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Aviation Medicine on the Threshold of Space: A Symposium

Achievements of the Past Year

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IN THE INTRODUCTION to this symposium I would like to point out that when the final history of space travel is written, the year 1957-1958 will stand out among the most important milestones. This will be true, first, because of the incontrovertible demonstration this year that the orbiting of vehicles above the drag of the atmosphere is possible and feasible; second, that they operate in general according to past calculations; third, that there are no particular "bogey men" up there which have not been suspected, pretty well assessed and properly taken into consideration; fourth, because public interest and support of the space travel effort has caught up with and possibly is now running ahead of programs for its accomplishment.

That which is true of space travel is similarly true of space medicine. Certainly, we of this organization have been among the leaders and pioneers and have done more than our part in pointing to the path and the problems. This service has been performed in a dignified manner which has always appeared logical, reasonable, and digestable to the scientific community and the public.

In my own estimation, the most significant mileposts of the year have been, according to date:

August 19-20, 1957—Lieutenant Colonel David G. Simon's balloon flight to a peak altitude in excess of 102,000 feet. He remained in the capsule for approximately thirty-two hours before descent.

October 4, 1957—The launching into orbit of the Russian satellite *Sputnik I.*

November 3, 1957—The launching into orbit of the Russian *Sputnik II* which, ac-

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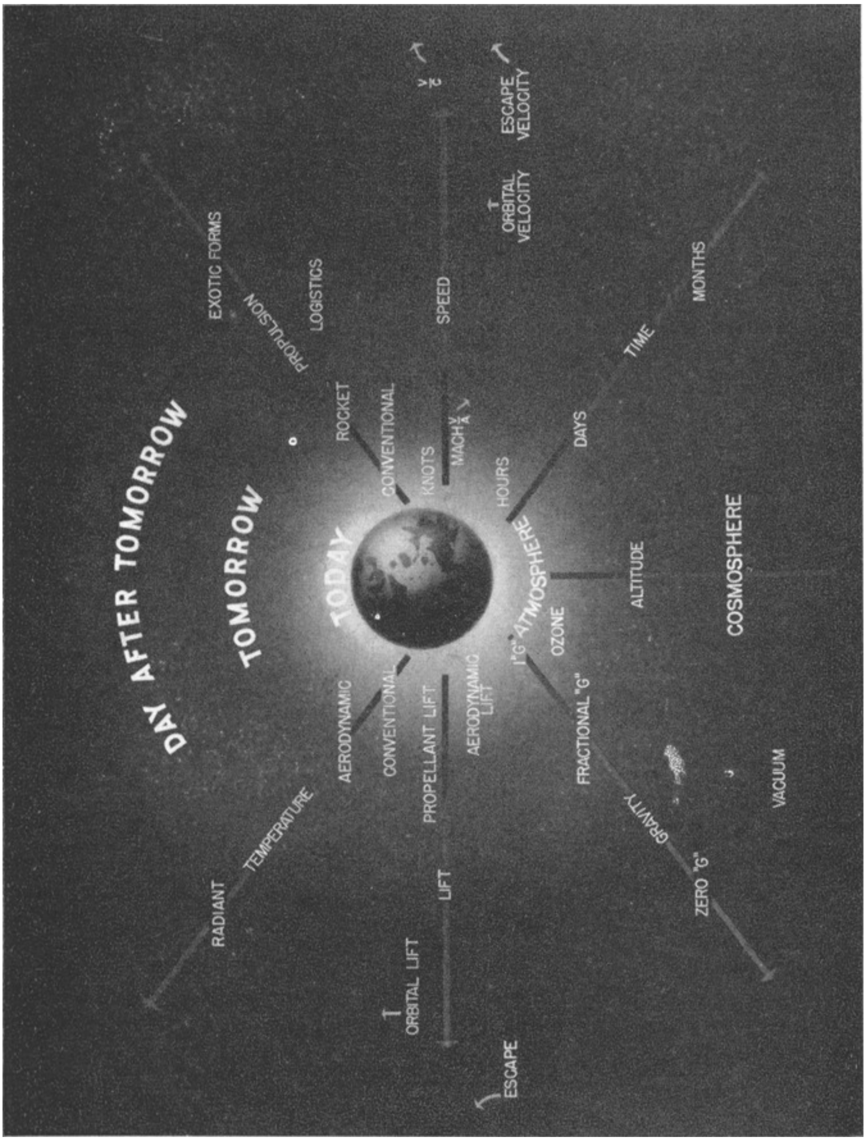

Fig. 1. The human parameters of space flight, couched in terms of today, tomorrow, and day after tomorrow, and demonstrating the transition of aviation medicine into space medicine.

cording to press reports, placed a live dog in orbit.

