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14 September 56

Subject: Conference on Aircrew Viability and Performance Monitoring.

to: Life Sciences Research Advisory Group.

A. Background Information:

1. Over the past 15 years considerable interest and effort has periodically been focussed on the problem of determining, as a function of time and place in the flight path, the precise state of an aircrew members consciousness and purposeful responsiveness. Although a wide range of psychophysiologic parameters have been studied and many different techniques of remote monitoring have been attempted, ~~the~~ the fact remains that, to date, there is no proven operationally usable system available.

2. Currently the only reliable (reasonably) means of determining the pilot's state of functional responsiveness is by voice communications with him through the radio link. If for any reason voice communications are lost by virtue of range, spherics, power failure or 'things happening too fast' in the cockpit for the pilot to use the radio then, in the event of a fatal accident, the true status of the pilot throughout the terminal emergency period may never be known. It is a well-known fact that a significant percentage of fatal accidents are listed as 'cause unknown.' As a corollary to this latter fact is the rather dubious indirect inference which is drawn to the factor of 'pilot error' or 'hypoxia' as being the basic causative factor, all of which might well constitute a completely erroneous conclusion.

3. Newcomers to the field of physiologic monitoring are frequently perplexed as to why, with all of the work going on in NASA, DOD & NIH R&D groups, we have yet to fly an operationally proven and reliable system. The simplest reply to such a query is to state that no system thus far has been able to satisfy all the requirements (and constraints imposed) set by such factors as; pilot comfort & mobility; aircraft electronics & power supply; reliability of the indicator(s) provided to the monitor at his observation post. It is unfortunately true that with all of the equipment, personnel and flying hours available to those of us in the Armed Services, we have yet to justify and mount a program which, over a period of reasonable time, would give us a usable solution to this very important problem. Perhaps, with the newly-injected interest of the FAA and the Commercial Airlines generated by forthcoming flight test and operational use of the SuperSonic Transport, we may be able to focalize our interests and integrate our resources in a more productive program than we have had in the past.

B. Directions of Current Programs:

1. Previous reference has been made to the fact that, at the present time there are a large number of programs underway which contain various degrees of inference in this particular problem. NASA continues to support a broad spectrum of research and development in this area of physiological monitoring and data retrieval, much of which has, at the very least, what could be called 'negative value' to this specific requirement, since their operational and scientific objectives are, understandably, more broader-based than this particular one. The term 'negative value' is applied only in the context that we can use the results of their R & D programs as indicators that certain avenues of approach are neither feasible or practical for our specific objectives. These areas of investigation are concerned principally with the sensing of a fairly large amount of psycho-physiological data which when properly coded, cross-referenced and integrated can be stored on board, read out on a rapid time sequence or used individually and/or collectively to signal a significant change in viability or performance to ground monitors or other companion crew members. This isn't at all to say that if a simple type of viability or performance indicator based upon a new principle were developed they would have no use for it, but rather that because of their broad operational requirements, they must work toward more complicated and sophisticated systems than this objective represents.

2. In a similar sense, the DOD aerospace medical efforts in the biotlemetry field are largely directed toward the rather complex and sophisticated systems of personnel monitoring as are envisioned as being required for the MOL program. Although one finds considerable disperse interest expressed by operational flight surgeons assigned to flight end-- test activities and in some AF special projects, one does not find any large scale interest backed up by financial support within the R&D commands for a device of such seeming simplicity. One might even say that the operational people can, in effect, see no justification in developing such a capability.

3. If one then looks over into the clinical field of the intensive care monitoring projects supported by NIH, there is found virtually the same type of closely contained interest and directions; namely the attainment of a reliable capability to sense and display with great rapidity, minute and detailed changes occurring in a patient who already is in a state of criticality, and therefore represents no true analogue of our human component in his operational environment and milieu. Again, as in the case of the NASA and DOD work, there is undoubtedly some guidance which we can obtain from the NIH work which may prove of value but at the same time the glib coordinators must realize that there is no direct and easy extrapolation from the sick room to an air craft nor from a severely ill or damaged patient to the (initially) healthy air crew member.

