



The Space Congress® Proceedings

1970 (7th) Technology Today and Tomorrow

Apr 1st, 8:00 AM

Off-Duty Concepts for Long Duration Space Missions

Edward W. Karnes

Martin Marietta Corporation, Denver, Colorado

Leonard A. Loudis

Martin Marietta Corporation, Denver, Colorado

J. K. Thomas

Martin Marietta Corporation, Denver, Colorado

Thomas Spiritoso

Temple University, Philadelphia, Pa.

Follow this and additional works at: <https://commons.erau.edu/space-congress-proceedings>

Scholarly Commons Citation

Karnes, Edward W.; Loudis, Leonard A.; Thomas, J. K.; and Spiritoso, Thomas, "Off-Duty Concepts for Long Duration Space Missions" (1970). *The Space Congress® Proceedings*. 2.

<https://commons.erau.edu/space-congress-proceedings/proceedings-1970-7th/session-4/2>

This Event is brought to you for free and open access by the Conferences at Scholarly Commons. It has been accepted for inclusion in The Space Congress® Proceedings by an authorized administrator of Scholarly Commons. For more information, please contact commons@erau.edu.

EMBRY-RIDDLE
Aeronautical University™
SCHOLARLY COMMONS

OFF-DUTY CONCEPTS FOR LONG DURATION SPACE MISSIONS

Edward W. Karnes, Leonard A. Loudis, J. Kirby Thomas,
Martin Marietta Corporation, Denver, Colorado
Thomas Spirito, Temple University, Philadelphia, Pa.

ABSTRACT

Leisure time preferences were surveyed in three populations which are potential sources of future spacecrew candidates: test pilots, military pilots and aerospace engineers and scientists. A questionnaire designed to provide rating scale measures of preferences for various types of spacecraft recreational equipment items, leisure time activity categories, content within activity categories, and various kinds of snack items was administered to the samples from the three populations. The results indicated that leisure time preferences in the three populations were quite similar.

Representative spacecraft off-duty concepts for long duration space missions and possible engineering constraints are discussed.

INTRODUCTION

The problem of off-duty or leisure time on manned space missions is a rather recent one in the space program. Only small amounts of leisure time have been available on the relatively short space missions of the past and little more is planned for those in the immediate future. However, preliminary mission analyses of orbiting laboratory and interplanetary missions have indicated that large amounts of crew free time will be available on these long duration flights. Therefore, consideration must be given to provisions for leisure time activities and recreational equipment on the future long duration space missions.

The development of space mission off-duty concepts is important from another standpoint. One of the biggest questions in planning long duration space missions such as planetary exploration concerns the psychology of long term isolation during space flights. The inclusion of appropriate leisure time equipment and carefully planned mission timelines can help to alleviate psychological problems which could arise as a result of the relative isolation and physical restriction imposed by the spacecraft environment.

Effectiveness of off-duty time requires activities which can accomplish more than the mere passage of time, as was pointed out by Fraser (1968). He suggested activities which were a combination of passive entertainment and creative work. However, the most important factor in the enjoyment of leisure time activities is freedom of choice. That is, people enjoy their leisure time activities because they choose those activities. Therefore, the development of off-duty concepts for future space missions should be made with due consideration

given to preferences of the individual crew members; that is, crew acceptance must be the primary goal in the selection of off-duty concepts. Furthermore, preliminary studies of spacecraft off-duty activities will be necessary to define a restricted set of such activities in order to determine their impact on spacecraft design.

One method of reducing the set of possible spacecraft leisure time activities while still allowing for the element of individual choice is to survey populations from which future spacecrews are likely to be drawn to determine their preferences in leisure time pursuits. Fraser (1968) and Eddowes (1961) reported certain survey data concerned with the types of activities in which people engage during their leisure time. The data were taken from two populations: an urban group and a group of professional personnel in an industrial aerospace organization. These data were somewhat limited for studies of spacecraft off-duty concepts, however, for several reasons: the urban group was not representative of present or future astronauts; the aerospace group was surveyed over eight years ago; and the data were presented in the form of rank orders based only on frequency of mention.

