CAN THE HUMAN BODY KEEP PACE WITH THE AIRPLANE?

*David A. Myers**

WE ARE in the midst of a new industrial and commercial era born of aviation. New eras commenced with steamboats, with the railroads, and the automobile. Their dawns were marked with misgivings and catastrophes that befogged the popular vision. So in aviation, the heroic recklessness that the hazards of war made necessary, the dramatic daring of pioneers trying their wings beyond the realms of known safety, the foolish adventures of unskilled fliers in obsolete machines, diverted public attention for awhile from what was going on in the solid, safe development of air transportation. This new era does not imply the discarding of old established means of transportation. It means a sudden extension of the capabilities of man; the power to reach hitherto inaccessible spots unerringly and with great swiftness; a means of leaping geographical boundaries in comfort and safety, and another triumph over all consuming time."

Let us assume that the human body is a machine endowed with brains and supplied with an intelligence system. This intelligence system is comparable to the intelligence system of a nation and has two functions, one dealing with domestic (internal) and the other with foreign (external) relations of the body. An inflamed appendix about to burst is a strictly internal domestic affair, but the approaching surgeon with his shiny instruments is something for the foreign relations department to look after. It is not possible for the "domestic relations" department to be upset and not affect the "foreign relations." The reverse is equally true. Between the two departments harmony must exist if the human body is to survive and perform its functions while living in the air.

You engineers push a plane out on the line and say, "There she is boys. She'll do 500 an hour and go to 50,000 feet," and be it said to their everlasting credit, some pilot will step up and say, "All right, let's go." About this time, a serious looking gentleman (the boys call him a Flight Surgeon) steps up and says, "How about going along? I think the crate will do what they say it will, but I am not so sure what will happen to 'Old Timer' up there in the pilot's seat, and if you fellows are going to continue these flights, I've got to know because I have to take care of 'Old Timer' after he gets back and fix him up so he can go again." So far the engineers have outdistanced the Flight Surgeons. You have built aircraft capable of annihilating space at any altitude including the stratosphere. The Flight Surgeon has not yet arrived at definite conclusions as to what "major overhaul" it is necessary to accomplish in human beings in order that they may operate and accompany, with safety and comfort, these speeding demons. The reasons for this lagging are very evident. Every era of transportation has produced its own category of human ills and problems. Each era has eventually produced a solution of these problems. An essential thing in the progress of mankind is the prevention of untoward effects arising from the environment in which we live and function.

From the Wrights and Kitty Hawk to the present space annihilating airplane is a long way in terms of transportation. It is a much longer way in terms of adapting the human body to the change. You and your airplane are subjecting the human body to conditions heretofore deemed impossible. Unlimited speeds are in the offing. Substratosphere flying is already here; the stratosphere

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is next. Can the human body survive and continue to efficiently function in such environments? Frankly we do not know. It is imperative therefore that construction and aerodynamic projects be co-ordinated with medical research. It is useless to build ships if we cannot use them, and if we cannot use them it is useless to build them. For after all is said and done, the airplane is still a man controlled machine. Mechanical robots will not solve the problem, for if the human pilot cannot survive neither can the passenger, and commercial aviation depends on "passengers." The whole world is "air minded," but unfortunately not "air wise." It is therefore up to us who make a vocation of flying and its allied factors to solve the problems confronting both military and commercial aviation, in order that mankind may proceed with safety and comfort, when, where, and how he desires.

There are very few local factors to be considered. Air is air, whether it is blistering hot or icy cold, dense or rarefied, it is still air and on it we must depend for life. The effects of speed, sudden accelerations, centrifugal and centripetal force, altitude, cold, fatigue, extraneous gases, gravity, etc., are the same at the equator as at the north pole.