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11 C. Summary of Current Status:

12 1. There is no (known) R,D & T program in the field of physiologic
13 cal monitoring which has, as its principal objective, the ability
14 to reliably determine the functional and responsive state of the
15 aircrew member under operational conditions.

16 .2 The objectives of on-going NASA and DOD programs in this
17 area of biotechnology are primarily directed toward;

18 a. improving the quality and quantity of bio-signals,

19 b. integrating and automatizing certain bio-variables
20 in order to provide more significant and readily
21 interpretable real time information to the ground
22 medical monitors for flight safety decisions.

23 c. to facilitate and validate the read-out and
24 interpretation of large amounts of in-flight psycho-
25 physiological data for both short and long range
26 research studies.

27 d. to provide greater comfort and mobility to the
28 flight crew in wearing the bio-sensor rigs.

29 e. to optimize the amount of ^{valid} bio-information
30 handled within the prescribed limitations of
31 power, band-width and recording modes available.

32 3. The objectives of on-going programs in this area
33 being prosecuted under the aegis of the Government
34 Health Agencies are primarily directed toward the
35 improvement in the institutionalized care of the sick
36 particularly under critical conditions requiring
37 'intensive care.'

38 4. Fringe areas of interest such as are ~~found~~ expressed
39 in a wide variety of uncoordinated projects and programs
40 are found in such fields as; sport medicine; industrial
41 health & hygiene; parachuting & sky diving and underwater
42 exploration and habitation. The principal results to date
43 of these programs which have some ancillary bearing on
44 our specific objective are:

45 a. the improvement of the wearability of the bio-
46 monitoring rigs by individuals working (or playing)
47 under a wide variety of/activities,
48 environmental conditions and

b. In general, the data obtained through the use of these various rigs have been of poor quality with poor signal to noise ratios with all of them suffering from the same set of factors, namely: excessive mobility and poor conductance of the body sensors; excessive interference from 'outside' noise sources; inadequate transmitting power available and concomitant poor receptivity and signal discrimination at the display and/or recording station.

c. In those experiments from which interpretable data has been obtained the principal conclusions reached have been as follows:

i - man generally shows a wider variation in physiological systems response (pulse & resp) throughout his daily activities than previously held.

ii - the anticipation of a difficult or potentially hazardous task evokes greater response than in the subsequent actual performance of it.

iii - Training, past experience and a good index of physical fitness significantly reduce the degree of response; 'lessen the total body burden'.

D. Proposed Work to be Carried Out at Madira Center.

1. Through his past 4-5 years work in the Cardio-vascular Laboratory unit within the FAA GCRI complex which has since been disbanded with partial relocation at has developed a highly skilled team of scientists and technicians capable of carrying out extensive and detailed studies of cardio-respiratory function. Equipment and instrumentation provides for a wide range of functional studies under both normal and stressful situations, with complete facilities for data retrieval and correlation. In addition to his own team, he has the privilege of calling upon additional experts in specialized biomedical fields for guidance from the faculty members of the Medical Center. His program of continued research is being partially supported by

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2. Subject population for use by Dr. [redacted] group in their further experimental studies is largely composed of flying personnel and air traffic controllers, the majority of whom have been followed by the GCRI for at least 4 years. Additional subjects are readily available from the student body and also as volunteers from the local government organizations.

3. Within the above subject population group are a number of individuals with proven coronary disease who have been quite extensively studied on a continuing basis. Displaying a wide variety of 'patterns' of cardio-vascular malfunction in the form of electro-mechanical and acoustical abnormalities, they provide a template of sorts against which can be measured certain patterns of early changes in 'normal' individuals which may prove useful in predicting 'pre-coronary' susceptibility.

4. Based on a premise that these same early, abnormal responses found in both aged pilots and those with coronary disease might be indicative of degraded cardio-vascular function in a younger individual with poor, intrinsic stress-response characteristics, it would appear feasible and potentially valuable to join with this group, in the furtherance of our own studies.

5. In addition, (to the reason given in #4 above) it would be equally valuable for [redacted] to have immediately available, a completely equipped and operating laboratory research facility which would allow a quick reacting capability to assess and evaluate new techniques and procedures for possible further development and operational trial.