December 20, 1957—Mr. Siegfried Hansen of Litton Industries, Beverly Hills, California, reached a simulated vacuum chamber altitude of 7×10^{-6} mm. Hg. (This represents 84 miles of simulated altitude if one uses the ARDC model atmosphere as a guide, or 129 miles according to the NAVORD report. This discrepancy points to our need for more information concerning the density of the fringe areas of the atmosphere.)

January 31, 1958—The launching of America's satellite *Explorer I.*

February 16, 1958—The completion of Airman Donald Farrell's one week's stay in the U. S. Air Force School of Aviation Medicine space cabin simulator.

March 17, 1958—*Vanguard* launched.

These events represent a beginning of a more or less precipitous portion of the upward exponential swing of the curve of progress towards the achievement of space travel. This situation has resulted from the accumulation of bits and pieces of knowledge piling upon other accumulations and resulting in logarithmic growth. Many in this organization have anticipated such a trend for a number of years. The growth curve of the organization's membership and its productivity reflects the trend. The achievements in space medicine have, without doubt, been among the causal factors in the rapid development of the state of the art of space travel. The Aero Medical Association has been a sounding board for the communication of new ideas and new knowledge, much of which has been grasped by other groups for application.

Probably the most significant happening of the past year has been the public recognition of the possibility of space flight. That which our youngsters have accepted for the past few years without much reservation has now reached adult consciousness and has, to say the least, enthralled them. I understand fathers are now telling their children about space flight—a complete reversal of the former trend.

Let us have a look at our human factors parameters and see approximately where we stand (Fig. 1). The parameters of space flight can be categorized as propulsion, speed, time, the correlates of altitude, the presence or absence of the gravity vector, types of lift and finally the temperature parameter. It can readily be seen in a diagram of this sort how aviation medicine makes a smooth transition into space medicine and that the problems of space medicine, for the most part, are those of aviation medicine projected into more hostile situations and environments. The human parameters of aviation medicine and space medicine in general, are the same.

Turning first to propulsion, it appears that we can now live with most of the various types of propulsion which might be used to get man into space. Acceleration, produced by the propulsive systems, must of course be tolerable. Ballinger[1] and others have studied acceleration patterns for some of the types of flights which might be considered. They have considered them tolerable, within limits, if positioning is proper.

In the next parameter, speed, generally speaking, is one of the areas in which our manned vehicle achievements have lagged far behind that which is required.

Figure 2 is the usual graph of speed achievement plotted chronologically, ending with Captain Millburn Apt's ill-fated flight of 2148 miles per hour on September 27, 1956. When we study this same plot (Fig. 3) in terms of orbital speeds or possibly escape velocity, the present situation leaves much to be desired. Formerly we indicated airspeed in terms of miles per hour, then knots, and now in Mach numbers. There can be no airspeed where there is no air; there is no Mach number where there is no speed of sound, as is true in the vacuum of space. Consequently, there are many problems in the field of navigation, instrumentation and display which need considerable study, even from the human factors point of view.

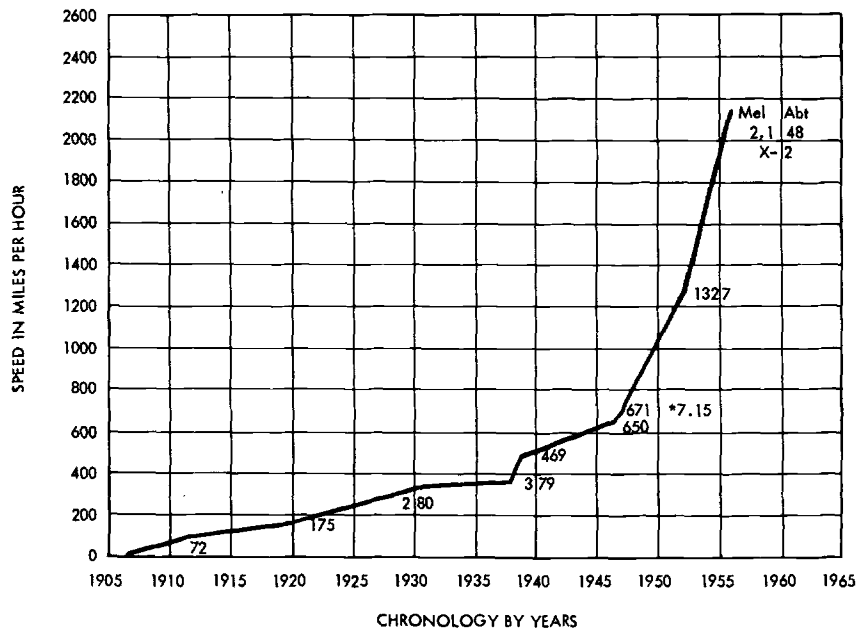

Fig. 2. Speed achievements plotted chronologically.