Given time and opportunity the Flight Surgeon who understands the human machine will eventually solve the human problems of flight. Perhaps you are asking what kind of a bird is a Flight Surgeon? A Flight Surgeon is a doctor ordered to the Medical Division of the Air Corps, a component part of the Medical Corps of the Army, assigned to the duty of living with, flying with, studying these human birds both in flight and on the ground. The Flight Surgeon Corps is a body of men both civilian and military, all government trained at a special school of Aviation Medicine; officers by profession, doctors by education, and fliers by necessity. They are able to draw upon the unlimited store of knowledge possessed by the medical profession in general, trained in specialized examinations, and taught especially to observe the reactions of the human body under stress of flying. These pioneer flying doctors, with the aid of the profession at large, are able to come to definite conclusions on the human problems of flying. Much experimental and research work is still needed before the present attainable speeds and altitudes are made safe for not only military personnel, but for Mr. Average Citizen. Recent legislation restricts the number of Flight Surgeons who can participate in flying to five (5) for the entire army. This will naturally stop all medical experimental and research work incident to flying. Since commercial aviation has almost entirely depended on the Air Corps for the solution of the human problems incident to flying, this information of necessity will no longer be available unless future legislation changes the present status.

Altitude Sickness

The life of man is dependent not on the quantity or percentage of oxygen in the atmosphere but on its pressure. Altitude sickness is a form of asphyxia due to diminished partial pressure of oxygen. Bert, Douglas, Haldane, Henderson, and others have accomplished much valuable research work regarding the physiological phenomena of altitude. As soon as an attempt is made, however, to interpret the phenomena of altitude in terms of their causes, difficulties arise. The reason for contradictory theories is to be found in the complexity of the factors which enter into the environment at high altitudes. Among the climatic variables are the low atmospheric pressure with its low partial pressure of oxygen, the peculiarities of the sunshine, low temperature and humidity, the high wind, the electric conditions of the atmosphere and ionization.

It is clearly established that high altitudes or low barometric pressure, when first encountered interfere with the normal workings of the human machine. A sudden disturbance of any sort of the bodily functions is usually manifested by symptoms of illness. The disturbances brought on by change of altitude, the symptoms of which are occasionally so mild, depending upon the altitude, may be entirely overlooked by the unobservant. Mankind differs greatly in the power of adjustment to changes of environment. Hence, it is found that altitude sickness befalls some individuals at a lower, others at a higher altitude, but it is also certain that no one who ascends beyond a certain elevation—the critical line for him—escapes the malady. An elevation of 10,000 feet or even less might provoke it in some, others may escape the symptoms up to 14,000 feet, while only a very few possessed of unusual resisting power, can without distress venture upward to 19,000 feet. The symptoms of altitude sickness depend not only on the nature of the individual and his physical condition, but also on various contingencies, especially on the amount of physical exertion made in ascending. Somewhere between 40,000 and 45,000 feet is undoubtedly the limit for man, even when supplied with oxygen *under ordinary circumstances*. Somewhere near this point the barometric pressure would be 100 mm. Deducting from this the 47 mm. of water vapor accumulating in the inspired air, leaves a pressure of 53 mm. when the air finally reaches the lungs (Bauer). Now if we breathed pure oxygen this would be true and life would be sustained, but under the present plan of tube or mask inhalation, the oxygen cannot remain undiluted, but becomes decreased by the nitrogen of the air. The diminished pressure causes nitrogen to be given off by the blood which still further dilutes the aveolar air present. The true available oxygen pressure in the lungs is therefore not 53 mm. 40 mm. available oxygen pressure in the depths of the lungs is about the minimum required and even at this point the blood is venous and there is oxygen want. However, if the oxygen pressure remained at this point it would be possible to survive so far as *oxygen* was concerned, provided the CO_2 pressure was kept up. The oxygen want present however causes the CO_2 to be lost from the body with a rapid fall of CO_2 pressure. This results in decreasing the oxygenation of the tissues, so that if the CO_2 pressure falls below 40 mm., even though the oxygen pressure is maintained at 40 mm., there will not be sufficient oxidation of the tissues to continue life. A mixture of CO_2 and oxygen would possibly allow a little higher altitude. Beyond the critical line, 40,000 to 45,000 feet, it is impossible for a human being to go and live, even though he is breathing pure oxygen, for beyond this point the available oxygen pressure in the lungs will not sustain life (Bauer). Henderson confirmed the importance of the relationship of oxygen and CO_2 when he demonstrated that it was possible to produce so great a deficiency of CO_2 in the lungs by overventilation that death ensued from a lack of oxygen due to lack of efforts to breathe. It has been demonstrated that up to 14,000 feet (barometric pressure 450 mm.) the inhalation of small amounts of carbon dioxide with the inspired air was distinctly beneficial in protecting the individual against the vicious circle of abnormal breathing and oxygen want. These results were noted on experiments made on individuals who had undergone any particular physical exertion in arriving at the testing altitude. The advisability of testing out the use of carbon dioxide at higher altitudes is therefore apparent. Data available from any research work on the use of oxygen in the prevention of altitude sickness show only one positive finding—that oxygen is absolutely essential. There are no conclusive results available covering the following points:

1. The most favorable amount to be inhaled by each individual.
2. The effects of frequent use.

3. Effects if used for long periods of time.
4. The cause of its apparently destructive effects on the teeth and perhaps other body components.
5. As to whether gaseous or liquid forms are best for human use.
6. The degree of concentration at which it becomes detrimental to the system.
7. The oxygen requirements of a sealed cabin and a supercharged pressure cabin.
8. Effects of oxygen and CO_2 mixtures at altitudes above 14,000 feet.

The symptoms produced in the nervous system by higher altitudes are of the most importance from a performance standpoint. There is dulling of the senses and intellect without the individual being aware of it. Memory is affected early and is finally almost lost. Rational judgment is impaired, resulting in fixed, erroneous ideas and often in uncontrolled, emotional outbursts. Muscle coordination is much affected. Power over the limbs is lost, the legs begin to paralyze, then the arms, and finally the head. The senses are lost one by one, hearing being the last to go. Any sense of pain is lost early. Without cause there may be laughter, shouting, singing, tears, or actual violent actions. Always, however, there is present complete and satisfactory confidence regarding everything that is happening. Those of you who are familiar with the apparatus originated by Prof. Yandell Henderson and called the Henderson Rebreather that was in universal use during and after the World War in the altitude classification of flier, will vividly recall your experiences. With the passing of the old time fliers who have all been altitude classified, the advisability of again establishing Rebreather or altitude classification units is being seriously considered. If commercial aviation invades the "next to nothing" spaces, some ready means of classifying passengers would appear worthy of development. It is desired to stress the following: That while the essential cause of altitude reactions is lack of oxygen (anoxemia), the functional disturbances noted are not merely anoxial but are largely the expression of a secondary and almost equally important deficiency of carbon dioxide in the blood and the tissues. Deficiency in oxygen induces over-breathing and a resulting deficiency of carbon dioxide. Reduced carbon dioxide in turn causes subnormal respiration and this in turn increases deficiency in oxygen.

It is therefore apparent that the problem we are confronted with in altitude flying is the maintenance of the positive pressure around the body and in the lungs. This is an engineering problem. From the physical standpoint, the low densities, pressures and temperatures are a serious hindrance, in that special precautions must be taken to allow the human body to survive.

Our findings regarding the physiological reactions of man to the several types of anoxemia show clearly that the response to lack of oxygen varies with the rate at which the oxygen is decreased, the degree to which it is reduced, and the length of time it is reduced. The respiratory, circulatory, and blood changes have not been found to be the same in the several methods studied for producing this condition. It seems the reaction of the aviator to the lack of oxygen experienced during high altitude flights is quite different from either the very rapidly produced anoxemia of nitrogen breathing or the slowly developed condition of the mountain climber. Because man reacts in a certain way to nitrogen or to mountain living, it is not safe to predict how he will respond to lack of oxygen during high altitude flights. Laboratory results are positive only when we subject man to the conditions of an altitude flight. This is reasonably well accomplished with the use of the pneumatic cabinet, in which it is possible to eliminate all factors except lowered barometric pressure, and also to study the added influence of other altitude factors. Your answer to all this at the present time is "super-charging"; only time and extended research can furnish the ultimate solution.