The purpose of the present study was threefold: (1) to provide data on leisure time preferences in populations which may reasonably be expected to provide future spacecrew candidates; (2) to use this data in developing representative spacecraft off-duty concepts; and (3) to identify spacecraft engineering constraints on selected off-duty concepts. Three populations were identified as sources of future spacecrew candidates: test pilots, military pilots, and engineers and scientists employed in private industry. A leisure time questionnaire was administered to samples from each of the three populations; the questionnaire was designed to provide rating scale measures of preferences for leisure time activities and equipment.

QUESTIONNAIRE DATA

Design

The questionnaire was designed to provide 5 point rating scale values for items in four separate sections: recreational equipment items, leisure time activity categories, content within activity categories, and various types of snack items.

An introductory page provided an explanation of the purpose of the questionnaire and stated that all responses were to be anonymous.

The first section of the questionnaire was concerned with anticipated usage of various types of off-duty equipment on a long duration space mission. Nineteen items such as television sets, AM and FM radios, books, sports equipment, etc., were listed. Respondents were asked to rate items according to how much they thought they would use them during off-duty time if they were crew members on a long duration space mission. Scale categories were: "very little use, little, moderate, much and very much use."

The second section of the questionnaire was concerned with current, earthbound leisure time activities. Twenty one separate leisure time activities were listed such as reading, playing sports, watching TV, movies, etc. Respondents were asked to indicate the amount of leisure time that they currently spend in each activity. Scale categories were: "very small amount, small, moderate, large, and very large amount."

The third section of the questionnaire was concerned with content preferences. Items were listed under five categories: reading material; TV, radio, or movie content; music; and sports and exercising. For example, technical books and journals, newspapers, Playboy type magazines, etc., were listed under the category of reading material. The scale dimension in the third section was concerned with degrees of preference. Scale categories were: "dislike very much, dislike, neutral, like, and like very much."

The fourth section of the questionnaire was concerned with preferences for ten different types of snack items which might be provided during off-duty time. Respondents were asked to indicate their preferences for items such as tobacco, alcoholic beverages, chewing gum, etc. Scale categories were the same as those in section 3.

Subjects

The population samples consisted of three groups: 42 pilots who were either in flight test training or were instructor pilots at the USAF Aerospace Research Pilot School (ARPS), Edwards AFB, and 2 ARPS graduates; 37 USAF Tactical Air Command fighter pilots (TAC) stationed at McConnell AFB; and 43 aerospace engineers and scientists (MMC) working on the Apollo Applications Program at the Martin Marietta Corporation.

Procedure

The questionnaires were distributed to each group in a single session. A brief verbal explanation of the purpose of the questionnaire at the beginning of the session. The questionnaires were administered to the MMC group at the Martin Marietta facilities in Denver, Colorado. One of the authors (L.L.) administered the questionnaire to the entire

class of pilots enrolled at ARPS and Lt. Col. E. Shudinis administered the questionnaire to the TAC personnel at McConnell AFB.

No time limit was set for completion of the questionnaire; however, less than 10 minutes were usually required since respondents were required to simply pencil-check the appropriate rating scale category for each item in the questionnaire. Adequate blank spaces were provided throughout the questionnaire for additional comments.

Results and Discussion

Scale values of 1-5 were assigned to the five response categories with 1 corresponding to the categories "very little use," "very small amount," and "dislike very much." To facilitate presentation of the data, the individual items listed in sections I and II were subsumed under general leisure time equipment and leisure time activity categories, and the data for individual items listed in section III were combined into general categories of content preferences. Mean rating scale values are shown in Table 1.

Table 1. Mean Rating Scale Values

Section I: Equipment Usage In Spacecraft	ARPS	TAC	MMC
	Mean	Mean	Mean
1. Active Recreation	(3.57)	(3.06)	(3.17)
Physical exercise equipment.	3.64	3.08	3.28
Sports equipment	3.50	3.05	3.06
2. Passive Entertainment	(3.23)	(3.17)	(3.21)
Viewports in spacecraft.	3.14	3.57	3.67
Books	3.57	3.30	3.32
Hi fi, record, or tape players.	3.43	3.16	3.25
AM, FM radio	3.25	2.92	3.42
Magazines	3.20	3.22	2.92
Newspapers	3.05	3.11	3.02
Television sets	3.00	2.97	2.85
3. Communication	(2.68)	(2.48)	(2.43)
Radio equipment for personal communication.	2.82	2.78	2.78
Writing supplies	2.54	2.19	2.08

