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A SYSTEM FOR ANALYSIS AND CLASSIFICATION OF VOICE COMMUNICATIONS

THE PLANAR CORPORATION

A SYSTEM FOR ANALYSIS AND CLASSIFICATION OF VOICE COMMUNICATIONS

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SUMMARY

The purpose of this study was to develop a method for analysis and classification of verbal communications typically associated with manned space missions or simulations. The study was carried out in two phases. Phase I was devoted to identification of crew tasks and activities which require voice communication for accomplishment or reporting. Phase II entailed development of a message classification system and a preliminary test of its feasibility. The classification system permits voice communications to be analyzed to three progressively more specific levels of detail and to be described in terms of message content, purpose, and the participants in the information exchange. A coding technique was devised to allow messages to be recorded by an eight-digit number. This report describes the methodology employed in the study, provides a discussion of results, and presents conclusions and recommendations for further research.

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CHAPTER 1

INTRODUCTION

Extended Manned Space Missions

Within recent years the National Aeronautics and Space Administration has undertaken several research projects concerned with human capability to live and work in a closed environment for extended periods. Much of this research has been devoted to developing the technology to sustain human life and to provide a closed ecology in a space cabin. However, the problem is not wholly one of technology and system hardware. There is the parallel concern of man's ability not just to survive but to live and work productively in such an isolated and self-contained world.

A major test of an integrated long-term life support system took place in 1968 when NASA conducted a 60-day ground test which demonstrated for the first time that potable water could be recovered from urine and that man could consume this water without detriment to his health. The test also demonstrated that the occupants of this closed system could successfully perform maintenance of the life support equipment, thus indicating that doubly and triply redundant backup systems might not be necessary (Jones,1970).

In 1970 a 90-day manned test of a regenerative life support system in a space station simulator was carried out by McDonnell Douglas Astronautics Company, under the sponsorship of NASA Langley Research Center. Four crewmen lived in a completely closed system which regenerated and purified the cabin atmosphere and recovered potable water from urine and wash water. This test demonstrated that the technology to sustain life in a closed ecology almost indefinitely is available or can be attained by the 1980-1985 time period (NASA, 1970).

As a parallel to these efforts NASA is proceeding with development and testing of the Skylab system, in which men will inhabit an orbiting space station for extended periods. A major 56-day ground test of Skylab was conducted in the summer of 1972 and the first flight test is scheduled for mid-1973.

As indicated earlier, technology development is only one aspect of the problem. The medical and physiological factors associated with long-term inhabitation of a closed ecology are being carefully examined. Man's social and psychological needs and creature comforts in extended confinement are also under scrutiny. It has been established that man can live and work in a simulated space station for periods of several months and perhaps longer, but there is still some question as to his capacity to perform useful work in a completely closed environment month after month. There may be subtle performance degradations which will occur over time and affect the success of the mission. It could be that the limiting factor in space explorations is not technology but man himself. Since the purpose of all space missions is not just to put man into space and sustain him there until his return but to have him accomplish some useful activity while he is there, it becomes crucially important to know how man's performance capability is affected by confinement of long duration.

Problems of Space Crew Performance Measurement

The foregoing suggests that one of the central problems of long-term manned space missions is the measurement of the crew's capacity for effective work. This entails determination of workload in relation to capacity, assessment of energy reserves, and--most important--prediction of circumstances where additional workload could result in performance degradation or jeopardy to crew safety and mission success. Unfortunately, neither workload nor its inverse, the capacity to perform work, are easily measurable. In part, this stems from a lack of universally acceptable definitions of what constitutes "work" and what is meant by the "capacity" to perform work (Grandjean, 1968). But, even if the question of definitions were set aside, there would remain the practical methodological problem of how to measure an individual's internal state which consists of a complex and subtle interaction of physiological and psychological variables.

Faced with such a task, research in the field of ergonomics has generally followed either of two approaches, both involving proximate or secondary measures. In one approach, the focus is not on the work process itself but on the outcome of the process. This is reasonably effective in circumstances where there is an objectively measurable product, whose quantity or quality can be assessed and used as the basis for inference about the "work" required to achieve the output. The general assumption in this approach is that the greater or better output indicates a greater workload or higher level of individual effort. The alternative approach is to focus attention on the working organism itself and to measure some difference in physical state before and after an activity (e.g., fatigue by-products in the blood, perceptual-motor reaction time, ability to perform mental arithmetic). The change of state of the individual is assumed to be an index of the amount of "work" required to perform a given activity.

In an earlier study, the authors summarized this basic problem of human performance research as follows:

> "Workload can be defined and quantified either in terms of a product or a change of state in the working organism . . . . Because only indirect access to the process is usually possible, problems of causal relationships and interaction effects frequently arise in the interpretation of experimental results. As the work considered becomes more complex, as the process tends to have . . . fewer tangible results, and as the interplay of environmental and situational effects grow more subtle, the problems of measuring workload take on increasing difficulty (Jenney, et al., 1972).

These observations are especially pertinent to crew performance measurement in real or simulated space missions. Space vehicle crews are exceptionally well trained. Routine procedures and emergency or contingency actions are practiced to the point where errors and performance decrements due to lack of proficiency almost never occur. This, coupled with the unusually strong motivation of space crews, means that performance levels tend to be high and to remain stable throughout the mission. Furthermore, careful planning and scheduling of crew activities assures that whatever work the crew does is usually well within normal human performance capabilities. Safety requirements, even in simulated missions, preclude deliberately overloading the crew or creating artificial stress to induce errors in performance.

Even the nature of the work performed by space crews militates against conventional performance measures. The activity is usually of a highly cognitive nature (decisions, interpretations, and inferences), making it difficult to apply meaningful quantitative or qualitative measures of output. The amount of purely physical (i.e., muscular) effort required of the crew is rather low, which means that measures of energy expenditure are seldom discriminating enough to detect differences in the workload imposed by different tasks. Also, in the actual space mission, the abnormal gravitational and environmental effects tend to mask or confound the effects attributable to the task itself.

An even more fundamental problem of performance measurement lies in the dual nature of man. At any given moment the individual's performance (or, by extension, his capacity for further work) is the product of his physiological and his psychological state. While the monitoring of bodily processes has attained a high degree of sophistication and sensitivity, the assessment of psychological state is still in a rather primitive state. Thus, it is difficult to obtain a balanced picture of the two factors which influence performance capability. In space missions the problem is further complicated by the observer's remoteness and isolation from the crewmen. Telemetry of physiological data has become routine through the Mercury, Apollo, and Gemini programs, but no equally satisfactory method has been developed for telemetering psychological data.

A part of the difficulty lies in the difference between physiological and psychological monitoring. Physiological processes can be measured without interfering with ongoing crew activities and operational responsibilities. Moreover, the individual's awareness that physiological measures are being taken on him does not have an appreciable influence on his bodily processes. That is, physiological measures of the sort appropriate for monitoring space crew activity and physical state tend to be noninterfering and nonobtrusive. The same cannot be said for psychological measures.

Psychologists are seldom subtle in their efforts to assess human subjects. Psychological testing requires the subject's cooperation and attention, usually to the exclusion of any other activity. In a space mission this inevitably creates operational as well as methodological problems. On one hand, the psychological assessment adds to the scheduled workload, thus generating frustration, antagonism, and a decrement in performance on essential operational tasks. On the other hand, by the very act of using measures which preclude the subject from carrying out operational tasks, the psychologist defeats his purpose. He is measuring the individual's psychological state not while engaged in operational activity but while engaged in an essentially irrelevant testing activity.

Even where psychological testing does not interfere with ongoing operational activities, it is usually intrusive. Psychological measurement alters what is being measured because the subject knows he is being evaluated and probably modifies his thoughts, feelings, and behavior in light of this knowledge. Intrusive measurements are subject to biases such as social desirability, response sets, and evaluation apprehension. In effect, the subject tries (either consciously or subconsciously) to create false instrument readings. He gives answers which he thinks the psychologist wants to hear rather than what he inwardly feels to be true (Collins, et al., 1970).

A final consideration in applying psychological measurement techniques in space missions is the matter of crew acceptance. Most of the work carried out by the crew is important and its relevance to mission success is clear. Special tasks and testing routines which seem to the crew to be trivial, artificial, or irrelevant are not well received and motivation to perform well on them is low. This becomes particularly troublesome over extended periods of time when crews are asked to complete the same task on a repetitive, routine basis. Consequently, the most acceptable forms of testing will be those which are based on activities and operations identical or highly similar to the regular ongoing work which the crew performs in carrying out the mission.

An ideal psychological measure for assessing space crew performance capability would be one which satisfied the following criteria:

1. <u>Task relevance</u>. It should measure in the domain which is most critical to successful task performance (e.g., cognition, psycho-motor activity or sensory-perceptual ability).

2. Sensitivity. It should be sensitive to subtle differences among highly trained and motivated individuals.

3. Realism. The activity required of the subject during testing should be related to mission tasks or should be a direct outgrowth of mission tasks.

4. Nonobtrusiveness. The subject should have minimal awareness that his activity is being observed and measured.

5. Noninterference. Performance of the test activity should not interfere with operational tasks, conflict with operational requirements, or impose an additional task load.

6. Acceptability. The test activity should be recognized by the subject as a relevant and important part of the overall schedule of tasks.

7. Practicality. The measurement technique and apparatus should impose minimal weight and volume penalties in the space vehicle and should lend themselves to telemetry.

None of the psychological performance measurement techniques now available fully satisfies all of these criteria. However, there is one which, although it has been only partially explored, offers substantial promise as a solution to space crew performance assessment. This is a technique based on analysis of the verbal communications among crew members and between the crew and ground control personnel.

The advantages of performance measures based on voice communications are manifold. Voice communications form a natural and integral part of the mission itself. The voice messages are related to operational tasks and often form a part of the tasks themselves, thus imposing no workload on the crew over and above that required by operational duties. Since the voice communications commonly deal with the tasks in progress, there is good reason to suppose that voice messages could serve as an index of task difficulty and workload. Normally, voice communication would not be expected to interfere with task performance. Analysis of voice communications would not be obtrusive since it would require no special response by crewmen and, in fact, no response at all beyond that normally expected in carrying out operational tasks. For these same reasons, it could be expected that crew acceptance would be high. Finally, of course, performance measurement through voice communication analysis would be eminently practical. No special test apparatus would be required within the space vehicle, and all analysis and interpretation could be accomplished on the ground either as the messages are received or later at a time of convenience.

Study Objectives

The general hypothesis upon which this study was founded is that verbal communications could serve as an index of performance level or workload. This assertion is based both upon a logical analysis of the problems of human performance measurement and upon examination of earlier research efforts which have suggested the use of voice communication analysis as a measure of operator workload (Parkins, 1969; Busch, 1970; Jenney, et al., 1972; and Ratner, et al., 1972).

The keeping of voice records of mission activities and the examination of such records to analyze and interpret events is, of course, a common investigative procedure which has been used for many years. However, this use of voice records is not communications analysis in the strict sense since it does not employ a well defined system for classification of voice communications and since the voice record is not used as an index of operator workload as such. The essential proposition advanced in this study is that voice communications contain within themselves a reflection of the workload imposed upon the individual at the time and that proper analysis and classification of voice communications can yield a measure of this workload.

