AVIATION PSYCHOLOGY

by

Masaru Hochizuki
Koku Hombu (Air Headquarters)
Japan

(Translated by Willard F. Day,
University of Virginia)

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Committee on Aviation Psychology

Executive Subcommittee

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LETTER OF TRANSMITTAL

NATIONAL RESEARCH COUNCIL

2101 Constitution Avenue, Washington, D. C.
Division of Anthropology and Psychology

Committee on Aviation Psychology

August 30, 1949

Dr. Dean R. Brimhall
Civil Aeronautics Administration
Room 5217, Commerce Building
Washington 25, D. C.

Dear Dr. Brimhall:

At the request of Dr. F. A. Geldard, Human Resources Division (AFMHR), DCS/M, Dir. R. and D., USAF, the Committee on Aviation Psychology has sponsored the translation of a Japanese text on Aviation Psychology which, so far as is known, represents the first book in the world published under this title. The request for sponsoring this translation was made by Dr. Geldard, who had had an opportunity to make a survey of developments in aviation psychology in Japan, in the belief that the book could be helpful in throwing light upon significant problems and in presenting ways of thinking about these problems which are relatively unknown both to civilian and military personnel in this country.

One of the most significant contributions of the Committee on Aviation Psychology has been integration of knowledge from various areas of psychology and of related sciences pertinent to the solution of human problems in aviation. As a result, it was deemed desirable to undertake the project and to support it through a small grant to the University of Virginia, where the translation was undertaken by Willard F. Day.

As is suggested in the Preface by Dr. Frank A. Geldard, certain of the materials in this book will appear strange to the occidental mind. It is felt, however, that the more rigorous approach to psychological problems, characteristic of activities in this country, may be enriched by consideration of the many insights which this book yields into the Japanese approach to work in this area. Certainly much of the material in this book would not be found acceptable in terms of American standards. Nevertheless the progress of science can be enhanced by a thorough understanding of alien points of view. It is in this spirit that this translation was undertaken.

Acknowledgment should be made to Dr. Frank A. Geldard, through whose cooperation the original text was obtained and who supervised the project, and to Mr. Willard F. Day, who supplied the very competent translation.

Cordially yours,

Morris S. Viteles, Chairman
Committee on Aviation Psychology
National Research Council

MSV:rm

PREFACE

by

Frank A. Geldard, University of Virginia;
Human Resources Division (AFMHR), DCS/M,
Dir. R. and D., United States Air Force

In November, 1945, Dr. Chester W. Harris, now of the University of Wisconsin, and the undersigned visited Japan, under U. S. Army Air Forces orders, with a view to the first hand investigation of the methods used by the Japanese, during the war, for the selection and classification of their flyers. The salient features of Japanese military aviation psychology, as revealed by interrogations of the responsible Army and Naval Air Force officials, interviews with academic psychologists, examination of documents, and field trips to military flying installations, were reported in The American Psychologist[1] for June, 1946.

One of our best informed sources was Mr. Mamoru Mochizuki, who had been attached to Koku Hombu, the Air Headquarters, in a position of considerable responsibility. In a series of interviews, facilitated both by his helpful attitude and his mature professional outlook (not to mention a more than fair command of English!), he was able to sketch for us the main lines of development of Japanese military testing and, perhaps somewhat more usefully since we had other reliable sources of information on selection practices, he provided our best information on morale in the air services. He alone of our informants knew enough of the "kamikaze" policies to give us a correct picture of that bizarre but not ineffective enterprise.

In the course of the conversations with Mr. Mochizuki the information emerged that he had been the war-time author of a technical book bearing the title Koku Shinri, "Aviation Psychology." This was surprising news indeed, such a title never before having appeared anywhere in the world. It developed that the book had been written mainly in fulfillment of a pledge to a dearly loved brother, a fighter pilot who "washed the clouds of the sky scarlet with his blood" in the Coral Sea, and with whom there had been a strong common bond of enthusiasm for aviation. The book had appeared in 1944, an edition of 3000 having been printed as a private venture. Nearly all copies, distributed among Tokyo bookstalls, were destroyed in the B-29 incendiary raids. However, a surviving copy was produced and graciously yielded. Its inscription is not without interest: "Presented with sincerity to Frank A. Geldard, Esq., to keep favorably. Maybe one of your war-seized materials."

Beyond the knowledge that the author possesses a sense of humor it may add interest to learn something of his professional and military career.