PROBLEMS ARISING FROM THE EFFECTS OF HIGH SPEED ON LIVING TISSUE

In considering this most important subject, two main factors must be kept in mind (1) the immediate and the ultimate effect on the body tissue; (2) the immediate effect from a performance standpoint on the individual. The problems of speed, centrifugal force, sudden accelerations, sudden retardation, etc., are carefully figured out by engineers in order that the finished aircraft may withstand all the stresses it will be subjected to. Then it is turned over to a human being to put it through its paces. You cannot build human beings according to specifications. They are produced "as is," and to a doctor usually C.O.D. You can design a wing that will not come off or crumple at 600 miles an hour, but we cannot supply a liver that will stay in its proper place and continue to function under the imposed conditions. Engineers estimate the ultimate speed at sea level at around 660 miles per hour (thank God for small favors), and undoubtedly human beings can withstand this speed or speeds in excess of it. It's when the aircraft makes turns, banks, and dives that centrifugal and centripetal force will begin to create havoc with the human body. The effects of speed "per se" may be minimized, the effects of changes of rapid motion will cause trouble, how much is yet unknown. Firestone remarks the time is at hand to (1) evaluate the possible attainable speeds and (2) study the possible effects of these speeds on the flier. The engineering problems of design of aircraft to attain speed and withstand the increased stresses are primarily (1) the power plant, (2) the aircraft itself, (3) air resistance. What the limitations of speed are from an engineering standpoint are unknown to the author. Your problem is one of design and construction; our problem is one of adaptation of a known and fixed entity to new environment.

Garsaux in experiments with dogs rotated them on a wheel at speeds varying from four to six turns per second. Some of the dogs showed actual injury to the brain from the brain being pressed against the skull. Recovery followed in some, death in others. Autopsies showed that there was an anemia of the brain and an engorgement of the vessels of the abdominal area, thus bearing out the above statements about the aviator. Bauer states, "It is, therefore, not a wild theory to presume that a speed may yet be attained which when a turn is made would be sufficient to cause pressure on the stem of the brain in such a manner as to cause death. Furthermore, the force of such violent action would be sufficient to rupture blood vessels both in the brain and in other parts of the body, which might be sufficient to cause death or lasting injury." Firestone disagrees with the findings of Garsaux because as he states Garsaux rotated his animals. He attributes the actual trauma produced in the brains of these animals to the rotation and not the centrifugal and centripetal force applied. Stating that no flier would rotate enough to produce Garsaux's findings, he believes that it is difficult to conceive how sudden changes of direction in a high speed plane can produce injury to the brain. Bauer does not agree with Firestone's deductions. Centrifugal force acts away from the center. Centripetal force acts towards the center. Centrifugal force acting on the individual tends to carry him in the original direction he was traveling. Traveling at a high rate of speed and suddenly going into a turn, centrifugal force acts on the flier to carry him in the direction of original travel. He cannot move, being firmly fixed by strapping.

The body, however, being made up of much that is fluid and semifluid, and everything contained in the body that is moveable, tends to keep moving in the original direction. This actually does produce temporary unconsciousness ("blacking out") and it is conceivable that damage may ensue to any of the internal organs and possible for the brain to be sucked down towards the foramen magnum and result in actual brain injury. The damage incurred is the result of the endeavor of the fluid and semifluid contents of the body to move in the direction of centrifugal force. In 1925 Bauer made the statement, "A straight ahead speed will cause less effect than turning at the same speed, and what the limit is time alone will tell." So far as we know time will still have to tell. There is no question that the body accommodates itself to gradual accelerations and one would be rash indeed to assert what the limit of the human body is to straight ahead speed. Sudden changes of direction at high speeds are dangerous, however, as has been proved in many instances, and it is this factor of turning at high speed which renders speed flying dangerous. There may be some argument as to the physiological cause of "blacking out," eye retinal hemorrhages, and brain damage, that have been known to occur, but there can be no argument that they have occurred.

A centrifugal machine is being constructed at the Physiological Research Unit of the Air Corps at Wright Field, Dayton, Ohio, under the supervision of Capt. Harry G. Armstrong, M. C., Flight Surgeon Medical Director. By means of this equipment, animal experimentation will be carried out and definite conclusions searched for as to the limits of human resistance, with the hope in the background that the research may enable the medical man to evolve some means whereby he can "overhaul" the human body to keep pace with the engineers and their modern aircraft. Wurdeman suggests that animal organs and small live animals be projected by rockets or gun grenades with self-opening parachutes at the height of trajectory. Recovery and examination of these animals would help decide the effects of speed, rapid acceleration and retardation on the tissues of the body. Information could be obtained from delayed parachute jumpers and examinations following a series of such might yield much information. The autopsy findings in the case of the fellow who was shot out of a cannon at one of the California beaches might be useful. That flight had the elements of sudden acceleration and sudden retardation, including death. Until we can correlate all of our findings and accomplish more research the engineers are requested "to slow up on the turns."