The full proof and demonstration of this proposition is beyond the scope of this study, which was conceived as only the first step toward developing a set of measures of crew status and performance capability. The immediate goals of this study were:

1. To identify, from all the tasks and activities typically performed by crews in actual or simulated extended missions, those which require communication for task accomplishment or reporting;

2. To determine the form and content of representative messages related to these tasks;

3. To develop a classification system to permit communications to be analyzed and assigned to categories relevant to the tasks or activities being performed.

Thus, this undertaking was aimed at laying the groundwork of a communications taxonomy upon which to build later a set of crew status and performance measures. Subsequent steps to reach the long-range goal would involve isolation of communications variables, establishing empirically the correlations between communications and performance variables in controlled test situations, development of laws relating communications to workload and capacity, and finally validation of these laws in operational circumstances.

CHAPTER 2

RESEARCH METHOD

This study was carried out in two phases. Phase I was devoted to identification of typical crew tasks and activities requiring verbal communication. Phase II involved analysis of samples of verbal communications obtained during manned system tests and development of a communications classification system, including a test of the feasibility of the classification technique.

Phase I

At the beginning of the project an extensive review was made of the technical reports dealing with the 90-day manned test of a regenerative life support system in a space station simulator (NASA, 1970; United Aircraft, 1970; and McDonnell Douglas, 1971). This test was conducted from June to September 1970 by McDonnell Douglas Astronautics Company (MDAC) under contract to the NASA Langley Research Center. The 90-day test was selected for two reasons. First, it represented a rather full and realistic simulation of the range of performance which would be required of the crew in an extended space mission. Second, the detailed planning which preceded this test and the results of the various biomedical and psychological experiments conducted during the 90-day confinement were extensively documented, thereby offering an ample record of crew performance.

Particular attention was given to reports dealing with crew schedules, test and experimental procedures, training syllabi, and crew event descriptions. From this material, a comprehensive task list was compiled and then cross-checked against the computerized manned mission activity analysis and mission events profile prepared by MDAC as part of the test documentation. The objective of this analysis was to develop an account of how the crewmen spent their time and, further, to make a preliminary identification of those activities or tasks which were likely to require verbal exchanges among the crew or with outside test directors and monitors.

The major areas of activity identified through this analysis included:

1. Operation and monitoring of atmospheric regeneration equipment.

2. Operation and monitoring of water regeneration equipment.

3. Mass balance experiments.

4. Maintenance of life support systems.

5. Collection and management of biomedical samples and physical data.

6. Biomedical experiments.

7. Collection and management of psychological data on confinement, habitability, and human performance in a closed environment.

8. Housekeeping and personal hygiene.

The analysis of crew schedules and mission event profiles thus provided a catalog of tasks which served to define the universe of activity to be considered in developing a communications classification system. While the catalog was reasonably complete, in that it included all of the crew activities pertinent to the 90-day test situation, there remained some question as to the applicability of such task list to other manned space systems. Therefore, the task list was re-examined and task descriptions were rephrased to make them more general. In addition, documents relating to other system simulations and to the design of manned space systems were reviewed to identify other types of activity which, although not part of the 90-day test, could be considered representative of crew tasks in manned space systems.

The result was a task/activity listing of a more general character and with a reduced number of categories. Thus, where the original task/activity list consisted of some 91 items in 12 categories, all specific to the 90-day MDAC/LRC test, the revised list was consolidated into 7 categories containing from 2 to 9 items each and totaling 43 items. This list of crew tasks and activities is presented in Chapter 3.

As a final step in Phase I, the task/activity list derived through document analysis was compared with recordings of verbal communications made during the conduct of the 90-day test. With the assistance of NASA Manned Spacecraft Center, arrangements were made with MDAC to obtain several hours of voice communications recorded on tape while the 90-day test was in progress.* See Table 1 for a description of the voice tapes.

A review was made of these voice exchanges, and on the basis of internal evidence,an attempt was made to assign each to one or more of the categories of the task/activity list. In essence, this was a preliminary test to see whether the task/activity list could, in fact, account for all of the verbal communications of the crew and test directors and monitors.

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*The assistance of Dr. William E. Feddersen of NASA MSC and Dr. George Murphy and Mr. Edward R. Regis of MDAC in making these voice recordings available is gratefully acknowledged.

TABLE 1

DESCRIPTION OF VOICE TAPES FROM 90-DAY TEST

Tape Number	Duration	Minutes of Voice	Estimated Time of Recording
1	1 hr.	29 min.	Day 1-2
2	1 hr.	12 min.	Day 1-2
3	2 hr.	27 min.	Day 1-2
4	1 hr.	16 min.	Day 1-2
5	2 hr.	36 min.	Day 40-50
6	2 hr.	47 min.	Day 40-50
7	2 hr.	48 min.	Day 60-80
8	2 hr.	40 min.	Day 60-80

Some problems were encountered in analyzing the voice recordings. Because of the placement of microphones in the chamber and the masking noise of equipment, communications among crewmen were virtually unintelligible. Fortunately, the audio quality of the voice recordings of communications between the crew and test personnel outside the chamber was excellent and provided an ample sample of material for analysis. MDAC was not able to specify the exact dates and times when recordings were made during the test, nor could MDAC assure that the sample was representative of the entire spectrum of crew activities and voice communications. Thus, there is the possibility that the sample of messages was biased in some way.* As a result, the voice tapes could not be used to validate fully the accuracy and completeness of the task/activity list. However, insofar as the exchanges between the crew and test personnel in these eight brief

*From internal evidence it appeared that four of the eight tape recordings were made about 24 hours after the start of the test. Two others were apparently made about midway in the 90-day period, and the remaining two were probably made sometime within the final 30 days of the test.

time periods might be considered representative of all voice communications during the 90-day test, it was possible to ascertain that all voice messages were classifiable in terms of the task/activity list and that there were no significant omissions from the list.

Thus, Phase I was devoted to attaining the first of the three study objectives, viz. to identify tasks and activities which require voice communication. Figure 1 is a summary of Phase I activities in schematic form, showing the work steps and the specific study products.

Phase II

The first step in Phase II was to develop a paradigm for analysis and classification of voice communications. This paradigm was to serve two purposes. First, it was to provide a means for structuring the voice communications and for dividing the material into basic units for classification. Second, the paradigm was to provide the dimensions for the classification process itself.

The analysis and classification method employed in this study was derived from the system developed at the FAA National Aviation Facilities Experimentation Center (NAFEC) by Busch and his colleagues (Parkins, 1969; and Busch, 1970). Over a period of several years NAFEC personnel have perfected a technique for analyzing voice communications between pilots and air traffic controllers. In addition to providing a reliable and replicable scheme for classification of voice messages, the NAFEC method has been systematized to the point where it can be employed by relatively untrained personnel. In adapting the NAFEC method for the purposes of this study the intent was to develop an equally simple and reliable classification scheme which would be suitable for analysis of voice communications associated with manned space systems.

As an extension of the analysis and classification paradigm, a system was devised for coding the classification in digital form. Because of the enormous volume of verbal communications which typically result from even short space flights or simulation exercises, analysis by paper and pencil techniques is seldom practical. Employing a digital classification system thus offers machine compatibility and its attendant advantages of speed and versatility in carrying out subsequent analyses and trade-off studies.

As a final exercise in Phase II, the classification system was tested by applying it to a sample of the voice communications recorded during the 90-day manned system simulation conducted by MDAC and NASA. In addition to providing a specific example of the application of the communication classification technique, this exercise helped to iron out some of the practical details of the method and to refine the definitions of the classification categories.

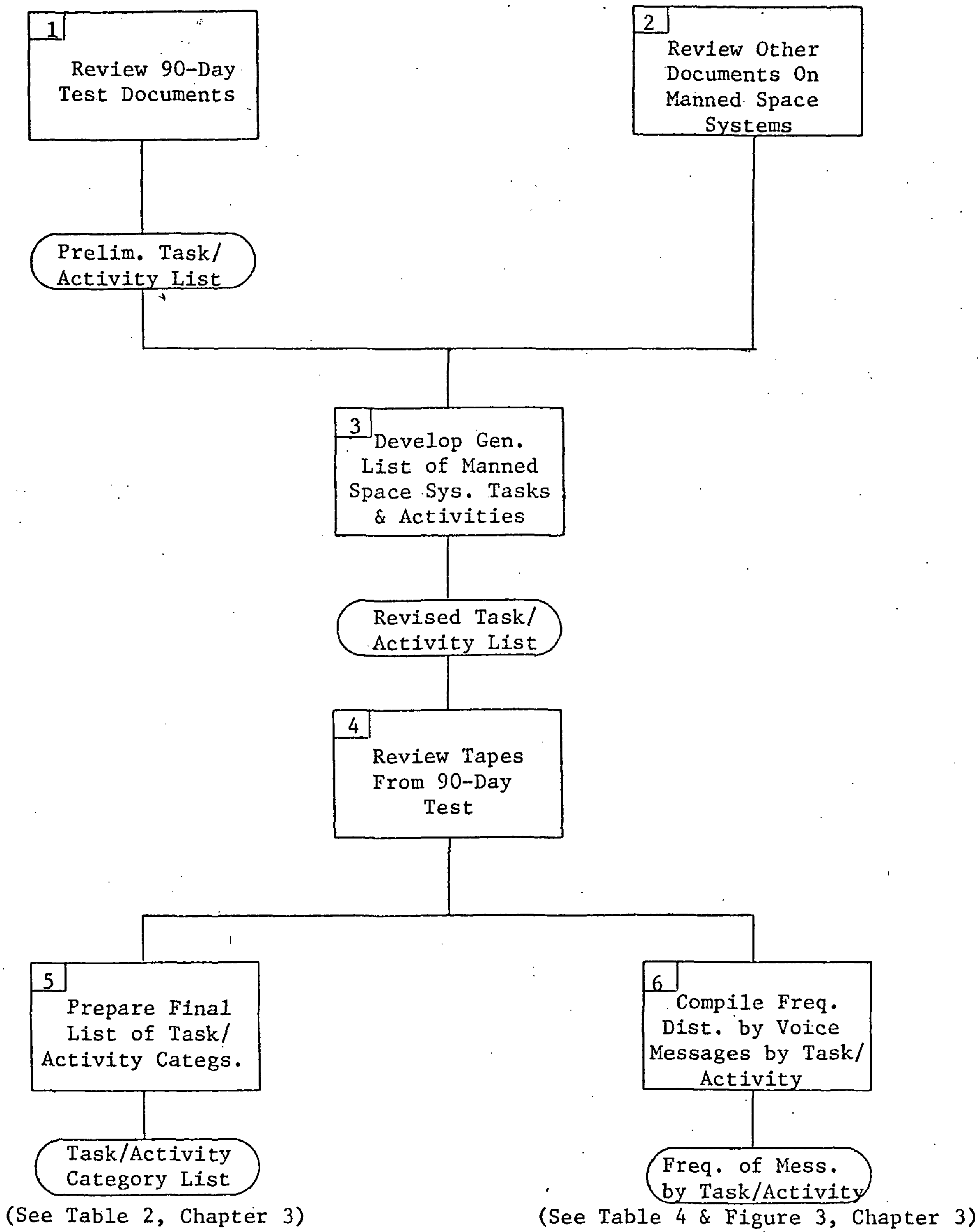

FIGURE 1. SUMMARY OF PHASE I RESEARCH TASKS.