In the time parameter we have two important achievements which have been mentioned before. Both Colonel Simon's stay in a sealed capsule on the fringes of space for approximately thirty-two hours, under space-equivalent conditions and Airman Farrell's week-long residence in a simulated space cabin, are significant mileposts.

Altitudewise (Fig. 4), we must still use Captain Iven Kincheloe's flight of September 7, 1956, penetrating something in the neighborhood of 99.6 per cent (Fig. 5) of the mass of the atmosphere, as our primary achievement, although it was performed a year and a half ago. This achievement is particularly important because, as is well known, most of the human problems of space flight stem from either the presence of, or the absense of, the

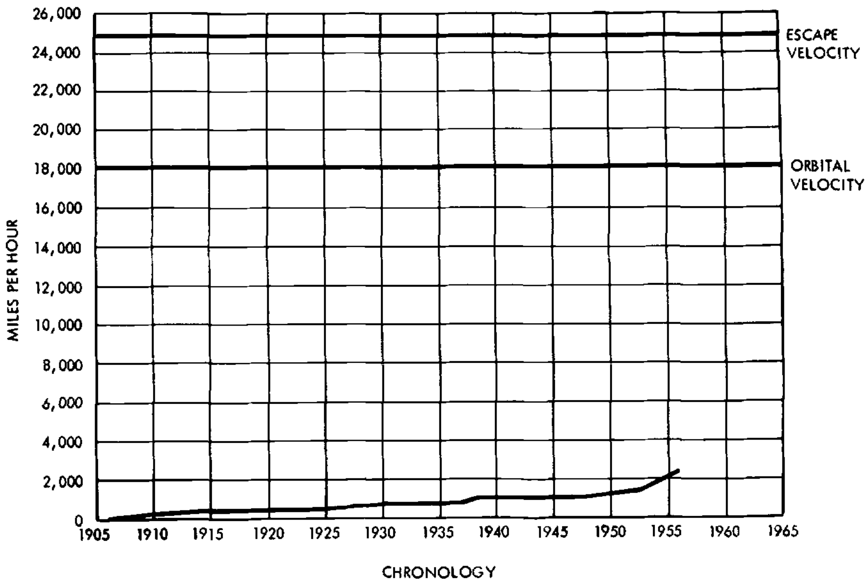

Fig. 3. Speed achievements plotted in relation to orbital and escape velocity.