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[1]Geldard, F. A., & Harris, C. W. Selection and classification of aircrew by the Japanese. The American Psychologist, 1, 6, June, 1946, pp. 205-217.

Mochizuki graduated in psychology from Tokyo Imperial University in 1933. After a year of graduate work at the same university he was conscripted into the army and assigned to the Air Forces After having served his year he went to work for the navy and was among the first to introduce experimental psychological methods in naval aviation research. With the Japanese infiltration into China, in 1937, Mochizuki was recalled to active army duty as a Lieutenant and was stationed with the Air Command at Tachikawa. From then until final demobilization in August, 1945, (as an Army "technician" with the equivalent rank of Major) he served continuously with the Army Air Forces, the major portion of the time in Air Headquarters. When interviewed in November, 1945, he was with the Toho Movie Production Co., Tokyo.

His chief contributions to the Japanese war effort Mochizuki listed as: planning and standardization of the Air Forces Intelligence Test and the Kraepelin - Uchida "Test of Working Ability"; analysis of accidents and the compilation of a handbook on flying safety; improvements in the flying training curriculum (involving better spacing of learning periods and the introduction of early glider training); investigations of morale (troops under air raids, kamikaze units, and hunger conditions in the Army), and studies in communication techniques. The latter he regarded to have resulted in the greatest concrete gains. His applications of Koch's theories are described in Chapter IV.

A word should be said in appreciation of the excellent job of translation done by Mr. Willard F. Day, an undergraduate student majoring in psychology at the University of Virginia. In early 1946 the book was turned over to the professional Japanese translators of our military establishment. Whether they lacked the necessary technical background or were rushing through the task with one eye on getting home to mend some Nisei fences is not known. At any rate a sample chapter yielded a manuscript no single paragraph of which made the slightest sense. The reader will agree that Mr. Day's translation is in good English even though there is much that sounds strange to occidental ears. Nor, in the light of knowledge of the translator's work-habits, is there any doubt of the authenticity of the translation.

F. A. Geldard

TRANSLATOR'S PREFACE

Psychologists are interested first of all in understanding human behavior; yet insofar as they attempt to make use of the experience of others in doing so, they are interested in communication.

If necessary, the almost endless number of specific communications could be arbitrarily typed or classified according to the means, purpose, or effects of communication, but in general all communication affords the opportunity to make a more adequate environmental adjustment by providing one with data that have not been experienced first hand. Yet since the direct interchange of experience is not possible, some sort of external interaction between representations for the discrete experiences of two individuals is necessary for communication. One of the individuals concerned must collect together the experiences he wants to express in the most appropriate form and send them out; since he then loses control over what he has done, he can only hope they produce the desired effect. The other must wrestle with the stimuli that are presented him and try to extract from them usable information.

Thus the responsibility for successful communication lies in two places: it is the responsibility of him who will share his experience to make its expression as clear as possible; it is then the responsibility of the receiver of the communication to make every effort to fit the stimuli which confront him into meaningful experiential frames of reference.

In the fall of 1944 a communication entitled Koku Shinri was published in Tokyo. In order that American psychologists might be able to profit from the experience of the Japanese author a translation of the book to English became necessary. In such circumstances the success of the communication depends upon the mutual fulfillment of three separate responsibilities. The responsibility for the adequacy of the communication rests equally with the author, the translator, and the reader.

Mamoru Mochizuki has accepted the responsibility of presenting a survey of the chief psychological issues facing contemporary aviation. In his Foreword and Introduction he has been careful to point out the purpose and limits of his undertaking. In the six chapters that follow he has described the psychological problems that are met in attempting to adjust to the sky as a human environment; then he has reviewed the selection and training of personnel for piloting, communications, and maintenance work, and has discussed at length the matter of aviation safety. He has illustrated with clarity and precision his interpretation of the experience he has had in these fields.

Having accepted the responsibility of translator, I feel that in some ways the communication could not be transmitted to the reader in the clear and lucid manner of the author. The literary techniques effective in one language are found to be so only rarely when converted to another. Yet, as a whole, I feel that I have been faithful with respect to my responsi-

bility, in that I have preserved at all costs the logic of the author's argument and have attempted to provide a reliable correspondence of English and Japanese ideas.

In any event, the author has integrated his experience and set it out as Koku Shinri; the translator has picked it up, torn it apart, and put it together as Aviation Psychology. At that, they have done their tasks. The responsibility now lies with the reader.