As a further validation of the classification system, it was intended to analyze a second sample of voice communications drawn either from an actual mission or from a simulation of a space system other than that used in the 90-day test. After consultation with NASA MSC, it was determined that certain policy considerations precluded obtaining voice tapes from an actual mission in the Apollo program. Fortunately, a major 56-day manned simulation of the Skylab system had just been completed, and it was felt that voice tapes from this test would provide a suitable alternate means of checking the general applicability and utility of the classification system. The Skylab test had the additional advantage of being a more realistic exercise than the 90-day test in terms of operational tasks, systems performance, and crew composition. Efforts were made through MSC to obtain Skylab voice tapes, but they could not be made available before the deadline for completion of this study.

It was also contemplated to conduct an exploratory exercise using the voice communications classification system in conjunction with a simplified voice print technique. The objective was to investigate possible differences among voice characteristics as a function of message type or message content. Unfortunately, the unavailability of the Skylab material also prevented carrying out this investigation before expiration of the study contract.

Figure 2 on the following page is a summary of the study tasks carried out in Phase II. The results of the Phase II effort are presented in Chapter 3.

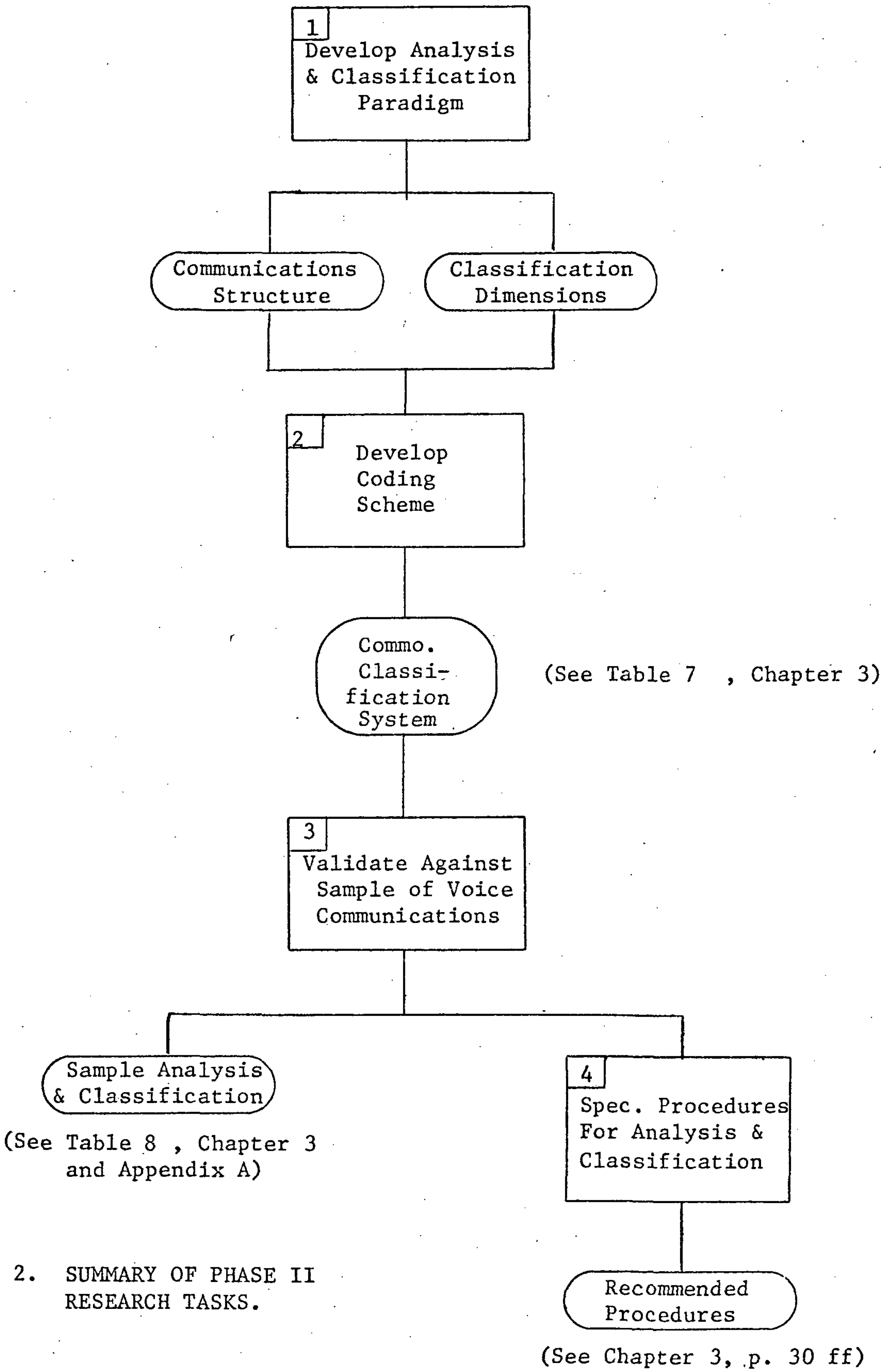

FIGURE 2. SUMMARY OF PHASE II RESEARCH TASKS.

CHAPTER 3

RESULTS

The Phase I and Phase II study efforts resulted in five major end products:

1. Task/activity categories

2. Analysis of message frequency by task/activity category

3. Communications classification system

4. Sample analysis and classification of voice communications

5. Recommended procedures for voice communications analysis.

This chapter contains a discussion of each of these results and an interpretation of the findings.

Task/Activity Analysis

Crew activities in manned space missions can be grouped under seven major categories, as follows:

1. Life support

2. Equipment monitoring

3. Crew monitoring

4. Equipment operation and maintenance

5. Crew sustenance

6. Crew protection

7. Management and logistics.

Within each activity category there are specific items which represent related clusters of crew tasks. A complete listing of the activity categories and their component task clusters is presented in Table 2.

With the exception of the categories dealing with equipment monitoring and equipment operation and maintenance, the list can be considered generic to all manned space systems. This is not to say that all manned space

TABLE 2

CREW TASK/ACTIVITY CATEGORIES

LIFE SUPPORT

- o Atmospheric Supply & Composition
- o Temperature/Humidity
- o Atmospheric Pressure
- o Contaminants
- o CO_2 Removal
- o Water Management
- o Waste Management

EQUIPMENT MONITORING

- o Atmospheric Supply & Control
- o Water Supply & Control
- o Waste Disposal & Management
- o Food Preparation & Storage
- o Housekeeping
- o Biomedical & HF Experimental Equipment
- o Communications
- o Emergency & Safety Equipment
- o Other

CREW MONITORING

- o Biomedical/Physiological
- o Psychological/Behavioral

EQUIPMENT OPERATION & MAINTENANCE

- o Atmospheric Supply & Control
- o Water Supply & Control
- o Waste Disposal & Management
- o Food Preparation & Storage
- o Housekeeping
- o Biomedical & HF Experimental Equipment
- o Communications
- o Emergency & Safety Equipment
- o Other

CREW SUSTENANCE

- o Sleep
- o Eating and Food Preparation
- o Hygiene
- o Exercise
- o Recreation
- o Housekeeping

CREW PROTECTION

- o Radiation
- o Magnetics
- o Electrostatics
- o Sonics
- o Safety Precautions/Checks
- o Illumination

MANAGEMENT & LOGISTICS

- o Supplies
- o Plans
- o Schedules
- o Personnel and Assignments

systems necessarily involve all of the crew tasks specified in Table 2. Obviously, mission requirements and crew tasks will differ from system to system, with the result that some of the items listed here may be omitted in some cases. However, there is no major area of space crew activity which is not included in the list, and it may be assumed that crew task requirements for any given system will constitute a subset of the tasks itemized in Table 2.

The categories of equipment monitoring and equipment operation and maintenance, as noted above, are not intended to be strictly generic. Each system consists of a more or less unique configuration of equipment, and to this extent the crew tasks in monitoring, operating, and maintaining the equipment will also be unique. Therefore, it would not be practical or particularly meaningful to describe equipment-related tasks in a nonspecific way. For system design or trade-off studies the analyst needs to know exactly which items of equipment or which subsystems impose workload on the crew. For this reason the crew task clusters associated with equipment are described in Table 2 according to the specific features of the regenerative life support system used in the 90-day test. To classify crew tasks for a different system it would be necessary to develop a new, system-specific list of equipment categories and task requirements.

For the system used in the 90-day test, nine equipment-specific task areas are listed in Table 2 under the categories of equipment monitoring and equipment operation and maintenance. These task areas were derived from an analysis of system descriptions and crew task schedules published in connection with the 90-day test (NASA, 1970; and McDonnell Douglas, 1971). Table 3 is a detailed itemization of the subsystems and equipment modules associated with each of the nine task clusters.

TABLE 3

SUBSYSTEMS AND EQUIPMENT MODULES OF SPACE STATION SIMULATOR USED IN 90-DAY TEST

ATMOSPHERIC SUPPLY & CONTROL

- Two-Gas Control Unit
- Thermal Control
- Toxin Burner
- Electrolysis Unit
- Sabatier Reactor
- CO_2 Concentrator
- Atmospheric Particle Counter
- Mass Spectrometer

WATER SUPPLY & CONTROL

- Vacuum Distillation/Vapor Filtration (VD/VF) Unit
- Wash Water Recovery Unit
- Air Evaporator Unit (Wick Evaporator)
- Humidity Control
- Multifiltration Unit
- Water Dispenser
- Potable Water Tank
- Isotope Handling
- Backup Water Supply

WASTE DISPOSAL & MANAGEMENT

- Commode
- Urine Collector

FOOD PREPARATION & STORAGE

- Food Storage
- Refrigerator/Freezer
- Microwave Oven
- Electric Oven
- Eating & Cooking Utensils
- Garbage Handling & Disposal

HOUSEKEEPING & PERSONAL HYGIENE

- Laundry
- Cleaning Equipment
- Haircut/Shaving Equipment
- Solid & Liquid Waste Material Disposal
- Dryer

TABLE 3 (Continued)

BIOMEDICAL & HUMAN FACTORS EXPERIMENTAL EQUIPMENT

- Reynier Air Samplers
- Bacterial Samplers
- Medical Monitoring Equipment
- Blood Sampling Equipment
- EEG/Sleep Monitoring Equipment
- Urine Sampling Equipment
- Respired Air Measurement Equipment
- Psycho-Acoustic Measurement Equipment
- LRC Complex Coordinator
- Rater
- Light Measurement Equipment
- Ergometer

COMMUNICATIONS

- Intercom (Internal)
- Intercom (Inside/Outside)
- Telephone (Hotline)
- Closed Circuit TV
- Backup Intercom

EMERGENCY & SAFETY EQUIPMENT

- Air Pack Breathing Equipment
- Pocket Respirators
- Fire Extinguishers
- Emergency Lighting
- Water Spray System & Hoses
- Smoke Detector System
- Trace Gas Monitoring System
- Emergency Repressurization
- Warning Sirens & Bells

OTHER

- Lighting Controls
- Recreation & Entertainment
    - AM/FM Receiver
    - Pico Projector
- Furniture & Storage Facilities
- Tools

Message Frequency by Task/Activity Category

The task/activity list developed in this study was intended to be a complete inventory of the crew performance required in the 90-day manned system test. To check the validity and completeness of the inventory, an analysis was performed on the voice recordings made during the test to see whether each exchange between the crew and test directors could be classified in terms of the task/activity list. In effect, this meant listening to the voice recordings and, on the basis of message content, determining the task or activity being performed.