	ARPS Mean	TAC Mean	MMC Mean		ARPS Mean	TAC Mean	MMC Mean
4. Games	(2.04)	(1.93)	(1.91)	5. Casual Activities	(1.68)	(1.77)	(1.87)
Playing cards	2.57	2.16	2.16	Being alone	1.73	1.72	2.02
Board games	2.05	1.95	2.24	Resting, relaxing, doing nothing in particular	1.75	1.86	1.84
Dice	1.50	1.68	1.33	Eating snacks	1.57	1.75	1.77
5. Hobbies	(1.79)	(1.89)	(1.98)	6. Communicating	(1.77)	(1.62)	(1.42)
Photographic equipment.	2.30	2.58	2.81	Technical writing	1.91	1.46	1.51
Model building kits.	2.05	2.05	2.02	Personal writing	1.64	1.78	1.33
Musical instruments.	1.82	1.88	1.96	7. Hobbies	(1.40)	(1.56)	(1.71)
Painting & drawing supplies.	1.73	1.68	1.91	Model building, cabinet making, etc.	1.82	1.97	2.00
Stamp & coin collecting equipment.	1.07	1.27	1.22	Painting, drawing, sculpting, photo- graphy	1.36	1.68	1.79

Section II: Present Leisure Time Activities

	ARPS Mean	TAC Mean	MMC Mean		ARPS Mean	TAC Mean	MMC Mean
1. Self Improvement	(3.72)	(2.72)	(2.14)	Playing musical instruments, singing	1.36	1.43	1.84
Studying or course work.	3.89	2.49	2.42	Stamp collecting, coin collecting	1.07	1.16	1.21
Job related activities.	3.56	2.96	1.86	8. Games	(1.38)	(1.47)	(1.55)
2. Passive Entertainment.	(2.82)	(2.99)	(2.75)	Card games	1.55	1.65	1.70
Reading	3.34	3.32	3.21	Board games	1.34	1.46	1.60
Listening to radios, records, tapes.	2.73	2.81	2.64	Gambling games	1.27	1.32	1.37
Watching TV, movies, plays.	2.41	2.84	2.42				
3. Active Recreation	(2.92)	(2.79)	(2.62)				
Family activi- ties (picnics, drives, etc.)	2.89	2.81	3.00				
Physical exercises.	3.02	2.81	2.56				
Playing sports	2.86	2.77	2.30				
4. Religious Activi- ties.	(1.84)	(1.92)	(2.26)				

Section III: Content Preferences

	ARPS Mean	TAC Mean	MMC Mean
A. Reading Matter			
1. Current affairs, newspapers, news magazines	4.02	4.04	3.78
2. Historical and biographical	3.76	3.62	3.39
3. General interest comic strips, Playboy, Life, etc.	3.59	3.68	3.49
4. Technical	3.60	3.29	3.58
5. Fiction - western novels, science fiction mysteries	2.20	2.72	2.87