The reader's responsibility is the greatest of all since it is he who stands to gain most from the communication. If the reader genuinely desires to profit from the experience of the author, he will exert every effort to search out suitable aspects of his own experience in terms of which he can make the expression of the author meaningful. Only by juggling his experience in this way can he succeed in understanding what it is the author has attempted to convey. The reader then must accept as a premise to communication the fact that the author is as equally sincere in his desire to share his experience. This fundamental premise is implicit within all profitable communication.

However, contemporary psychology often hesitates to accept premises; indeed in its desire to escape doing so, it is apt to beguile itself into unknowing acceptance of even less valid ones. Instead of an effort for mutual benefit from experience, psychological communication frequently seems to take the form of a perpetual game in which the merit is awarded those men who show the most skillful play. Certain terms and concepts are apt to be considered in bad taste and the entire game of those who use these terms rejected because their play does not seem to correspond with the current regulations. There often arise various schools of play, each with its own particular technique, that view with some derision the behavior of other schools.

The Japanese author of this book is not playing a game. He has expressed his experience plainly and simply; yet he has used at times words that when translated to English perhaps do not satisfy the conflicting demands of the various psychological schools. However, he has selected his words to stand for real experience. If the reader desires to share that experience, he will not attempt to evaluate the book in terms of a game that is or is not well played; he will attempt to place his own experience in parallel with that of the author and to evaluate this new experience in terms of that of his past. This active part in communication is the clear responsibility of the reader. To accept or refuse this responsibility is the choice he will have to make.

University, Virginia
April, 1949

W. F. Day

FOREWORD

This book is written in honor of my brother, Lt. Commander Tagahashi Kuzuhara, who was killed in the battle of the Coral Sea. In defense of our country, he washed the clouds of the sky scarlet with his blood; it is to him that I dedicate this book.

I remember the time my brother came home after having been in his first battle in the attack on Hawaii. Naturally, at that time he was the center of everyone's attention, so it was necessary for us to promise to get together again at a later time for our long anticipated discussion of aviation. But on one summer day, scarcely a few weeks afterward, I was brought the news of his death in action. This manuscript is no more than the fulfillment of our promise.

For the most part, I have taken up in this book a few of the problems of aviation from a psychological point of view. It includes, as it were, only a small discussion of these topics. At any event, it should by no means be considered the systematized organization of a science of aviation psychology. I am at present entirely unable to write a book of such dimensions, and my purpose in writing this book has never been to do so. Rather than to commence so great an undertaking, I have felt it to be more appropriate to deal directly with material that could be applied as soon as possible to current wartime aviation needs.

For the most part in this book I have taken up three jobs: plane operation, radio communication, and on-the-ground preparation and maintenance. I have attempted to explain in terms of psychology just what kinds of jobs they are, while making use of illustrations from experiences common to all. Thus those people who are already occupied in these fields will realize that psychology also is related to their kind of work, and those persons who are expecting to go into such work and into the study of aviation will possibly understand more clearly the nature of these jobs. Of course it is difficult for me to judge to what extent I have succeeded in my plan. However, I firmly believe that it must be the function of psychology to mediate between machines and men, and I believe that only when a harmony between men and machines is achieved and there is a unification of our techniques and personalities will there be possible a true Japanese aviation. Unfortunately, in this book I have had to leave untouched many problems related to Japanese aviation which I should have liked to have treated. I hope to discharge my duty to these matters in the near future.

Although by this time there should be available a psychological study which deals with the general problems of aviation, still none has appeared to date. I feel that this is probably due to the fact that nearly all of the aviation psychologists are now in military service. I, also, am at present connected with the Army, and although I have spent considerable effort in the preparation of this book, I must be content to have neglected much of what I wanted to say, while at the same time having gone too far afield in other subjects and to have presented only a broad summary of the

material. This book is not something that will make a name for itself as a complete psychological survey; however, if it can successfully point out and identify the chief psychological problems related to aviation I shall feel that it has been useful.

It has taken a year and a half to complete this manuscript. Throughout this time, I have absorbed myself almost nightly in the fulfillment of the promise to my brother. The book grew slowly. During that time the war situation continued to develop. Rough drafts were written, and discarded, and rewritten, and discarded again. But here today, on the first day of the third year of the War of Greater East Asia, I lay down my pen. In taking time for this little discussion, I feel that at last my promise has been kept.