A total of eight voice tapes, covering approximately 13 hours of crew activity and consisting of 255 minutes of voice material, were available. To analyze this material it was first necessary to define a basic unit of voice communication. This unit, designated a transaction, was defined as the complete and uninterrupted verbal exchange between two individuals (i.e., a crewman and a test monitor outside the chamber).* A new transaction was considered to start each time a crewman addressed, or was addressed by, a test monitor. Thus, if Crewman A spoke with Monitor X and then Monitor Y, this was considered to be two transactions. Similarly, there would be two transactions if Monitor X spoke with Crewman A and then Crewman B. If Crewman A spoke with Monitor X, Monitor Y, and then Monitor X again, this was counted as three transactions because the exchange with Monitor Y intervened between the two with Monitor X. A new transaction was also considered to start if there was a pause of more than 10 seconds, even though the same two participants resumed speaking after the pause.

Each transaction was classified according to its content under one or more of the task/activity categories listed earlier in Table 2. No attempt was made to force a given transaction into a single category or to make an arbitrary choice between two possible assignments. Multiple classifications were permitted in order to describe the content of the transaction as fully and accurately as possible. Thus, if a crewman was instructed to take a reading on the Two-Gas Control Unit, this transaction was classified under both Life Support since it pertained to the cabin atmosphere and Equipment Monitoring since it pertained to a particular item of equipment.

Table 4a shows the distribution of transactions by task/activity category for each of the eight voice tapes from the 90-day test. The number of transactions classified under each task/activity category is given in the first seven rows of the table. The eighth row, titled nonclassifiable, indicates the number of transactions which could not be assigned to any of the seven task/activity categories.

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*Because of the poor quality of voice recording within the chamber, no attempt was made to analyze communications between crewmen.

Table 4b shows the number of transactions which received single and multiple task/activity classifications. In all, there were 636 separate transactions, 293 with single classifications and 343 with multiple classifications, yielding a total of 1,002 task/activity classifications.

TABLE 4

FREQUENCY OF VOICE COMMUNICATIONS BY TASK/ACTIVITY CATEGORY

A. Number of Transactions by Task/Activity Category

TASK/ACTIVITY CATEGORY	VOICE TAPE #1	#2	#3	#4	#5	#6	#7	#8
Life Support	35	23	45	15	63	86	109	23
Equipment Monitoring	9	14	18	7	20	44	39	22
Crew Monitoring	11	5	2	3	6	12	3	51
Equip. Operation & Maint.	17	5	19	4	36	40	39	16
Crew Sustenance	8	2	3	7	6	15	3	23
Crew Protection	0	0	0	1	2	0	3	4
Management & Logistics	6	0	9	0	3	4	5	9
Nonclassifiable	9	0	8	14	9	4	0	4
TOTAL	95	49	104	51	145	205	201	152

B. Number of Single and Multiple Classifications

CLASSIFICATION	VOICE TAPE #1	#2	#3	#4	#5	#6	#7	#8
Single	49	17	27	32	40	37	34	57
Multiple	22	15	37	10	52	81	83	43
TOTAL	71	32	64	42	92	118	117	100

Figure 3 is a histogram, giving the cumulative frequency distribution of voice transactions by task/activity category for all eight tapes analyzed. It can be seen that the largest single communications category is Life Support (almost 40 percent), with Equipment Monitoring and Equipment Operation & Maintenance together accounting for an additional 35 percent. It is not surprising that the preponderance of voice communications dealt with either life support or equipment since the basic objective of the 90-day space station simulation was to test the workability of regenerative life support equipment.

The rather high percentage of nonclassifiable communications was cause for some concern. Nearly 5 percent of the transactions could not be related to one of the established task/activity categories, which suggested either that the task/activity list was not as comprehensive as supposed or that the technique of classification was faulty in some way. A more detailed analysis was made of these nonclassifiable transactions to determine their specific content and the reason they could not be assigned to one of the seven major task/activity categories.

It was determined that of the 48 unclassifiable transactions, 15 could be considered purely personal messages, consisting largely of requests for greetings from crew members to be transmitted to persons outside the chamber. The preponderance of these personal messages (10 of the total 15) occurred during the first day of confinement and were probably a natural consequence of adjusting to isolation. Another 7 transactions were conversations dealing with topics having no relation to crew tasks and duties. These consisted of "chit chat" about current affairs or personal interests, and they occurred primarily when crew members and test monitors were casually conversing while waiting for an activity to start or to be completed. Excluding these two types of communication, there remained 26 which were definitely task-related but not clearly assignable to one of the seven task/activity categories. Six of these were transactions which were too fragmentary or obscure for the content to be determined. The remaining 20 were determined to be facilitative exchanges; i.e., they were intended to establish communication between two parties, to sign off, or to request one of the parties to speak louder or more clearly.

On the basis of this analysis, which is summarized in Table 5, it was concluded that the unclassifiable elements did not represent a defect in the classification system and that there was no major type of crew activity which was not accounted for by the seven task/activity categories. However, it was decided to lump all such transactions in an eighth category designated miscellaneous so as to have a full and complete accounting of all the voice communications contained in the voice recordings.

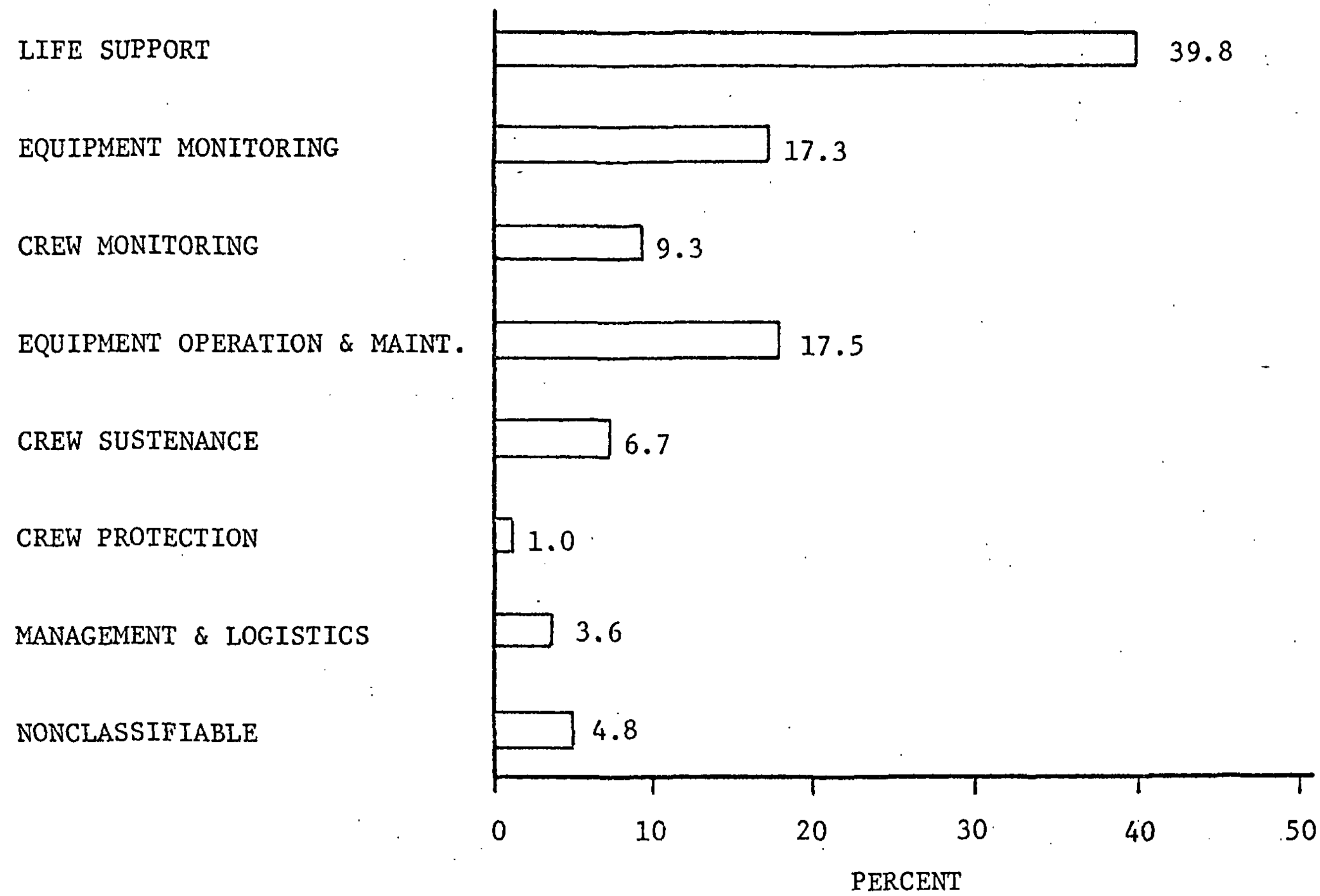

FIGURE 3. CUMULATIVE DISTRIBUTION OF VOICE COMMUNICATIONS BY TASK/ACTIVITY CATEGORY.

TABLE 5

ANALYSIS OF UNCLASSIFIABLE COMMUNICATIONS

COMMUNICATIONS CONTENT	VOICE TAPE #1	#2	#3	#4	#5	#6	#7	#8
Personal Messages	2	0	3	5	3	0	0	2
Non-task-related	3	0	1	2	1	0	0	0
Fragmentary or Obscure	1	0	1	2	1	1	0	0
Facilitative	3	0	3	5	4	3	0	2

Communications Classification System

For the purpose of this study, communication was defined as a verbal interchange between two persons for some purpose. Communication occurs, therefore, when one party in a transaction conveys information to the other so as to effect some desired outcome. From this definition it is possible to adduce three major dimensions of the communication situation. Communication, or more specifically verbal exchange, may be described in terms of the substance of the communication (i.e., what is being talked about), the purpose of the communication (what is the desired outcome), and the identity of the parties involved in the communication.

The communication classification system developed here makes use of these three attributes as the basis for categorization. An explanation of each dimension of communication is provided below.

Subject

The classification of communications according to subject is based upon the supposition that the content of voice messages in a simulated or actual space mission is closely related to the task or activity being performed. Thus, the task/activity analysis carried out in Phase I of this study and described earlier in this chapter forms a list of probable topics of verbal communication. The review of the voice tapes from the 90-day test showed that nearly all the verbal exchanges between the crew and test monitors could be related to one or more of the task/activity categories and that the proportion of miscellaneous (i.e., nonclassifiable) elements was acceptably small. Therefore, it was concluded that to classify communications according to subject, it would be sufficient to relate the content of the messages to the appropriate task cluster(s) listed previously in Table 2, page 15.

Purpose

The second major dimension of classification is purpose. The classification system proposed here is based upon two simplifying assumptions. First, only the avowed or ostensible purpose is to be considered since this is all that can be determined without some inference or interpretive judgment. In other words, it is always assumed that the speaker means what he says and that he is motivated by the purely pragmatic concerns of transmitting or obtaining information pertaining to operational tasks and activities.