"Blacking Out"

"Blacking out" or temporary unconsciousness of the pilot first came under the author's personal observation during a tour of duty with a Pursuit Squadron in the Hawaiian Islands, 1923–1926. Pursuit aviation requires much aerobatic flying either single or in formation, and all the elements of speed, sudden acceleration, banks, turns, diving, etc., are present. Information was hard to obtain since the pilots were loath to admit anything was happening to them while in flight. Their idea was that this was an individual reaction and not a universal phenomenon. This "blacking out" was reported when coming out of long dives, and to a less extent on sharp banks and turns. It persisted in some cases until the upward flight had traversed several hundred feet. The period varied in individuals. The sequence of events producing this reaction is as follows:

1. Sudden change to dive position (head down) with increasing acceleration.

2. Sudden and violent change of direction and position at the end of the dive in preparation for the upward climb.
3. Sudden and violent change of position and direction with acceleration going into the upward climb.

This sequence of events takes place in military aviation in nearly all ground attack objectives, air combat, gunnery and bombing practice, etc. The reaction is universally admitted by all who participate. During the downward dive there is an excessive supply of blood drawn from the splanchnic (abdominal) reservoirs to the brain. During the flattening out of the sudden ascent, there is an excessive drainage of blood from the brain to the splanchnic area. Old time pilots adopted various means to try to overcome this "blacking out." Some cried out as loudly as they could. Some wore tight belts. Some cocked their heads sharply to one side. Some filled their lungs and forcibly held their breath. No matter what they did they all "blacked out." Unconsciously they were adopting measures in an attempt to prevent the reaction caused by the surge of blood to and from the brain and abdominal areas. Nothing has been found as yet that will prevent the occurrence. Undoubtedly pilots have lost control of their ships in doing dives and vertical banks at speeds. The return to normal was reported by the pilots as "sudden." They were in control of their ships or immediately assumed control upon recovery. This must have been true, the only other alternative being a sufficient altitude to furnish a margin of safety. It was concluded that "blacking out" was a transient phenomenon resulting from the violent disturbances of the blood supply to the brain, coupled with unusual movements of the brain itself produced by sudden changes of the body position at high speeds. What ultimate effect repetition will have on the brain is yet unknown.

Flier's Belly

During the observations made on "blacking out," it became apparent other physical conditions were arising as the result of this oft repeated sequence of flying maneuvers. Approximately fifteen (15) pilots eventually arrived at a physical condition which for want of a better term the author called "flier's belly." The same causative factors producing "blacking out," while they apparently had no findable lasting effects on the brain and brain tissues, produced a symptom complex definitely referred to the splanchnic (abdominal) area. The appearance of symptoms varied in individuals. The neurotics showed early, the semi-neurotics next, and the stables last. Recoveries were in the reverse order. There was capricious appetite; often a loss of desire to eat. Nausea was observed with actual vomiting especially in the neurotics. Indefinite pain and distress in the epigastric region was common to all. The circulatory efficiency test (so called Schneider Index) was usually low, indicating a neuro-circulatory involvement. Restlessness and capricious responses to sensory stimuli were common. The "muscular urge" was great and fatigue came on quickly and easily. Invariably the pilots attributed their condition to something wrong inside their "belly." No casualties occurred; therefore, post mortem data are not available. X-ray and laboratory findings were negative. Complete removal from participation in pursuit tactics and aerobatics with correction of any faulty habits usually sufficed to relieve the symptoms, particularly in the semi-neurotic and stable individuals. Transfer to slower ships, and routine flying or temporary complete removal from flying were often necessary in the neurotics.

Whether "flier's belly" is a distinct entity or merely the cumulative effects of occupational neurosis or staleness has not been proved. The author believes it is an entity and classifies it as a splanchnic neurosis induced by occupational acts, eventually resulting in a distinct splanchnic condition which if progressive, results in the well recognized staleness arising from digestive and splanchnic disorders. It would appear that since no lasting symptoms were observed in the brain, but did appear in the splanchnic area, that the brain encased in its protective coverings is better able to survive the oft repeated traumatic acts described than the less protected abdominal contents. Only time and further research will solve this problem. The author desires to go on record as believing "flier's belly" is a distinct entity.