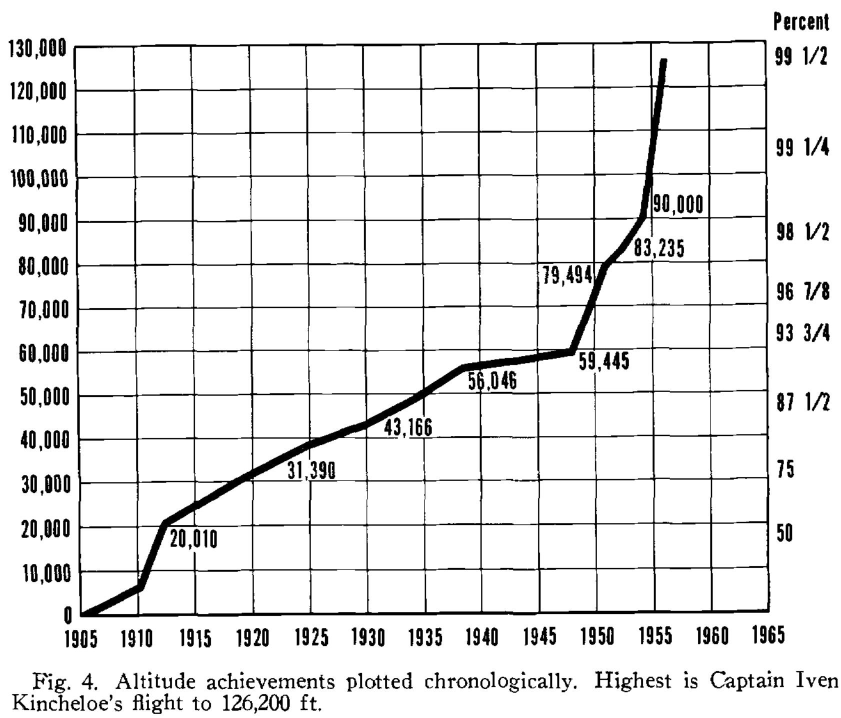

Fig. 4. Altitude achievements plotted chronologically. Highest is Captain Iven Kincheloe's flight to 126,200 ft.

earth's atmosphere. The Litton Industries' manned chamber, run to 84 or 129 miles of simulated altitude (depending upon the atmospheric tables used), has improved this segment of the state of the art by a factor of more than two and has given us the vacuum environment of the fringes of space as a workshop. The orbiting satellites will tell us more about atmospheric density in the upper reaches and will reveal if our quantitative and qualitative estimates of cosmic radiation and meteoritic material is about as calculated.

In the gravity meridian, the *Sputniks*, and the *Explorer* and *Vanguard* satellites have proven that the orbiting situation is as calculated. The School of Aviation Medicine's parabolic flights have increased our knowledge of biologic reactions to the weightlessness or fractional-gravity state, bringing the time factor up to about 40 seconds.

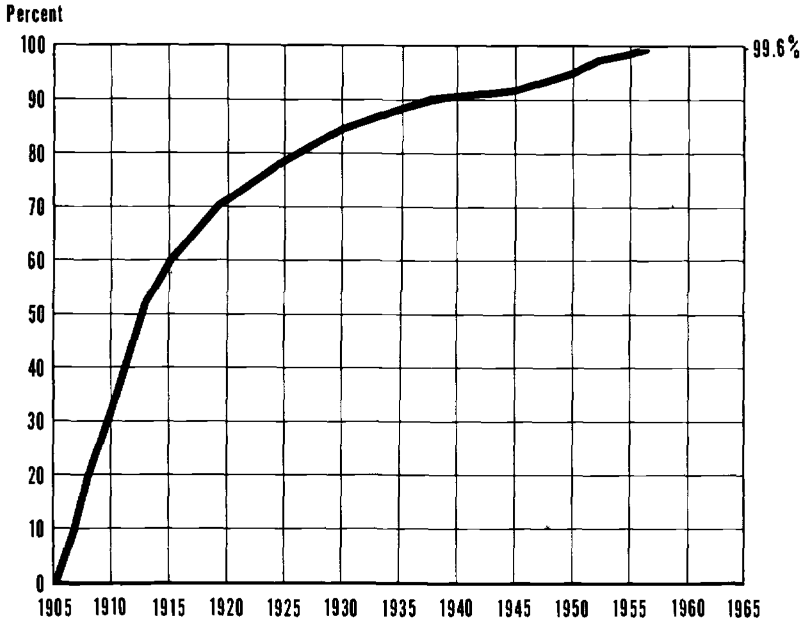

Fig. 5. Altitude achievements plotted in terms of per cent of mass of atmosphere penetrated.' Captain Kincheloe penetrated about 99.6 per cent of atmospheric mass.

We have covered the lift parameter and now come to the final parameter, which is temperature. The *Explorer*,[2] as it moves from direct sunlight to the earth' shadow, spans a potential skin temperature range of from 300° to 100° C. below zero. Internal temperatures have been kept between 10° and 30° C., or 50° to 86° F., an acceptable range for human habitation.

Before closing, it must be pointed out that the most serious human problem remains that of *reentry* under conditions of deceleration, temperature and vehicular control which will return the occupant safely to earth within a preselected area. To emphasize the seriousness of this problem, Figure 6 shows a line drawn about the earth into about four equal layers the innermost quarter would represent the first five miles—that portion in which all of the biologic inhabitants of the earth