The second simplifying assumption is that verbal communication in an operational environment is carried out for only three basic purposes:

1. To transmit or receive directions (i.e., to effect some further action);

2. To transmit or receive information (i.e., to describe an existing or past state of affairs); or

3. To support or facilitate the communication process (to establish or maintain contact for either of the two other purposes).

Table 6 presents a further analysis of communications under each of these three purposes.

It will be noted that to the category of Communication Support has been added what are termed incidents. These were included simply to provide a way of accounting for the artifacts of the voice transmission and recording process.

Participants

The identification of the participants in the communications exchange can be as general or specific as the requirements of the analysis dictate. As a minimum, the classification system should designate the speaker and the recipient and the generic role of both parties (i.e., crew member or test/mission control personnel). If desired, the system could be made more specific by classification according to the particular function or title of the participants (e.g., crew commander, test director, biomedical monitor, and so on). In some cases, it may be desirable to identify the participants still more precisely (e.g., Commander Smith, Test Director Brown, Medical Officer White).

The system adopted for this study is a minimum classification scheme, which designates only whether the speaker and the recipient are crew members or test monitors. Further particularization of identity was not deemed necessary since the objective of the study was only to demonstrate the feasibility of classification techniques and not to make an analysis of communications specifically associated with the 90-day test.

TABLE 6

ANALYSIS OF PURPOSES OF COMMUNICATION

DIRECTIONS

- Issue
- Request
- Receipt/acknowledgement (including a request for acknowledgement)
- Compliance (actual compliance or intent to do so)

STATUS REPORTING

- Transmittal
- Request
- Receipt/acknowledgement (including a request for acknowledgement)

COMMUNICATION SUPPORT AND INCIDENTS

- Call-up
- Answer
- Identification/verification of speaker
- Relay (request or compliance)
- Request for repeat
- Sign-off
- Communication equipment adjustment (volume, channel, etc.)
- Incomplete message
- Garbled or incomprehensible

Coding

To facilitate the classification process a digital code was developed to designate each of the three dimensions and the categories and subcategories within each. The code numbers are shown in Table 7.

The code is structured so that four two-digit numbers are required to classify each communication. The code is of the form:

TABLE 7

COMMUNICATIONS CLASSIFICATION CODE

SUBJECT

1. LIFE SUPPORT
   - 11 Atmosphere Supply & Composition
   - 12 Temperature/Humidity
   - 13 Atmospheric Pressure
   - 14 Contaminants
   - 15 CO_2 Removal
   - 16 Water Management
   - 17 Waste Management
2. EQUIPMENT MONITORING
   - 21 Atmospheric Supply & Control
   - 22 Water Supply & Control
   - 23 Waste Disposal & Management
   - 24 Food Preparation & Storage
   - 25 Housekeeping
   - 26 Biomedical & HF Experimental Equipment
   - 27 Communications
   - 28 Emergency & Safety Equipment
   - 29 Other
3. CREW MONITORING
   - 31 Biomedical/Physiological
   - 32 Psychological/Behavioral
4. EQUIPMENT OPERATION & MAINTENANCE
   - 41 Atmospheric Supply & Control
   - 42 Water Supply & Control
   - 43 Waste Disposal & Management
   - 44 Food Preparation & Storage
   - 45 Housekeeping
   - 46 Biomedical & HF Experimental Equipment
   - 47 Communications
   - 48 Emergency & Safety Equipment
   - 49 Other
5. CREW SUSTENANCE
   - 51 Sleep
   - 52 Eating and Food Preparation
   - 53 Hygiene
   - 54 Exercise
   - 55 Recreation
   - 56 Housekeeping
6. CREW PROTECTION
   - 61 Radiation
   - 62 Magnetics
   - 63 Electrostatics
   - 64 Sonics
   - 65 Safety Precautions/Checks
   - 66 Illumination
7. MANAGEMENT AND LOGISTICS
   - 71 Supplies
   - 72 Plans
   - 73 Schedules
   - 74 Personnel and Assignment
8. MISCELLANEOUS
   - 81 Personal Message
   - 82 Non-task-related Message
   - 83 Unclassifiable

TABLE 7 (Continued)

PURPOSE

1. DIRECTIONS
   - 11 Issue
   - 12 Request
   - 13 Receipt/Acknowledgement (including request for acknowledgement)
   - 14 Compliance (including intent to do so)
2. STATUS REPORTING
   - 21 Transmittal
   - 22 Request
   - 23 Receipt/Acknowledgement (including request for acknowledgement)
3. COMMUNICATION SUPPORT AND INCIDENTS
   - 31 Call-up
   - 32 Answer
   - 33 Identification/Verification
   - 34 Relay (request or compliance)
   - 35 Request for Repeat
   - 36 Sign-off
   - 37 Commo. Equip. Adjustment
   - 38 Incomplete Message (no reply)
   - 39 Garbled/Incomprehensible

PARTICIPANTS

1. SPEAKER
   - 11 Crew Member
   - 12 Test/Mission Control
2. RECIPIENT
   - 21 Crew Member
   - 22 Test/Mission Control

XX - XX - XX - XX

where the first pair of digits indicates the subject; the second the purpose; the third the speaker; and the fourth the recipient. Thus, a typical classification would be 41 - 11 - 12 - 21. Referring to Table 7, this would be interpreted as a communication dealing with operation or maintenance of atmospheric supply and control equipment (Item 41 under Subject), in which directions were issued (Item 11 under Purpose) by Test/Mission Control to a crew member (Items 12 and 21, respectively, under Participants).

Communications support and incidents (Items 31 - 39 under Purpose) are considered to be verbal exchanges without task-related content. This is denoted by using the digits 00 in the subject position of the code. Thus, a crew member calling up Test/Mission Control would be encoded:

00 - 31 - 11 - 22.

The 00 code number is used only to indicate a communication which has no specific subject. It should not be used in place of 82, which is a non-task-related message, or 83, which is an unclassifiable message.

It was noted earlier in this chapter that many communications deal with more than one subject. A full and accurate classification of the subject therefore requires that more than one two-digit descriptor be used. Multiple-subject communications are encoded by placing a slash (/) between each of the appropriate descriptors in the first position of the code. For example,

31/73 - 11 - 12 - 21

would be used to denote a communication concerning the biomedical monitoring schedule, in which directions were issued by Test/Mission Control to a crew member. Likewise, the digits 14/21 in the first position would describe a message dealing with contaminants and monitoring of atmospheric supply and control equipment.

Communications Structure

A final necessity for the analysis and classification of verbal material is the definition of units of communication. For the classification process to be meaningful, the information exchange must be divided into commensurate elements which can be treated as equivalent parts. The system employed here is a hierarchical structure consisting of three levels:

Transaction
Transmission
Message.

Transaction. This is the first level, which is defined as the entire, uninterrupted verbal exchange between two parties. Transaction, as a unit of communication, was discussed earlier in this chapter in connection with the analysis of communication frequency by task/activity category. The concept of transaction as a communications unit derives from the basic definition of communication as a verbal exchange between two persons for some purpose. Thus, a transaction is defined in terms of the participants; and whenever there is a change in participants, a new transaction results. The duration of the exchange is not important since the definition requires only that the same two individuals be involved, without interruption.

As noted earlier, a transaction is also considered to terminate whenever there is a pause of greater than 10 seconds in the exchange. This additional qualification was introduced for practical considerations and for operational convenience. It is not essential to the definition, and it was employed only to reduce some of the more protracted exchanges to manageable proportions.

Transmission. A transaction normally consists of two or more transmissions. A transmission is defined as that segment of the transaction spoken by either party at one time. Thus, if a test monitor gave instructions to a crew member and the crew member replied, there would be two transmissions. If the test monitor gave instructions to the crew member who replied and then was addressed again by the test monitor, this would be counted as three transmissions. In other words, a transmission occurs each time a test monitor or a crew member participates in the transaction.

Message. Each transmission consists of one or more messages. A message is a single item of information. A message can be operationally defined as the element of verbal communications which is uniquely classifiable as to subject, purpose, and participants. In terms of the classification code presented in the preceding section, a message can have no more than one four-part descriptor. The concept of message is thus analogous to the "bit" used in classic information theory and in automatic data processing. The message is considered therefore to be the basic and indivisible element of information exchange.

Sample Analysis and Classification of Voice Communications

As a demonstration of the classification system, a detailed analysis was made of one of the voice tapes from the 90-day test. The tape selected (Tape #8) was about two hours in length and consisted of slightly under 40 minutes of voice communication. There was one passage of almost continuous voice beginning 10 minutes after the start of the tape and running for about 11 minutes and 30 seconds. This was followed by about 40 minutes of silence and then another continuous voice passage lasting slightly over 28 minutes. The remainder of the tape consisted of silence interspersed with a few unintelligible exchanges between crew members within the chamber.

The analysis consisted of three steps:

1. Listening to the tape for familiarization and identification of the beginning and end times for each transaction;

2. Identification of transmissions and messages within each transaction; and

3. Assignment of message classification codes.

Table 8 is a brief example of how the analysis and classification were conducted. The example uses a fictitious text which was prepared to illustrate the significant features of the classification process.

Appendix A of this report presents the detailed results of the analysis and classification of the 40-minute sample of voice communications. The sample contained 316 separate transmissions. Of these, 294 consisted of a single message, and 33 contained multiple messages, making a total of 360 messages. Table 9 shows the frequency of messages by subject category (Table 9a) and the frequency of messages by purpose of communication (Table 9b).

Recommended Procedures for Voice Communications Analysis

The full analysis and classification of voice communications requires four basic operations:

1. Familiarization. This involves listening to the voice record and preparation of either a transcript or a key word abstract.

2. Identification. The record must be divided into transactions and transmissions, with the beginning and ending words of each identified.

3. Timing. The starting time and duration of the transmissions (or the transactions) must be determined.

4. Coding. Individual messages must be identified and assigned classification codes for subject, purpose, and participants.

The preparation of a full transcript is largely a matter of preference and available resources. Transcribing a voice record verbatim can be a tedious and time-consuming chore, especially since it is not absolutely necessary for the subsequent steps of analysis and classification. Except for extremely difficult passages or recordings with poor voice quality, a key word abstract with beginning and end of transmission identifiers is usually sufficient. On the other hand, a verbatim transcript

TABLE 8

SAMPLE OF VOICE COMMUNICATIONS CLASSIFICATION

UNEDITED VOICE	TRANSMISSIONS IDENTIFIED	MESSAGES IDENTIFIED	MESSAGE CODES[a]
Hello, Mission Control?... This is Mission Control... Ed here. Do you want us to take the heart rate measurement now?...Yes, and take respiration, too...OK, will do...By the way, Ed, give me your dosimeter reading now... OK, it's point two six... Thank you.	Hello, Mission Control	(Hello, Mission Control)	00-31-11-22[b]
	This is Mission Control	(This is Mission Control)	00-32-12-21
	Ed here. Do you want us to take the heart rate measurement now?	(Ed here)	00-31-11-22[c]
		(Do you want us to take the heart rate measurement now?)	31-12-11-22[c]
	Yes, and take respiration, too	(Yes,)	31-11-12-21[d]
		and (take respiration), too	31-11-12-21[d]
	OK, will do	OK, (will do)	31-14-11-22
	By the way, Ed, give me your dosimeter reading now	By the way, Ed, (give me your dosimeter reading) now	31/ 61-22-12-21[e]
	OK, it's point two six	OK, (it's point two six)	31/ 61-21-11-22
	Thank you	(Thank you)	31/ 61-23-12-21

a. See Table 7 for the key to the message codes.
b. Communications support messages (in this case a call-up message) have no specific subject, which is denoted by 00 in the subject position of the code.
c. Note there are two messages--an identification (00-31-11-22) and a request for directions about biomedical/physiological monitoring (31-12-11-22).
d. Again, note two messages--Yes, (issue of directions about heart rate) and the remainder,(issue of directions about respiration measurement).
e. The dual subject is denoted by a doubling of the subject classification digits with a slash between (31/61).

