill Set

Life Support Systems

Accelerations

Atmosphere

Early Biomedical Concerns

Heart Failure

Pneumonia

Muscle cramps

Balance

Sleep

Bone loss

Eating/drinking

Disorientation

Manual control

Vision

Hearing

Separation

Acceleration Tolerance

Transverse (Eyeballs In)

Fitted couches

Decreased tolerance

Animals in Space First?

Science Community wanted Animals

Chimps trained for flight

Enos had ectopic heart beats

Ham successful in Mercury suborbital flight

X-15 program seemed to qualify man for flights

Biosatellite 3 flights with chimps 1963-67

Office for Biotechnology & Human Reseacrch

Man-machine integration

Advanced life support

(AG and closed systems)

In-flight animal studies

Bioinstrumentation

In-Flight Medical Monitoring

No knowledge of o-g tolerance

A source of friction with crews

Originally only:

- Body temp. (rectal, then oral)
- Respiration rates (thermistor then impedance pneumograph)
- Blood pressure, later, ECG

Reliance on voice and interrogation

Pilots vs. Flight Docs

- Pilots feel invincible
- Flight surgeons are conservative and are considered a threat
- Scientific community wants more studies
- *See Charles Berry quote, p. 149 of Engle and Lott*

Astronaut Duties

Backup of the automatics systems

Scientific observer

Engineering observer

Test pilot

Crew Training

Space familiarization

High performance aircraft

Exposure to stresses

Simulation

Flight Crew Training

Selection

Physical health

Mental health

Test Pilot Experience

Training

Coordination of Manned Program

NACA WG on Human Factors

Chaired by Guy Stever (MIT)

Report by Randy Lovelace

Air Force Lead (X-15 and beyond)

Dyna-Soar

Mercury Biomedicine

Life Science Advisory Committee, 1959

Randy Lovelace, Chair

Stan White, MD

Bob Voas, PhD

Only involved in selection

14 day Gemini key to Apollo Biomedicine

Acceleration

(Henry-Gauer)

Pneumatic cuffs

Bungee exerciser

Weightlessness

Radiation

Capsule environment

Waste management

Isolation

Sleep

Man-machine

Food and water

RBC loss found

Life Science in Apollo

- Microgravity Effects
- Radiation Protection
- Planetary Protection
- Other science

Oxygen vs Air

Oxygen Advantages	*Oxygen disadvantages*
Lower pressure	Long term hyperoxia
Lighter structure	Fire hazard
Avoids hypoxia	Science impact
Avoids bends	Toxic oxidation products
Simpler engineering	

Carbon Dioxide

Potentially lethal if not regulated

Simple LiOH Cannisters

Need for monitoring

Later – molecular sieve and other chemical reactions

US and Soviet Spacecraft

Figures removed due to copyright restrictions.

Graph of atmosphere compositions of various U.S. and Soviet spacecraft, and image of the Apollo-Soyuz joint mission.

Pre-Selection Testing

Only active duty military test pilots tested

IQ and engineering and math aptitude

Medical evaluation

Centrifuge

Hypo-baric chamber

Thermal chamber

Parabolic flight

ORIGINAL SEVEN

Selected for:

Intelligence

Physical Stamina

Health

Science/Engineering

Light Weight

Not too tall (71 in.)

Below 35 (later 39) yrs

Pilot Performance

Disorientation

Isolation

Illness

Recency

Space Suits

Designs based on high altitude pressure suits
Backup to cabin pressurization
EVA mobility
Pure oxygen PLSS, 3.7 psi
Evaporative cooling, later liquid cooling
Excessive heat production