December 8, 1944

Residence at Zuchi
Mochizuki

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INTRODUCTION

The Development of the Spirit of Aviation

1. The road from a desire to a science.

It was without doubt one of man's first wishes to fly. Certainly everyone has dreamed at some time or other that he was flying. I can now vividly bring to mind the strange and intense excitement of these dreams wherein one flies by his arms and legs. Even though we may have never openly expressed the wish to fly, still the feelings of trembling joy at this hitherto unknown power have formed a real part of our dreams. I remember that once I awoke from a dream with such a realistic feeling that I had actually flown, that I became quite angry that I was no longer able to fly up from my bed. But, as with all other dreams, it ended merely in grumbling against my handicapped frame for not being able to fly. Regardless of how one might like to interpret this dream by such theoretical approaches as psychoanalysis, I feel that it indicates that it has always been man's desire to fly.

One might expect the first expressions of man's will to fly to be found in mythology. The winged horse Pegasus was formed from the bloody drippings of Meduse's head; he was saddled by Bellerophon and driven into the sky. However not even Bellerophon was able to master the sky and Pegasus continued on till he became a star. In that Pegasus was not a bird itself but was a horse which had wings, one can see here the longing of the ancients to fly. This seems to be a reasonable interpretation of that myth of the horse that was loosed from the restrictions of the earth so that he took wings and rose into the sky. Indeed man expresses the limits of his aspirations in the form of his gods.

However in birds we have animals that are actually able to fly. Birds, like men, begin life on the earth and must return to the earth when they die. One often hears such envious remarks as, "If I could only cast off the fetters of the earth as the eagle!" or again, "I am as a bird, who loved and felt compassion towards the world, yet could not fly." So even the poets of Western Europe sing praises of the birds' joyous freedom.

From the first, man has desired that this intense wish might become a reality for human beings, and towards this end he has directed great effort. There have been those at first who perished like weak spring fledglings in trying to imitate the flight of birds. These men, like their desires, fell in defeat to the earth below. Yet these attempts were continued time after time, even until some considerable progress had been made towards a direct imitation of the flight of birds. As time passed, however, man's accomplishments in other fields began to multiply rapidly, yet because of its misdirected theoretical approach, the flight of man was delayed. Whenever a complex apparatus was designed its form seemed almost a blasphemous attempt at the creation of a bird. The men who designed these devices were the bravest and most progressive men of their time. Yet it seems to us now almost as if in trying to keep their designs in

the shape of birds or dragons, these men were attempting to discover just where the creator had hidden the key to flight. It reminds us of our children when they paint the word "Dragon" on the kites which they fly in the spring.

However, the realization of man's will to fly could never be achieved together with superstition. So long as science was fundamentally allied with superstition it was impossible for man to develop a flying machine. With the increasing number of scientific achievements it became necessary for man to adopt a scientific outlook. The will to fly needed a new, romantic, impelling force. In those times when there existed no such force, the air machine became no more than a fantastic dream.

But there were at that time such passages as the following which have been handed down to us from the eighteenth century.

"Ten generations from now, when two hundred and fifty years have passed, many changes shall come upon the earth. The forces of Christianity shall have covered all countries. Men that are able to fly in the air shall appear. They shall harness the wind and the rain, and the lightning shall be their tool. They shall become instruments of death. Man shall have a bad heart, and all shall seek for help in that terrible world. Thus shall many things of today be destroyed. Earth, water, fire and wind shall cause great calamity in the land, and out of ten men on the earth five shall be slain. Even the armies of foreign lands shall come to attack us. Then at that time a godlike lord shall be given to the world and the people shall repent and follow him; and on earth man will return again to honesty and righteousness." To the farming people living during this time when the country was closed to foreign trade, such prophecy assumed the immutable form of destiny, and they could only lament that fate was not to be hastened. To them the science of the Christians gave only the picture of a frightful world, and they sought to evade the scientific attitude. In those times the urge to fly was merely an intense hope considered to be in vain beyond human achievement.

Nevertheless, as time passed the conspicuous achievements of science continued to accumulate. Yet before these scientific achievements could be coordinated within one new approach, it was necessary to have a free spirit.

Dr. Tadahachi Futamiya cites the following quotation of Yoshimasa Ojima written in 1895.

"While I was on yesterday's march, suddenly a great flock of birds came out from a hollow. Both wings of each of the birds had only a slight inclination from the ground; and maintaining this angle, they flew into the sky." This seemingly insignificant expression of feeling contains a sharp scientific observation. However, when he goes on later to say "... by means of which we can improve the complicated and cumbersome articles as the balloon in such wide use today," he diverts the mark of

his sharp scientific discernment. One can discover the direction of his words in the "improvement" of complex and cumbersome things.