	ARPS Mean	TAC Mean	MMC Mean		ARPS Mean	TAC Mean	MMC Mean
6. Religious	2.75	2.73	2.77	3. Solitary - crossword puzzles, solitaire	2.77	2.96	2.90
B. TV, Radio, Movie Content				4. Non-skill, inactive - Monopoly, Craps, Sorry.	2.69	3.00	2.70
1. Current affairs - news reports, sports events.	4.31	4.34	4.09	5. Party games - Password, Charades	2.59	2.68	2.43
2. Educational - TV classes, travelogues	3.25	3.75	3.82		2.59	2.68	2.43
3. Fiction - comedies, dramas, west- erns, mysteries	3.35	3.56	3.42	Section IV. Preferences for Consummables			
4. Quiz shows and contests	2.18	2.43	1.98	1. Fruits	4.39	4.19	4.13
C. Music				2. Ice cream products	4.27	4.00	4.08
1. Popular	3.98	4.03	3.40	3. Hot drinks (coffee, tea, cocoa)	3.93	3.92	3.96
2. Folk	4.00	3.78	3.43	4. Sandwiches	3.89	3.97	3.79
3. Classical	3.64	3.80	3.66	5. Carbonated beverages	3.61	3.67	3.79
4. Jazz	3.39	3.73	3.34	6. Crackers, cookies	3.80	3.30	3.64
5. Electronic	2.36	2.42	2.32	7. Alcoholic beverages	3.55	3.73	3.19
D. Sports & Exercises				8. Candies	3.18	2.78	3.34
1. Team sports - football, basketball, icehockey, baseball.	3.70	3.74	3.66	9. Chewing gum	2.95	2.95	3.13
2. Competitive skill sports, handball, auto racing, golf.	3.66	3.59	3.29	10. Tobacco	2.25	2.86	2.57
3. Physical fitness - swimming, jogging, calisthenics.	3.44	3.47	3.43	The rating scale data in each of the questionnaire sections were subjected to separate analyses of variance. The major statistical results were as follows. In each of the eight analyses (section I, II, the five subsections of section III, and section IV), significant effects were obtained for the Items main effect ($p < .01$). In addition, using the usual F test procedure, significant interactions between Groups and Items were obtained in all of the analyses except the Music and the Games/Puzzle subsections of section III. However, with the exception of the section II analysis, the F ratios for these significant interactions were quite small and do not attain significance if a conservative test such as the Greenhouse and Geisser procedure as described by Weiner (1962) is used. The interaction between Groups and Items in the section II analysis is significant beyond the .01 level under the most conservative F test procedure. Analysis of the simple effects of groups at individual items revealed that the groups differed significantly on five items. The significant differences between populations on each of these five items are shown in Table 2.			
E. Games and Puzzles							
1. Competitive, active - pool, darts, ping- pong.	3.69	3.56	3.62				
2. Competitive, sedentary - chess, scrabble, bridge, checkers, poker.	3.25	3.33	3.34				

Table 2

Newman-Kuels Significant Differences Between Population Samples in Leisure Time Activities.

Item	Significant Differences	Significance Level
Watching TV, movies, plays.	TAC > ARPS, MMC	.05
Studying or course work.	ARPS > TAC, MMC	.01
Job related activities.	ARPS > TAC > MMC	.01
Playing sports	ARPS, TAC > MMC	.01
Playing musical instruments, singing.	MMC > ARPS, TAC	.05

The major conclusion to be drawn from the questionnaire data is that populations which may reasonably be expected to provide future spacerev candidates are in essential agreement concerning leisure time preferences. The populations spend the greatest amount of leisure time in self-improvement, active recreation, and passive entertainment activities and the least amount of time in games and hobbies. Correspondingly, active recreational and passive entertainment equipment were most preferred and games and hobbies least preferred as leisure time equipment for a space journey. The implication of this correspondence is that, given the opportunity, the populations would engage in essentially the same leisure time activities onboard a spacecraft as they do on Earth.

It must be pointed out that questionnaire data obtained in the present study is somewhat limited, and should be used only to establish general guidelines for the development of off-duty concepts. The selection of specific off-duty concepts for space missions will require additional research. The problems involved in providing alcoholic beverages and tobacco should be investigated in addition to the obvious problems involving sexual restrictions and food acceptability. Other major problems involve the effects of the physical restriction and social isolation imposed by the spacecraft environment. Questions of particular relevance to the problem of space mission off-duty time include: the correspondence between stated preferences and participation during confinement; possible changes in preferences during prolonged confinement; and the effects of competitive games on crew compatibility.

OFF-DUTY CONCEPTS

The data obtained from the leisure time questionnaire and additional information obtained by review of the available literature have been used to

establish seven guidelines in the development of off-duty concepts for space missions. These are as follows:

1. It should be possible for any crew member to select spontaneously how he wishes to occupy his leisure time.
2. Off duty activities should not be directly related to mission tasks.
3. Ample exercise opportunities should be offered.
4. Means of venting emotional tensions in a non-disruptive manner should be provided.
5. Earth orientation, in terms of keeping up with "what's going on" earthside, shall be maintained insofar as possible; opportunities encouraging maintenance of normal social roles should be provided (e.g., "father", "husband").
6. Opportunities for crewmen to dine and relax together should be maximized.
7. Allowance should be made for changes in crew preferences with time.