TABLE 9

FREQUENCY DISTRIBUTIONS OF MESSAGES IN SAMPLE ANALYSIS

a. Message Frequency by Subject Category

	SUBJECT CODE*																				
	00	16	22	26	31	32	42	46	47	49	51	54	64	65	66	71	72	73	74	82	83
Message Frequency	57	45	38	1	127	10	32	6	2	2	21	31	1	2	6	1	9	12	3	25	1
Total by Category	57	45	39		137		42				52		9			25				26	

b. Message Frequency by Purpose of Communication

	PURPOSE CODE*																
	DIRECTIONS				STATUS			COMMO. SUPPORT & INCIDENTS									
	11	12	13	14	21	22	23	31	32	33	34	35	36	37	38	39
Message Frequency	48	6	25	9	104	48	49	12	7	12	2	8	2	2	0	26
Total by Category	88				201			71									

*See Table 7 for key to subject and purpose codes.

can be useful for checking the correctness of classification, since it spares the reviewer of the need to listen to the recording. Thus, the decision on whether or not to prepare a written transcript should be made on the basis of available manpower, the number of people who will need to have later access to the voice communications record, and the intelligibility of the material itself.

Timing the voice recording is also a matter of preference to some extent. If the communications analysis is to be used subsequently for a study of channel usage or for estimating proportionate workload imposed by tasks and activities, it is essential to have a precise record of the duration and pace of voice messages. Timing is also extremely helpful if a verbatim transcript has not been made since it facilitates location and review of individual transactions, transmissions, or messages within the total voice recording. However, it is possible to classify communications without timing them. Here, too, the decision rests upon how the analysis is to be conducted and to what uses it will be put.

Several different procedures for performing the analysis and classification operations were tried during this study. The three which have the greatest practical merit are described below.

Method I

This method consists of five sequential work steps:

1. Listen to the recording and identify the beginning and ending words of each transmission.

2. Listen to the recording a second time and time each transmission.

3. Listen to the recording again and classify each message as to subject.

4. Listen to the recording, assign the purpose classification code to each message and check the accuracy of the subject classification.

5. Listen to the recording to assign the participant classification code and to check the purpose classification.

This method is obviously very time-consuming since it involves listening to the recording five separate times. It can also be tedious for the analyst to sit through five repetitions of the material. On the other hand, this method has high inherent accuracy since each operation is checked at the next work step. On the whole, however, Method I appears to be too time consuming to be practical in routine use. It was found to be useful as a technique for training analysts and as a way of dealing with material which was noisy or complex.

Method II

In Method II the procedure consists of only three steps:

1. Listen to the recording and identify the beginning and end of each transmission.

2. Listen to the recording again and time each transmission.

3. Listen to the recording a third time and classify the messages for subject, purpose and participants.

In effect, Method II simply collapses the final three steps of Method I into a single step. This virtually halves the time to carry out the analysis and classification; and with experienced analysts, there is no appreciable increase in the classification error rate. Since this method is still iterative, the analyst can check his work as he progresses. While he is timing the transmissions he can check the accuracy of the beginning and end of transaction identifiers. By the time he reaches the third step, he has gained enough familiarity with the material to make a rapid and accurate classification.

Method III

This method was tried to see if a further reduction could be made in the time required to analyze and classify voice communications. It consists of two steps:

1. Listen to the recording, time the transmissions, and at the same time identify key words.

2. Listen to the recording again and classify messages.

This procedure proved to be too demanding for the analyst. Manipulation of a stop watch, operation of the recording equipment, and preparation of a key word abstract at the same time was cumbersome and conducive to errors in timing or transmission identification. Because of the resulting need to go back over the material to correct mistakes, this method actually was more time consuming than Method II. However, if there is no need to time the voice communications, Method III is satisfactory, particularly for experienced analysts.

This experimentation with analysis and classification methods leads to the conclusion that Method II is probably the most practical for use by trained personnel. The error rate is about the same as for Method I but it takes only about half as much time. A reasonably proficient analyst, using Method II, can analyze and classify an hour of voice recording in between three and four hours, depending upon the difficulty of the material and audio quality of the recording. This estimate includes not only the time to perform each of the operations but also the time to prepare a handwritten analysis work sheet of the type shown in Appendix A.

Method I, as noted above, has some merit as a training technique and as a way of dealing with complex or poorly intelligible material. Method III can be used effectively when there is no need to time the transactions.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

This research was undertaken as a pilot study to develop a method for analysis and classification of voice communications typically associated with manned space systems. For the purpose of this study, voice communication was defined as a verbal exchange between two parties for some specific and task-related purpose. This definition served as the basis for an analytic scheme which distinguishes three progressively more specific levels of information exchange--transaction, transmission, and message. Classification is performed at the message level and consists of describing each message in terms of subject (or content), purpose, and participants. The subject or content classification scheme was derived from an analysis of typical tasks performed by space system crews. The purpose and participant dimensions of classification were derived from the basic definition of voice communication.

The classification system was designed so as to apply generically to operational space systems and simulators. However, the classification categories were structured so that they can be made specific to a given system if desired. Similarly, the categories were made flexible enough to be expanded to include any areas of special interest that may be appropriate either for a given system or some particular analytic purpose. The intent was to provide a classification scheme which is descriptive of specific system characteristics and yet sufficiently general in nature to permit comparisons among different systems.

As an adjunct to development of the classification system, tests were conducted to see how well the system could be applied to samples of voice communications recorded during an extended simulation exercise. These tests led to two major conclusions. First, the task/activity list which served as the basis for classification of the subject of voice communications is sufficiently comprehensive to account for all but a tiny fraction of the total messages. Ninety-five percent of the messages could be assigned to one or more of the 7 major categories of operational activity. Of the remaining 5 percent, about half were facilitative messages (call-ups, sign-offs, requests for repetition, etc.) and the other half were personal messages and general conversation. It was concluded that 95 percent, in this circumstance, represented the maximum degree of comprehensiveness which was practically attainable.

The second conclusion stemmed from the application of the classification system in a detailed analysis of a 40-minute voice communication sample. This experience indicated that the system was both workable and reliable and that it could be used by relatively inexperienced analysts after only brief training. The time required to perform a detailed communications analysis of the kind illustrated in Appendix A of this report was not unreasonably long. A trained person, with some experience, can be expected to analyze and classify an hour of voice messages in three to four hours, which includes timing, coding, and preparing a written record.

There are a number of possible applications for the communications classification system developed in this study. The following examples are illustrative of the range of potential uses:

- Identification of tasks or items of equipment which contribute substantially to crew workload.

- Identification of system design features which impose significant task or communication loads.

- Analysis and modification of procedures or work schedules.

- Assessment of crew proficiency or state of training.

- Identification of areas where data exchange should be automated.

- Crew interaction analysis.

- Comparison of operational systems and simulators and validation of simulator fidelity.

As a general recommendation, the communications classification system developed here should be subjected to further study and testing. Specifically, it is suggested that the following research efforts be undertaken:

1. Analysis of voice communications from other simulator studies to validate the general applicability of the classification system.

2. Analysis of voice communications from an actual space mission (or missions) to test the validity of the classification system in an operational realm.

3. Use of the classification system as a technique for conducting the system design and evaluation studies outlined in the preceding paragraph.

4. Studies to identify communications variables which can be related to other measures of crew status and performance capability.

As a final point, it should be recalled that this study was conceived and carried out as only the first step toward a much larger goal. The intent was to lay the groundwork for a systematic method of categorizing verbal communications in relation to operational activities and crew performance. It is believed that a better understanding of these relationships could lead in time to a way of using verbal communications as an index of crew performance and, by extension, as a predictive measure of workload or crew capacity.

APPENDIX A

DETAILED VOICE COMMUNICATION ANALYSIS

This appendix contains an analysis and classification of the voice messages in a sample of approximately 40 minutes duration. This sample was obtained from Tape #8 which was recorded during the 90-day manned test of a regenerative life support system conducted by McDonnell Douglas Astronautics Company under the sponsorship of NASA Langley Research Center from June to September 1970. The sample consists of two portions--Tape 8a (11 minutes and 30 seconds) and Tape 8b (28 minutes and 20 seconds).

Each horizontal line on the analysis sheets represents a transmission. The key to the column headings is as follows:

IDENT	The sequential number of the transmission.
START TIME	The time, as measured from the beginning of the tape, when the transmission starts. Tape 8a runs from 10 minutes 0 seconds (10:00) to 21 minutes 29 seconds (21:29). Tape 8b runs from 1 hour 1 minute and 2 seconds (1:01:02) to 1 hour 29 minutes 20 seconds (1:29:20).
END TIME	The time, as measured from the beginning of the tape, when the transmission ends.
TEXT	The abbreviated text of the transmission, indicating the beginning and ending words.
MESSAGE CODE	The classification code for each message in the transmission.

ANALYSIS OF TAPE #8A

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
1	10.00	10.01	Jim?	00-31-12-21
2	10.01	10.02	Yeah.	00-32-11-22
3	10.02	10.07	What do...carry on...hit this.	72-12-12-21
4	10.08	10.15	Yeah, I...right now, no reason to.	72-11-11-22
5	10.15	10.16	Okay.	72-13-12-21
6	10.17	10.22	Who is with...medical interview?	74/31-22-12-21
7	10.22	10.23	Uh, Terry.	74/31-21-11-22
8	10.24	10.27	Terry, okay do...with doctor...	74/31-11-12-21
9	10.28	10.29	Larry was inputting data...I think.	31-22-12-21
10	10.30	10.30	Yeah.	31-23-11-22
11	10.31	10.40	You want to...report it to us.	82-11-12-21 31-11-12-21
12	10.40	10.41	Right.	31-13-11-22
13	10.42	10.43	Garbled.	00-39-00-00
14	10.44	10.48	Everything...to be okay...caused it.	31-11-12-21
15	10.49	10.49	Okay.	31-13-11-22
16	11.11	11.30	Do you...wash water...quite a bit of water.	16-22-11-22 16/22-21-11-22
17	11.31	11.44	Okay, let's see...both heaters are still on.	16/22-23-12-22 16/22-34-12-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
18	11.47	11.48	Yeah.	16/22-23-12-22
19	11.50	11.53	I don't know...load cell information.	16/22-21-12-22
20	11.57	12.02	Yeah...check the vent.	16/22-11-12-21
21	12.06	12.10	Are we processing water...as indicated on the flow meter?	16/22-22-12-21
22	12.11	12.12	Are we uh?	16/22-35-11-22
23	12.13	12.18	It is just inside...on left hand.	16/22-11-12-21
24	12.19	12.20	Okay...take look...stations.	16/22-14-11-22
25	12.20	12.21	Sure.	16/22-14-12-21
26	13.00	13.03	My God...write about!	82-21-11-22
27	13.04	13.08	Hello Ken?	00-31-12-22
28	13.08	13.09	Bob.	00-33-12-22
29	13.23	13.24	Station Ten please.	00-31-12-21
30	13.25	13.28	Would you...better results.	00-37-11-22 47-11-11-22
31	13.29	13.30	Hello.	00-31-11-22
32	13.30	13.31	Hi.	00-32-12-21
33	13.31	13.34	Hi, can you...psychomotor please?	32/46-11-11-22
34	13.36	13.39	Okay Jim...another buzz here.	32/46-13-12-21 47-37-12-21

