

A Matter of No Little Gravity

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Human Factors of Outer Space

Production: AAAS Selected

Symposium 50

Boulder, Colo.: Westview Press, 1980.

206 pp. \$18.50

Review by

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This is not a book about human factors in the usual sense of the controls, displays, and work places to be used by human beings. Instead it is about the possible psychological problems of people, and the problems of selecting those people, who are going to live, work, play, and eat in a space "city." This factory, office, home, and farm is to be located either in LEO (low earth orbit) or in GEO (geosynchronous orbit). It is also about ways to feed the people. The other 30% of the pages are devoted to the economics of space factories, the man-machine problems, and the architecture of the system.

The book has nothing to say about the design of controls and displays for space flight or space work. The assumption is made, and explicitly stated, that "the environment of weightlessness is the single significant difference a designer must consider for human beings and machines in space vehicles" (p. 97). There are, I think, many who would disagree.

The largest portion of the book discusses psychological issues: crowding and privacy, leisure activity, authority structure, sex ("benign neglect" is the recommended policy), crew selection, and stress. There is no mention of training.

Much emphasis is given to the use of Antarctica as a field laboratory. I agree that there are similarities between the situations. The results of studies done in the Antarctic environment do not suggest that the more commonly used psychometric test instruments are going to be of much use. The MMPI in particular is cited as showing "significant improvement in psychological adjustment between the [two] MMPI administrations! [even though] in their appearance and behavior these men showed signs of ranging from, at best, clinical depression to, at worst, a state of profound chronic fatigue" (p. 31). Many years ago, while serving as chairman of a subcommittee (of the NAS/NRC committee on Bioastronautics) on psychological problems in space flight, I asked Stark Hathaway how we would ascertain the psychological state of astronauts in orbit. He said (as well as I can remember), "Pick up the microphone and say, 'How are you feeling, Joe?'" So the MMPI result does not surprise me. The discussion of tests based on cerebral lateralization is interesting and provocative, but no evidence really supports the notion that they would work; "much of what has been presented here is still highly speculative" (p. 37). Much is made of the fact that during an emergency the supposedly well-adjusted men, or a few of them, performed badly and "put themselves at risk for serious injury from frostbite" (p. 31). "Several men"—out of how many, I would like to know. Three out of five or three out of 50? There is a difference. If only "several" "ignored safety procedures," that sounds like an excellent record. Only brief mention is made of the experiences of submarine crews. There may have been serious psychological sequelae to the submerged circumnavigation of the world, but I do not recall seeing any report of them. The submarine seems like a better analog of the space factory and is closer to home.

The chapter "Well-Being and Privacy in Space: Anticipated Conflicts of Interest" has a good discussion of privacy as a psychological concept. There is also a section dealing with the problem induced by the stated requirement "that stresses and reactions to stress in space be monitored and documented" (p. 74). This is seen, correctly, as an invasion of privacy. But, I doubt that it is true that "the public will have an immense curiosity about every aspect of their physical and psychological functioning. . . . [like that shown in] Betty Ford's breast cancer, and Patty Hearst's physical and emotional condition" (p. 75).

I cannot recall any interest shown in the bowels, brains, or breasts of astronauts. What public display there was seemed to me to be the result of the poverty of both information and imagination displayed by the reporters covering the flights. I think the issue is a red herring.

The chapter "Habitat Requirements, Design and Options" covers the needs generated by both LEO and GEO missions. There are no rotating doughnuts for artificial gravity forces. There will be no "g" forces and no weight. The chief problem, aside from the weightlessness, is the radiation hazard, particularly in the GEO. It is so great in GEO that "redundancy [of orbital equipment], rather than in-flight repair techniques, is indicated" (p. 93). Further, the threat from solar flares is severe and a "storm shelter" will be needed there. All in all GEO is a pretty expensive place to put human beings.

One chapter, as pointed out earlier, is about "Man-Machine Design for Spaceflight," and it is entirely concerned with weightlessness and its effects on the size and posture of human beings. In general one should not expect one size to fit all, nor should one allow too snug a fit whilst on Earth. The finding that neutral posture is different from what it is on Earth makes it necessary to pay some attention to the layout of work spaces.

Then to dinner! What do you need to eat? How can it be produced by recycling your waste? How will the food be processed and prepared? How do you study the effects of variation in environment on plant growth? How do you begin to develop a controlled environment farm? These are the five chapters on food. The "phytotron," a functionally super greenhouse that allows one to do well-designed and *well-controlled* research on the effect of combinations of environmental factors on plant growth (Sir Ronald would have had a field day!) is touted as the answer, and it probably is.

Finally the economics of the whole scheme is considered. There are many profitable things being done, and to be done, in space. It is not clear that it is more profitable to put human beings into space instead of robots or *telepuppets* (I think that's Fred Whipple's term for remotely controlled, televideoed manipulators). I, for one, would like to see the jobs done locally by people, if only to show that it was worth all the money and trouble that has been expended in putting them into space in the past. It may be cheaper to go the other route. At no point is any service,

product, or task brought forward that cannot, with no more imagination than the authors have shown, be done by a conceivable machine, or by a combination of Earth-bound man and space-borne machine.

In summary, the book breaks down to 38% psychology, 32% food, 13% economics, 9% architecture, and 8% "human factors" (based on page count).

The lack of both name and subject indexes is infuriating. The failure to put all the references together is annoying. The small IBM typewriter print, the low effective contrast, and the reduced interline spacing all contribute to making it not a pleasure to read. ■