The following discussions delineate candidate off-duty concepts which might be appropriate for a long duration earth orbital laboratory space mission and identifies some of the engineering constraints applicable to the concepts.

Passive Entertainment

The questionnaire data indicated that gross differences existed for topical items in the area of passive entertainment. The highest preference was shown for items related to current affairs; the important implication is that audio-visual equipment for the maintenance of Earth contact, other than mission oriented communication, should be provided during off-duty time.

Radio and stereotapes could be provided. Radio reception should be real-time, patched in to the ground control voice communications system. Daily news, weather and sports broadcasts would be of considerable help in keeping activities "earth oriented". It is intended that broadcasts be available on an "as desired" basis. A tape player should also be provided. The significant problem with tape is the requirement to furnish enough variety of taped programming to assure as little repetition as possible. Commercially available tapes can be obtained with a 7-inch diameter reel on 1/2 mil Mylar at 1-1/4 lb. per reel. Four stereo channels (4 pairs, two per side) provide a total playing time per reel of 4 hours. Eight reels would provide playing time of 32 consecutive hours, and would approximate 640 selections. The selection of a generous supply of tapes should be directed by the crew. Blank tapes, beyond those required for voice logs, could be

included and used as desired. Earphones should be available for use with both the radio and tape systems.

The requirement for a generous supply of reading material has been established. To minimize weight and volume, a Personal Reading Display Device (micro film type viewer) should be developed and supplied to each crewman. A conceptualization of such a viewer is presented in Figure 1. Allowing adequate lead time, the flight crew could choose the reading material they wish processed and included. Also, photo-reduced schematics and similar specifications of any spacecraft hardware could be included.

There has been considerable interest expressed in the availability of viewports; this has been apparent in debriefings of past space missions and on the questionnaire. It would be beneficial to plan inclusion of one or more viewports in the crew quarters of the space vehicle. A telescope, adjustable from 60X to 240X should be available for earth viewing with mounting provisions by the port. Additionally, extra film could be provided for personal use with the mission cameras.

The provision of on-board movies has been considered but with present state of the art technology, does not appear feasible. The film quantity required and the projecting equipment would be prohibitive from a weight/volume standpoint. Similarly, television though desirable as off duty activity, has been evaluated and found to be impractical for the following reasons:

- a. Television transmission exposure in a pass over the U.S. is limited to 8-10 minutes. To complete a program, condensed transmission would be required. This would require three additional pieces of airborne equipment (Receiver-discriminator, tape device and display device) which have not been flight certified and would involve additional weight of approximately 25 to 30 lb. The volume would be about 2.0 cu. ft.
- b. S-band capability at the present time cannot be adapted to commercial TV band requirements. The best that could be achieved is 300 line reception (commercial TV is rated at 530 lines). The quality of reception utilizing existing RF systems is not equivalent to the type of TV that would be desirable for leisure watching.
- c. Pre-recorded video tape was considered but rejected. Picture reproduction of commercial quality requires a 6 ft./sec. playback; the weight and volume required is excessive.
- d. Power requirements for TV video tape recording and playback would approximate 40 to 60 watts for the tape operation, 20 watts for display and 1 to 2 watts for receiver.

The need for private conversation between the crewmen and family during extended space missions establishes the desirability for a "scrambler" system (or the equivalent). One scrambler/unscrambler unit could be integrated into the vehicle voice transmission link; the ground units (the second scrambler/unscrambler) could be located at remote terminals (home phone) as desired. The scrambled signal could be patched to the ground units by mission control. Activation and use of the scrambler system should be limited only by normal mission communications and task requirements. It is expected that this system could adequately fill the need for maintenance of normal social roles. A scrambler and unscrambler integrated into a vehicle voice transmission link would require about 1 watt and weigh about 1 lb. in a package approximately 4 by 4 by 4 in.

Active Recreation

The questionnaire data indicated that the potential spacecrew populations were in essential agreement in terms of preferences for active recreational activities; high preference was indicated for all three categories: team sports, competitive skill sports, and physical fitness activities. Devices which offer some entertainment as well as physical exercise would be the most desirable equipment for active recreational activities. However, devices which provide the opportunity for hard physical exercise may also prove to be desirable for two reasons: (1) they may be necessary to counteract possible cardiovascular and musculo-skeletal conditioning associated with the zero gravity environment; (2) they provide a means for adaptive outlet of emotional tension. Two such devices are the exercycle (a bicycle ergometer) and a "multiple exercise device" for isotonic and isometric exercise of major muscle systems. A typical multiple exercise device is shown in Figure 2.