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
35	13.48	13.50	Wilson do...station?	00-31-12-21
36	13.50	13.51	Yeah you do.	00-32-11-22
37	13.51	13.52	Okay.	00-33-12-22
38	13.53	13.58	Could that be possible...still going on?	16/42-22-11-22
39	13.59	14.13	Oh yeah...that's okay...used for something?	16/42-23-12-21 16-22-12-21
40	14.14	14.27	Oh no...for washing..on for cooking something.	16-21-11-22 16/42-21-11-22
41	14.27	14.39	Oh no,...back to the used tank.	16/42-21-12-21 42-21-12-21
42	14.40	14.40	Uh-huh.	42-23-11-22
43	14.41	14.47	So you should...filtration column.	22-21-12-21
44	14.47	14.48	Uh-huh.	22-23-11-22
45	14.49	14.51	Are you ... a flow?	22-22-12-21
46	14.51	14.53	No, no there's...at all.	22-21-11-22
47	14.53	14.54	Is there...valve open?	22-22-12-21
48	14.55	14.57	Uh...that I don't know.	22-21-11-22
49	14.58	15.03	Open it...100 cc's a minute.	42-11-12-21 22-22-12-21
50	15.04	15.11	I turned...still no flow.	42-14-11-22
51	15.12	15.16	Well, then...over to tank.	42-21-12-21

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
52	15.17	15.23	Three full turns...right meter now.	42/22-21-11-22 42-12-11-22
53	15.24	15.27	It's the only...base of it.	42-11-12-21
54	15.28	15.35	Okay, well,...now...	42-13-11-22
55	15.36	15.46	If you don't...full used tank again	42-21-12-21
56	15.46	15.48	I see...okay.	42-23-11-22
57	15.48	15.52	Uh of course..out of that tank	42/22-11-12-21
58	16.18	16.21	But the next...100 cc's a minute.	42/22-11-12-21
59	16.21	16.22	Okay fine.	42/22-13-11-22
60	16.23	16.23	Okay?	42/22-13-12-21
61	16.24	16.24	Yeah.	42/22-13-11-22
62	16.25	16.25	Alright.	42/22-13-12-21
63	16.25	16.27	Okay I'm leaving the station.	82-21-11-22
64	16.27	16.28	Right-on sir.	82-23-12-21
65	17.00	17.03	Did you...put it on.	00-39-12-21
66	17.05	17.12	131-127. Yeah...looks okay.	84-21-11-22
67	17.33	17.35	What do...(garbled)...too.	00-39-12-21
68	17.36	17.37	Yeah.	00-39-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
69	17.47	17.49	Uh, I'm...to Dave now.	82-21-11-22
70	17.50	17.52	Jim what's...schedule after that?	73-22-12-21
71	17.53	17.56	Uh...been in bed five minutes.	73/51-21-11-22
72	17.58	18.00	I don't think you're going to make it.	73/51-21-12-21
73	18.03	18.05	130 & 1.	54-21-11-22
74	18.06	18.07	How many...we got?	54/73-22-12-21
75	18.10	18.23	Let me...total.	54/73-21-11-22
76	18.24	18.24	Okay.	54/73-23-12-21
77	18.25	18.25	Steve here.	00-33-12-21
78	18.26	18.26	Yeah.	00-32-11-22
79	18.26	18.31	You're scheduled...one o'clock...alright?	51/73-11-12-21 51/73-13-12-21
80	18.31	18.32	At one o'clock?	51/73-35-11-22
81	18.33	18.33	Right.	51/73-13-12-21
82	18.34	18.34	Oh, okay.	51/73-13-11-22
83	18.40	18.50	Three four...at end of this...14-1/2 minutes on the bike.	54-21-11-22
84	18.52	18.56	Well, since we're...get a ruler.	54-21-12-21
85	18.58	19.03	Jim, do you...sleepy?	31/51-22-12-21

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
86	19.03	19.04	Yeah kind of.	31/51-21-11-22
87	19.05	19.05	Okay.	31/51-23-12-21
88	19.06	19.20	Ready mark 31, 1.0...about 30 secs...off the bike	31/54-21-11-22 54/73-21-11-22
89	19.21	19.26	Okay have...recovery.	31/54-11-12-21
90	19.27	19.30	Okay...every minute.	31/54-13-11-22 31/54-12-11-21
91	19.31	19.35	I can take...chart.	31/54-11-12-21
92	19.35	19.36	Okay.	31/54-13-11-22
93	19.56	20.03	Either the...more than fifteen minutes	31/54-21-12-21
94	20.03	20.06	Yeah okay...this is the end of my reading here...	31/54-21-11-22
95	20.06	20.07	Okay.	31/54-23-12-21
96	20.07	20.10	Got 15-1/2 minutes.	31/54-21-11-22
97	20.10	20.11	Okay tell them to stop.	31/54-34-12-21
98	20.11	20.17	Stop 31 and 1...readings here.	31/54-11-11-21 31/54-21-11-22
99	20.17	20.19	Okay just...sit there.	31/54-23-12-21
100	20.20	20.21	Stay on the bike.	31/54-11-11-21
101	20.24	20.26	Okay...relax.	31/54-13-12-21 31/54-11-12-21
102	20.27	20.28	Relax.	31/54-13-11-21 31/54-14-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
103	20.39	20.42	Okay start...now.	31/54-11-12-21
104	20.46	20.50	...Pretty good load.	31/54-21-11-22
105	21.05	21.16	Just a minute...ready go! 105 0.03	31/54-11-11-21 31/54-21-11-22
106	21.18	21.19	Okay.	31/54-23-12-21
107	21.21	21.22	Garbled.	00-39-00-00
108	21.27	21.29	We just...out of paper.	46/71-21-11-22

ANALYSIS OF TAPE #8B

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
1	1.01.02	1.01.04	It did...it again.	00-21-11-22
2	1.01.04	1.01.06	What's that?	00-35-12-21
3	1.01.06	1.01.07	It did it again.	00-21-11-22
4	1.01.07	1.01.10	It went one...I think.	16/22-21-12-21
5	1.01.11	1.01.13	I turned...really quick.	16/42-21-11-22
6	1.01.13	1.01.15	That's because...that's why.	16/22-21-12-21
7	1.01.15	1.01.16	Uh-huh.	16/22-23-11-22
8	1.01.16	1.01.16	Garbled.	16/22-39-00-00
9	1.01.17	1.01.17	Huh?	16/22-35-00-00
10	1.01.18	1.01.19	Want to see it go?	16/42-22-11-22
11	1.01.19	1.01.27	Yeah...screwing up numbers...but number.	16/42-23-12-21 16/22-21-12-21
12	1.01.27	1.01.29	Let me see...Terry on now?	82-11-12-21
13	1.01.30	1.01.32	Uh yeah...monitoring.	82-13-11-22 21-14-11-22
14	1.01.33	1.01.38	Okay...417-46	16/22-21-12-21
15	1.01.38	1.01.39	Okay.	16/22-23-11-22
16	1.01.51	1.01.53	Lights come...by battery.	66/49-21-11-22
17	1.02.10	1.02.11	Garbled.	00-39-00-00

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
18	1.02.34	1.02.35	Hello?	00-31-11-22
19	1.02.35	1.02.36	Hi, Terry?	00-33-12-21
20	1.02.36	1.02.37	It's Steve.	00-33-11-22
21	1.02.37	1.02.37	Yeah.	00-33-12-21
22	1.02.38	1.02.38	Hi.	00-32-11-22
23	1.02.39	1.02.40	How's it going?	82-22-12-21
24	1.02.40	1.02.42	Not bad..excitement here.	82-21-11-22
25	1.02.43	1.02.46	Uh, you didn't...in there?	66/49-11-12-21
26	1.02.47	1.02.49	Uh, you mean...light?	66-33-11-22
27	1.02.49	1.02.50	Yeah...general lighting.	66-33-12-22
28	1.02.51	1.02.52	Garbled.	00-39-00-00
29	1.02.53	1.03.03	Yeah...TV screen...out here.	66-21-12-21
30	1.03.04	1.03.08	I noticed...forward porthole.	82-21-11-22
31	1.03.09	1.03.10	Oh, is...that right?	82-23-12-21
32	1.03.10	1.03.13	Yeah...looking inside.	82-23-11-22 72-21-11-22
33	1.03.13	1.03.14	I don't...anything.	82-23-12-21
34	1.03.15	1.03.20	When we had...camera alert.	82-21-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
35	1.03.21	1.03.24	Oh...good idea.	82-23-12-21
36	1.03.25	1.03.31	Yeah...catch on fire will...garbled.	65-21-11-22 65-39-11-22
37	1.03.31	1.03.40	Yeah...uh, just in case.	16/42-11-12-21
38	1.03.46	1.03.48	What does...out there.	82-22-11-22
39	1.03.48	1.03.49	What does what?	82-35-12-22
40	1.03.40	1.03.55	The activity...is the crew.	82-22-11-22
41	1.03.56	1.04.14	Oh...operations...spectators.	82-21-12-21
42	1.04.14	1.04.15	Uh-huh.	82-23-11-22
43	1.04.17	1.04.24	Pretty quiet...excited...cameras.	82-21-12-21
44	1.04.27	1.04.27	Not interesting...?	82-39-00-00
45	1.04.28	1.04.32	You started...freaked out.	16-21-12-21
46	1.04.32	1.04.33	Uh-huh.	16-23-11-22
47	1.04.34	1.04.36	We figured...flow up.	16-21-12-21
48	1.04.37	1.04.37	Uh-huh.	16-23-11-22
49	1.04.38	1.04.41	So, how...you all feel?	31-22-12-21
50	1.04.41	1.04.43	Oh, pretty...well.	31-21-11-22
51	1.04.43	1.04.44	Good.	31-23-12-21

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
52	1.04.44	1.04.49	It's actually...throwing up.	31-21-11-22
53	1.04.49	1.04.52	Oh, yeah...water from new water.	31/16-22-12-21
54	1.04.52	1.05.01	Oh, somebody...pretty bad.	16/22-21-11-22
55	1.05.02	1.05.10	Oh, yeah...it was used.	16/42-11-12-21
56	1.05.11	1.05.11	Oh.	16/42-13-11-22
57	1.05.12	1.05.14	I think...pretty good now, for laughs.	16/42-21-12-21
58	1.05.23	1.05.28	Uh...okay...ready in there.	16-11-12-21
59	1.05.28	1.05.29	Yeah.	16-13-11-22
60	1.05.29	1.05.30	Okay...countdown and go.	16-11-12-21
61	1.05.30	1.05.30	Okay.	16-13-11-22
62	1.05.31	1.05.33	Okay, three-two-one...Go!	16-11-12-21
63	1.06.21	1.06.22	Garbled.	00-39-00-00
64	1.09.11	1.09.12	Uh, Terry?	00-31-12-21
65	1.09.12	1.09.13	Yeah.	00-31-11-22
66	1.09.13	1.09.18	I'm reading..322-28 okay.	16/22-21-12-21
67	1.09.19	1.09.19	Yeah.	16/22-23-11-22
68	1.09.20	1.09.32	Alright, I...Tuesday.	72-11-12-21