Exhaust Gases and Other Products of Combustion in Airplane Engines and Their Effects on Man

The following report is a study and correlation of work done by various agencies, and is in no sense original.

The products of combustion of ordinary gasoline, standard aviation gasoline and fighting grade aviation gasoline are CO_2; O_2; CO; CH_4; H_2 and N. There are indications that small quantities of various aldehydes are produced, but apparently their concentrations are too low to produce toxic effects.

When tetraethyl lead is added to gasoline, there are additional substances in the exhaust gases. These are thrown off as particulate matter and a part of them is deposited on cylinder heads and exhaust lines. A small amount undoubtedly reaches the cockpit in the form of fine dust and scales.

Lead retained in the lungs after inhaling dust from an exposure chamber in which exhaust gases were collected averaged 15% of the total inhaled, showing that a considerable amount is exhaled or deposited in the nasal passages or throat, where it is swallowed or expectorated. This behavior of the lead that remains in the air as suspended matter greatly reduces the danger of lead poisoning.

In summing up the investigation, the authors stated, "There was no evidence of plumbism (lead poisoning) in any of the animals used, though they were exposed for 188 days during a period of approximately 8 months to exhaust gases from ethyl gasoline in concentrations, with respect to lead content, that are several times that allowable from the standpoint of the carbon monoxide."

Carbon Monoxide

Analyzing the products of combustion of standard aviation gasoline, fighting grade gasoline and disregarding the tetraethyl lead, we find CO as the outstanding product which has definite deleterious effects on man.

This gas exists in varying proportions in the exhaust, depending on the H-C ratio of the gas, air fuel mixture ratio, and throttle setting.

A simplified method of CO determination has been developed whereby a complete analysis of the exhaust gases is unnecessary as it has been found that they exist in a definite interdependent ratio, according to Gerrush and Tessman.

Summing up a large number of exhaust gas analyses, it was found that a considerable variation in the component products was found. Carbon monoxide existed in from 1% to 7% quantities.

Carbon monoxide is a gas at ordinary temperatures. It has a slight garlic like odor; but is seldom noticed. It usually originates from the incomplete combustion of carbonaceous material. A rough estimate of the volume of CO that an automobile may produce is 1 cubic foot per minute per 20 horse power. This will convert a single car garage into a deadly gas chamber in five minutes, provided there is no ventilation. Carbon monoxide is, except for one reaction, a physiologically inert gas; it combines with the hemoglobin of the blood to the exclusion of oxygen. It has a greater affinity for hemoglobin than has oxygen. Long exposures to low concentrations will probably produce more serious effects than short exposures to high concentrations, assuming that the degree of saturation of the blood stream is the same. It is the ultimate deprivation of the tissues of the body of oxygen that produces the damage. Presence of .05% of CO will produce 40% saturation in four to five hours. Saturation of 80% is fatal. Concentrations of .01% may be safe for short periods but if persisted in will produce symptoms. Therefore a low concentration point for this gas in cockpits and cabins must be set. A maximum of .005% would be a safe figure. The presence of CO in cockpits and cabins must be considered as affecting performance at altitudes. The ability of the blood hemoglobin to absorb oxygen depends largely on the percentage of available oxygen in the air which decreases as altitudes are reached. Exposure to CO decreases the ability of the blood to absorb and carry oxygen; therefore, the degree of anoxemia produced by breathing a given concentration of CO at 14,000 feet should be much greater than that from breathing the same concentration of CO at sea level. There are no data available on this phase of CO and its effects on man in the literature. Research along this line should produce much useful information. At the present time, whenever a casualty occurs in the Air Corps, blood specimens are obtained and examined for CO. Efforts are being made to frequently check all cockpits and cabins for CO using the CO indicator manufactured by Mines Safety Appliance Company. Your attention to this important subject is apparent.