Devices which provide entertainment as well as exercise include a "space trampoline" as illustrated in Figure 3. The "space trampoline", however, has the serious drawback of causing perturbations in the spacecraft. Also, the weight and volume problems tend to limit the usefulness of this concept. Active recreational concepts that appear to be more feasible include "space ping pong" or similar ball and paddle sports as illustrated in Figure 4. The system shown has the advantage of imposing minimal weight and volume penalties; tether ball as illustrated in Figure 5 has the same advantage.

Games

Preferences for games and puzzles would appear to have little meaning in mission planning or spacecraft provisioning since the questionnaire data indicated that potential spacecrew candidates would make little use of games and puzzles on space missions (section I) and that they spend little of their present leisure time in such activities (section II). Nevertheless, the confining environment of a spacecraft could effect changes in

preferences especially over very long duration missions.

In terms of preferences in the areas of games and puzzles, it is evident from analysis of the questionnaire data that preference increased as a function of the degree of skill required to play the game. For example, high preference was shown for both active competitive games such as pool, darts, and ping-pong and for sedentary competitive games such as chess, bridge, and poker. Variations of both types of games could be adapted to a zero gravity environment, and active competitive games would also provide a certain amount of physical exercise as well as entertainment. An illustration of a zero-g dart game is shown in Figure 6. However, the area of competitive games, both active and sedentary, will require special consideration in future studies since such activities may disrupt crew compatibility. It is quite possible that competition between crew members in games of skill may lead to interpersonal conflicts. On the other hand, having crew members compete individually or collectively against an "outside entity", such as a machine, computer, or someone at a ground station, may prove to be acceptable and even desirable.

The development of educational (pedagogical) games has been given consideration. The Educational Development Center at the Massachusetts Institute of Technology has suggested a kit containing such common items as a rope, a gyro, magnet, balls, etc., for simple experiments and demonstrations in the unique zero gravity environment. A manual could be included suggesting experiments and demonstrations which could augment the crewman's own ingenuity.

Meals and Snacks

Certain studies e.g., Doll and Gunderson (1969) have shown that a major leisure time activity in remote duty areas is dining and conversing at length over and after meals. Therefore, meals, particularly the evening meal, on long duration space missions should be planned accordingly; there should be ample time allotted for the crewmen to relax and talk together.

It is interesting to note from analysis of the questionnaire data that the three potential space-crew populations were in rather close agreement concerning their preference for types of consumables. High preference values were obtained for fruits, ice cream products, hot drinks, sandwiches, carbonated beverages, crackers and cookies, and alcoholic beverages. Tobacco had the lowest mean preference value in all three groups; however, it also had the largest variance. A review of the individual response protocols indicated that preference for tobacco was polarized in each group. For example, in the ARPS sample, only 2 of the 44 responses were neutral (rating values of 1 or 5); in the TAC sample, there were 2 neutral and 17 extreme responses; and in the MMC sample, there were 6 neutral responses and 35 extreme responses.

Preference for alcoholic beverages was also polarized in each group but to a lesser extent than was preference for tobacco. For example, there were only 10 neutral responses for alcoholic beverages in the ARPS sample, 4 in the TAC sample, and 8 in the MMC sample. These data indicate that individuals in the three populations, on the whole, either very much like or very much dislike these two types of consumables. The problems involved in providing either type of consumable on a space mission should be investigated.

ACKNOWLEDGEMENTS

This research was supported in part by Contract NASS-24000, Amendment MSC-6S. The authors are especially indebted to Col. H. W. Cristian, Jr. of the Aerospace Research Pilot School, Edwards Air Force Base, California and Lt. Col. Henry Shudinis at McConnell Air Force Base, Wichita, Kansas for their cooperation in the data collection.