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
69	1.09.32	1.09.33	Tuesday.	72-13-11-22
70	1.09.34	1.09.38	Tuesday in moving...like that...	72-11-12-21
71	1.09.39	1.09.44	That's when...see you later.	72-11-12-21
72	1.09.44	1.09.45	Okay.	72-13-11-22
73	1.09.45	1.09.46	Goodbye.	00-36-12-21
74	1.09.46	1.09.47	Goodbye.	00-36-11-22
75	1.15.00	1.15.00	Hello?	00-31-11-22
76	1.15.02	1.15.03	Garbled.	00-39-00-00
77	1.15.08	1.15.09	Is anybody up?	51-22-11-22
78	1.15.10	1.15.12	Okay...look around.	51-14-12-21
79	1.15.20	1.15.25	Okay Jim...okay?	31-14-12-21
80	1.16.22	1.16.22	Hello.	00-31-12-21
81	1.16.23	1.16.23	Hello.	00-32-11-22
82	1.16.24	1.16.25	Dr. Levin here.	00-33-12-21
83	1.16.26	1.16.27	Oh, hi, Alex.	00-31-11-22
84	1.16.30	1.16.31	Jim Shoemake.	00-33-12-21
85	1.16.31	1.16.32	Yeah.	00-33-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
86	1.16.32	1.16.33	Okay, fine.	00-33-12-21
87	1.16.34	1.16.38	Uh, why...tongue.	31-11-12-21
88	1.16.38	1.16.39	Okay.	31-13-11-22
89	1.16.39	1.16.45	And, uh...at the same time.	31-11-12-21
90	1.16.45	1.16.45	Okay.	31-13-11-22
91	1.17.50	1.17.53	Okay, I got...98.	31-31-12-21
92	1.17.53	1.17.54	Okay.	31-23-11-22
93	1.17.55	1.18.03	And your pulse...a little bit...good...thought?	31-21-12-21
94	1.18.05	1.18.05	What?	31-35-11-22
95	1.18.06	1.18.08	Did you...or something	82-22-12-21
96	1.18.08	1.18.09	No.	82-21-11-22
97	1.18.10	1.18.14	It was 70 and...90.	31-21-12-21
98	1.18.15	1.18.19	Oh yeah?...heart rate.	31-23-11-22 31-21-11-22
99	1.18.20	1.18.20	Yeah.	31-23-12-21
100	1.18.22	1.18.25	Normally...temperature.	31-12-11-22
101	1.18.27	1.18.29	Yeah...take care of it.	31-11-12-21
102	1.18.20	1.18.31	Okay.	31-13-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
103	1.18.34	1.18.35	To read stabilizer.	31-11-12-21
104	1.18.36	1.18.37	Not yet...	31-13-11-22
105	1.18.42	1.18.43	Garbled	00-39-00-00
106	1.18.49	1.18.51	Garbled.	00-39-00-00
107	1.19.04	1.19.05	What you...on temp.?	31-22-12-21
108	1.19.37	1.19.38	Garbled	00-39-00-00
109	1.20.00	1.20.02	Okay...in general?	31-22-12-21
110	1.20.05	1.20.05	Garbled.	00-39-11-22
111	1.20.07	1.20.08	Oh, great.	31-23-12-21
112	1.20.10	1.20.12	What do you have...	31-39-12-21
113	1.20.14	1.20.20	I never have caught...cough.	31-21-11-22
114	1.20.31	1.20.31	Um-hum	31-23-12-21
115	1.20.32	1.21.05	Don't have...sore throat...noise level..ears.	31-21-11-22 31/64-21-11-22
116	1.21.21	1.21.23	Garbled.	00-39-00-00
117	1.21.39	1.21.43	Kind of steady droll...difficult.	64-21-11-22
118	1.21.43	1.21.45	Can you clear...ears?	31-22-12-21
119	1.21.45	1.21.46	Yes I can.	31-21-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
120	1.21.47	1.21.47	Garbled.	00-39-00-00
121	1.21.48	1.21.49	Pardon me?	31-35-11-22
122	1.21.49	1.21.51	That...important thing to do.	31-11-12-21
123	1.21.53	1.21.56	Uh...nausea?	31-22-12-21
124	1.21.56	1.21.57	No.	31-21-11-22
125	1.21.58	1.21.58	No vomiting.	31-22-12-21
126	1.21.59	1.21.59	No.	31-21-11-22
127	1.22.00	1.22.00	Diarrhea?	31-21-12-21
128	1.22.01	1.22.01	No.	31-21-11-22
129	1.22.03	1.22.04	Okay.	31-23-12-21
130	1.22.04	1.22.07	I had...first day.	31-21-11-22
131	1.22.08	1.22.08	Yeah.	31-23-12-21
132	1.22.09	1.22.12	But...trouble at all.	31-21-11-22
133	1.22.13	1.22.15	How many...movements today.	31-22-12-21
134	1.22.15	1.22.16	None.	31-21-11-22
135	1.22.17	1.22.18	One...say.	31-23-12-21
136	1.22.18	1.22.19	None.	31-21-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
137	1.22.19	1.22.20	None.	31-23-12-21
138	1.22.21	1.22.21	Zero.	31-23-11-22
139	1.22.22	1.22.29	Zero, okay...you...ears.	31-23-12-21 31-22-12-21
140	1.22.31	1.22.32	Garbled.	00-39-00-00
141	1.22.34	1.22.47	I'm not weak..don't think.	31-21-11-22
142	1.22.47	1.22.49	Do...feel sick?	31-22-12-]1
143	1.22.51	1.22.59	Nope I just...cold...mean sick?	31-21-11-22 31-35-11-22
144	1.23.01	1.23.03	No, do you...going to bed?	31-22-12-21
145	1.23.04	1.23.04	No.	31-21-11-22
146	1.23.05	1.23.15	Okay...need.	31-23-12-21
147	1.23.16	1.23.17	Garbled.	00-39-00-00
148	1.23.19	1.23.28	You mean...uncomfortable...functioning...to bed.	31-22-12-21
149	1.23.29	1.23.52	I...concentrate on my work...voice...all.	31-21-11-22
150	1.23.53	1.23.54	Your voice.	31-23-12-21
151	1.23.55	1.23.56	Garbled.	00-39-00-00
152	1.24.01	1.24.03	Did...well.	51-22-12-21
153	1.24.04	1.24.13	Uh, yea...I slept...period.	51-21-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
154	1.24.14	1.24.17	Alright...hour is that?	51-22-12-21
155	1.24.18	1.24.24	Uh, I don't know...station.	51-14-11-22
156	1.24.25	1.24.25	Okay.	51-23-12-21
157	1.24.27	1.24.45	Okay...8 hours of sleep...6 hours.	51-21-11-22
158	1.24.47	1.24.47	Okay.	51-23-12-21
159	1.24.48	1.24.49	Probably.	51-21-11-22
160	1.24.50	1.24.51	Did you...got up?	31/51-22-12-21
161	1.24.52	1.24.59	Yes, I did, quite...cold coming on.	31-21-11-22
162	1.25.03	1.25.12	Uh, are you...mentally tired test...to test.	32-22-12-21
163	1.25.13	1.25.13	Not particularly.	32-21-11-22
164	1.25.16	1.25.18	Psych. you're okay?	32-22-12-21
165	1.25.18	1.25.22	Oh, yeah, I'm...normal psych.	32-21-11-22
166	1.25.24	1.25.26	Uh, you don't have any headaches?	31-21-12-21
167	1.25.26	1.25.27	No, none...headache	31-21-11-22
168	1.25.29	1.25.29	Garbled	00-39-00-00
169	1.25.30	1.25.48	No,...noticed...eyes...psychomotor test	31/32-21-11-22
170	1.25.49	1.29.53	Are you...instruments yet?	32/46-22-12-21

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
171	1.25.54	1.26.05	No, mentally...psychomotor...might hand	32-21-11-22
172	1.26.05	1.26.06	Yeah.	32-23-12-21
173	1.26.07	1.26.10	My eyes...third time.	31-21-11-22
174	1.26.11	1.26.12	And they watered?	31-22-12-21
175	1.26.12	1.26.13	Yeah.	31-23-11-22
176	1.26.14	1.26.16	Okay buddy...off instruments.	31/46-11-12-21
177	1.26.17	1.26.23	Okay fine...in long time.	31/46-23-11-22 32-21-11-22
178	1.26.29	1.26.36	You are not...lights...dry throat?	66-22-12-21 31-22-12-21
179	1.26.37	1.26.51	Uh no, doesn't hurt...in my throat.	31-21-11-22
180	1.26.52	1.26.54	Okay...in your ears.	31-23-12-21 31-22-12-21
181	1.26.54	1.26.55	No.	31-21-11-22
182	1.27.01	1.27.07	Okay...stiff neck...breathing?	31-23-12-21 31-22-12-21
183	1.27.08	1.27.19	My nose is...blocked...breathing.	31-21-11-22
184	1.27.20	1.27.27	When you...exercise do you...	31/54-22-12-21
185	1.27.28	1.27.29	No, I...normal breathing.	31-21-11-22
186	1.27.31	1.27.32	Garbled.	00-39-00-00
187	1.27.34	1.27.35	No.	00-21-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
188	1.27.40	1.27.53	...do the exercises...short run...on the exercise	54-21-11-21
189	1.27.55	1.27.56	Thank you.	54-23-12-21
190	1.28.20	1.28.21	Garbled.	00-39-00-00
191	1.28.21	1.28.23	Have you had any...of your heart?	31-22-12-21
192	1.28.23	1.28.24	No, none at all.	31-21-11-22
193	1.28.25	1.28.26	Appetite has been good.	31-22-12-21
194	1.28.27	1.28.28	Uh yes, quite good.	31-21-11-22
195	1.28.30	1.28.30	Garbled.	00-39-00-00
196	1.28.45	1.28.47	I had two...a tube.	82-21-11-22
197	1.28.47	1.28.49	I see, uh...constipated?	31-23-12-21 31-22-12-21
198	1.28.50	1.29.00	No...I don't...sleepy right now.	31-21-11-22 31/51-21-11-22
199	1.29.03	1.29.06	You don't...stomach...or cramps.	31-22-12-21
200	1.29.06	1.29.07	No.	31-21-11-22
201	1.29.07	1.29.09	How many...urinated?	31-22-12-21
202	1.29.10	1.29.15	Uh about 3 times today.	31-21-11-22
203	1.29.16	1.29.17	Normal?	31-22-12-21
204	1.29.17	1.29.18	Yes.	31-21-11-22

IDENT.	START TIME	END TIME	TEXT	MESSAGE CODE
205	1.29.19	1.29.20	Okay normal.	31-23-12-21

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