Effects of Cold

1. Physiological Effects

At about 10° F. on the average, in spite of winter flying clothing, the personnel begins to suffer from cold. The hands and feet are the first parts affected, followed usually by the back, chest, abdomen and legs in order. At first there are chilly sensations accompanied by increased metabolism and muscular restlessness. The chilly sensations change to discomfort and the acuity of touch sensations and muscular reactions are dulled. As the cold increases, there is numbing of the parts, producing clumsiness of movements. The muscles assume a state of mild tonic contraction which further hampers and restricts free movement. Discomfort changes to pain and generalized shivering appears. Voluntary muscular movement becomes sluggish and finally tissue destruction and death may occur at about −50° to −60° F.

2. Psychological Effects

There is no direct effect of cold on the intellect, but the emotional state is affected indirectly by several factors.

Most pilots lose some degree of confidence while wearing winter flying clothing, being conscious of the fact that they are not then so able to properly control the airplane, operate equipment or "bail out" in an emergency. The constriction, restraining, discomfort and weight of the added equipment serve as a constant source of annoyance and detract attention from the mission at hand. The most serious effect, however, is from the psychic reactions to physical discomfort. As the cold increases the psychic reaction keeps pace with the physiological. From distracted attention, as physical coldness progresses, we find progressive mental distress, loss of morale, indifference or distaste for the mission, a tendency to panic and finally a stupor and death.

Without doubt, an uncomfortable pilot is operating at a tremendous disadvantage and nothing has a more disintegrating effect upon his morale or efficiency than the cold that heavy, bulky clothing cannot keep out. For years it has been known that heavy clothing cannot keep a flyer warm in open cockpits which are full of drafts. Open cockpits must be designed so that drafts through the floor and sides are shut out, and they must be heated. It is only through this method that an approximation of normal body heat can be maintained. The frosting of goggles and moisture under face masks have always been causes of complaint. Heating of cockpits would eliminate these difficulties as well as the wearing of electrically heated or too bulky gloves, which pilots find extremely awkward and bothersome in operating an airplane. A pilot suffering from cold has but one idea—to land as quickly as possible and regain comfort. He will not make his usual leisurely circle of the landing field to look things over before coming in, and so may experience a crack-up as a result of his haste and dulled perceptions. From studies recently completed, it has been shown that the *efficiency of the average pilot* at the temperatures prevalent at *10,000 feet* in continental United States *is reduced 23 per cent.*

Aviation is still in its infancy. With the passing years there have been astonishing developments and the end is far in the future. Aviation Medicine is still in its infancy. Much has already been accomplished in aiding the human body to survive and live in these unknown and unexplored regions. A vast field for research of the most vital and valuable kind is open for the specialist in Aviation Medicine. The surface has been scarcely scratched. The information gained from medical research in aviation will undoubtedly play a great part in the fundamental construction of equipment to meet all the human requirements of not only military necessity but the safety, health, and comfort of the individual from a commercial standpoint.

Engineers and doctors are much alike in many respects. Our lives are spent mostly in the solution of problems, yours—material, ours—human.

We have in common an ever present, scientific curiosity.

I have six honest, serving men,
They serve me 'til I die.
Their names are Who, and What, and When,
And How, and Where, and Why.

MEETING OF THE INTERNATIONAL SOCIETY OF PHOTOGRAMMETRY

The July-August-September, 1937, issue of PHOTOGRAMMETRIC ENGINEERING carried an announcement and the program in detail of the meeting of the International Society of Photogrammetry to be held in Rome, Italy, September 29 to October 5, 1938.

It is hoped that the American Society of Photogrammetry will be well represented at this meeting, and in order to stimulate the interest of the membership, the following information is given.

Steamer	*Line*	*Registered Tonnage*	*Sails from New York*	*Arrives Naples*	*First Class (One Way)*	*Tourist (Round Trip)*	*Third Class (One Way)*
Exochorda	American	9,300	Sept. 13	Sept. 26	$160.00	—	—
Saturnia	Italian	24,000	Sept. 17	Sept. 29	$220.00	$280.00	$115.00
Conte di Savoi	Italian	48,500	Sept. 24	Oct. 1	$275.00	$290.00	$122.50

The approximate time and railroad fare (second class) from Naples to Rome are $2\frac{3}{4}$ hours and $4.00 respectively.