REFERENCES

- (1) Doll, R.E. and Gunderson, E.K.E., Hobby Interest and Leisure Time Activity Behavior Among Station Members in Antarctica, Report No. 69-34, Naval Medical Neuropsychiatric Research Unit, San Diego, California, 92152.
- (2) Eddowes, E.E., Survey of Leisure Time Activity: Implications For the Design of a Space Vehicle, Aerospace Medicine, 1961, June, 541-544.
- (3) Fraser, T.M., Leisure and Recreation in Long Duration Space Missions, Human Factors, 1968, 10(5), 483-488.
- (4) Winer, B.J., Statistical Principles in Experimental Design. New York: McGraw Hill, 1962.



Barnstein



FIGURE 1...
PERSONAL READING
DISPLAY DEVICE

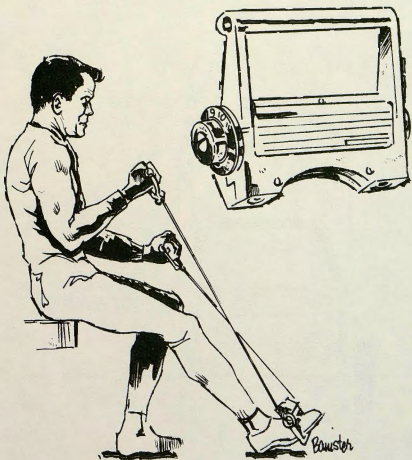


FIGURE 2... MULTIPLE EXERCISE DEVICE

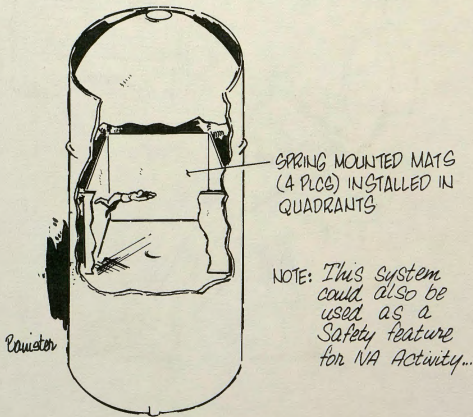


FIGURE 3... SPACE TRAMPOLINE

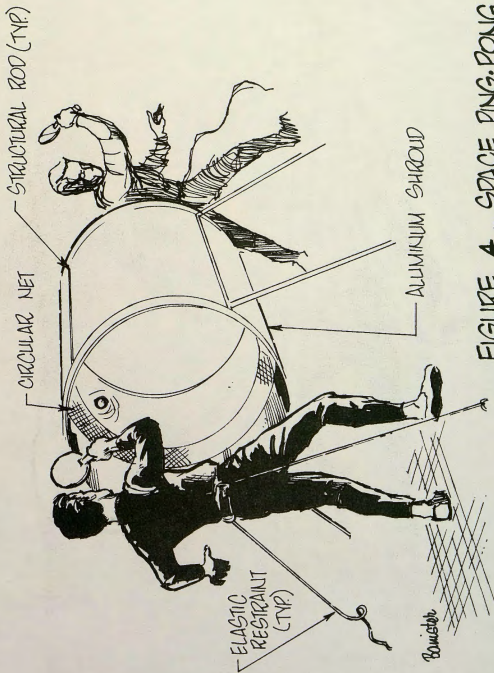


FIGURE 4 ... SPACE PING-PONG



ELASTIC
RESTRAINT
(TYP.)

FIGURE 5 ... SPACE TETHER BALL

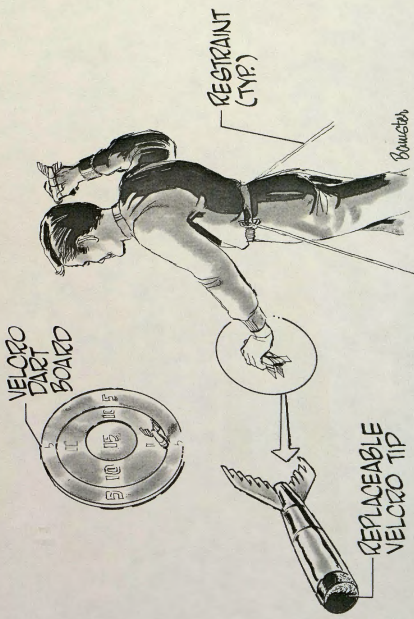


FIGURE G... SPACE DARTS