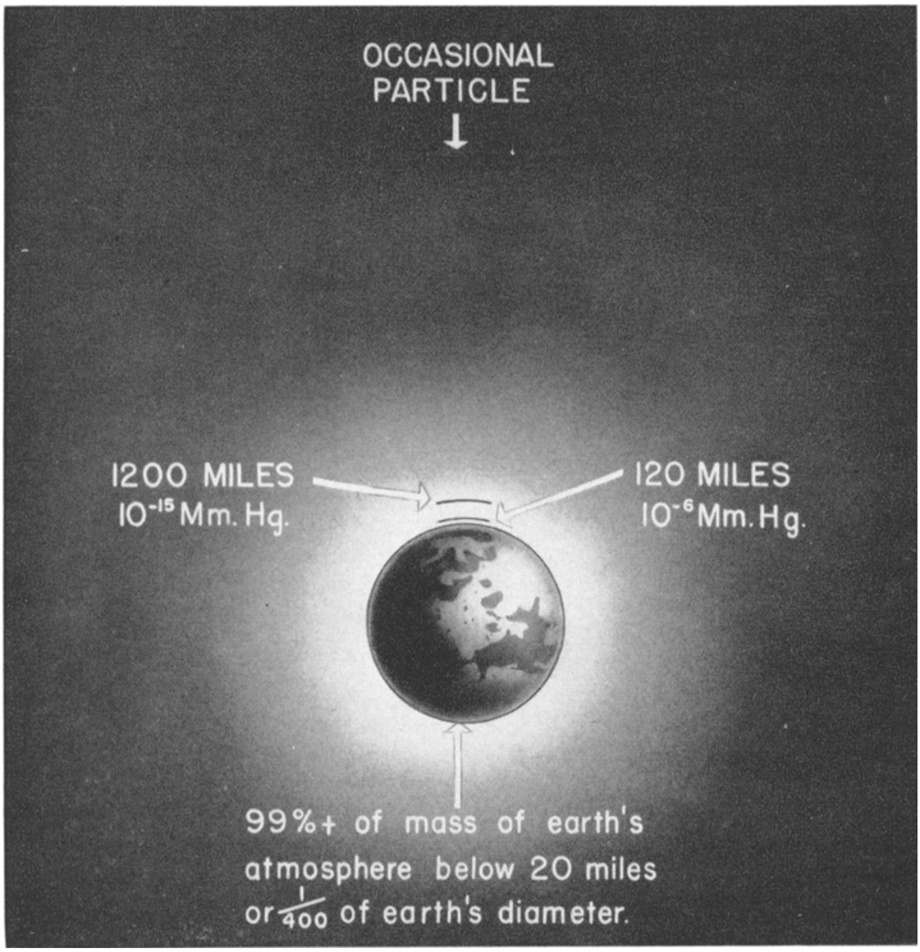

Fig. 6. Diagram illustrating the thinness of the major portion of the earth's atmospheric mass. The very fine black line around the earth represents 99 per cent of the earth's atmospheric mass. It lies within the first 20 miles of altitude.

with engineer's precision, having a thickness representing about one-four-hundredths of the earth's diameter, or about 20 miles. This is the thickness of that portion of atmosphere representing 99 per cent of the amospheric mass. If we divide this very thin line dwell. The first half corresponds to ten miles of altitude and is that area comprising something like 90 per cent of the atmospheric mass. Almost all flight takes place in this area. The numbers of those who have penetrated the third quarter have been limited to those flying the better aircraft. Only a few have penetrated the outermost quarter. Thus, one can visualize the immensity of the problem of entering this relatively compact mass at a proper angle at very high speed. If the angle with the earth's surface is too acute, aerodynamic heating will be the problem. If it is too obtuse, the vehicle will go outward again. Slowing before re-entry requires relatively huge amounts of energy, or dissipation of huge amounts of energy. In spite of all the obstacles, progress this year by any standard has been greatest of all the years of the past.

It is now time to review the state of the art of space medicine in terms of specific advancements. We shall turn to the experts of our symposium for their reports.

First, Dr. Hermann J. Schaefer of the U. S. Naval School of Aviation Medicine, Pensacola, Florida, will talk to us concerning new knowledge of "Cosmic Radiation." Dr. Dietrich E. Beischer will follow with the potentialities and ramifications of life under extraordinary environmental conditions. Dr. Siegfried Gerathewohl will describe new experiments during weightlessness. Mr. Everett E. Beson has chosen the title, "Considerations in Design of a Balloon-Borne Pressurized Capsule for High Altitude Bailout Studies," and Capt. W. R. Hawkins will speak on "Feasibility of Reutilization of Urine in Closed Ecological Systems." We will close with the presentation of Dr. C. C. Clark on "A Closed Food Cycle Atomic Conservation for Space Flights."

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2. Laurence, W. L.: Science in review. *New York Times,* February 9, 1958, p. E9.