I wonder, however, if he could have ever made the airplane a "simple convenient" object. Moreover, I certainly question whether the airplane of today is simpler and more easily operated than the balloon of his time. "The genius of the invention should not be considered to be on the same plane as the skill of the technician who has mastered the natural sciences and mathematics, and who can realize the most possible efficiency of a machine. The inventor achieves his success by means of his own concepts." Such attitudes as that the idea or essence of all inventions originates solely within the so-called technical skills, or that the creations of invention are gradual improvements of former techniques, simply do not coincide with the facts. On many occasions an invention is simply the result of a clever idea, having its grounds within the "common sense" of the inventor. Thus as common sense, the "ideas" of the inventor are at times bad ideas and lunacies. We have come to see this often in the history of invention.

Probably when an inventor attempts a problem he expands his imagination a considerable extent. Here he seems to transcend the common sense of the intelligent man. Yet his imagination is never entirely separated from science and technology, so that while evading the meshes of the thinking of the average man, he integrates with subtle ties the basic idea of the invention and the hard facts of practicability. The words of Tadahachi Futamiya - "The wings had only a slight inclination from the ground, and maintaining this angle..." -- is such a binding tie. If there were not this single thread, his conception would be no conception at all, and although it could not be said that he had resorted to dreams and fantacies, it would have had no practical use. It is the genius who discovers this one thread, spins it out, pursues it freely and vigorously, and follows it to actuality.

Since such is the nature of invention, it is probably true that the airplane of today could never have been realized through the effort of one man alone. Because the inventor realizes this fact, he records his ideas so that they might find later use by others. Yet he probably fears that the one thread which he has grasped would not be seized by the general public. Thus he becomes inconsistent with his actual conception of his invention, and uses the phrase "improvement" which destroys it. Compromise, the middle course between invention and improvement was the dilemma of that period, yet, at the same time, there was the common predicament of the many inventors who, while being unrewarded for their achievements, were unable to perform the functions of both inventor and technician.

"It is still a question whether the whole effort will be successful or not - that is, whether or not man will be able to travel in the air as well as he can on land and on water. If the economic theories of value are fundamental logical principles which actually do govern man's work, then all artistic creativity, all adventurous enterprise, and technical invention is ruined." There are many cases where the inventors do not

consider the economic aspects of a technical improvement; indeed such considerations as how the invention will "benefit mankind," or will lead to the "frightful world" described above, do not originate within the spirit of invention. In the history of Japanese invention it is a matter of record that the budding of superior originality in Tadahachi Futamiya was buried to our great loss as soon as it was plucked. In order for there to be ripe fruit of these creations, there must be the rich soil of scientific achievement and systematized scientific technology. At the same time however, it is necessary that there be formed a national and public awareness of science. Our country in particular should become conscious of this.

It was in 1903, nine years after the report by Tadahachi Futamiya, that the first real flying machine appeared, that is, the first that actually flew any distance at all. As for calling it "flight" it was hardly more than that the wheels got off the ground, but it was a precious event in that at last the dream of so long a time had become a reality. But if it was a flight, it was no more; it was simple, and crude. Yet even though it was simple and crude indeed, one could hardly fail to realize the store that this extraordinary invention promised to mankind.

The inventors were the Wright brothers, Orville and Wilbur, and they probably never dreamed in what manner the satisfaction of their simple desire to fly would come within a hundred years to affect the history of the world. After all, since they were inventors, they probably were actually little concerned with the matter. All that they wanted was to fulfil their desire to fly. The first flight did no more than finally to strike the target, after so long a period of groping and inquiry. Its principal effect was to give clear direction to the subsequent effort in the field.

The persons present at the flight of the Wright brothers' plane witnessed the event with their eyes glued to the ground. (Indeed in 1912, when the airplane was first exhibited in our country, everyone present stared only at the ground so as not to interfere with the flight. This is probably the way it was at that first time, too.) With the first flight it was demonstrated that the invention of an airplane had at last been achieved by man. The flight of the Wright brothers' plane was, so to speak, the true birth of the airplane, for whatever attributes of the airplane that have been developed since that time were contained in their plane in embryonic form. That is, the flight had, naturally, speed and altitude; yet the degree to which these factors were suppressed, and to what extent they would be developed, it was not possible to imagine at that time.

However, the two aforementioned attributes began immediate development. A speed of 41 k.p.h. in 1906 became five years later 133 k.p.h. By 1920 it was 313 k.p.h. and in eight years more the 500 k.p.h. mark was broken. As for altitude, 155 meters in 1905 became 3,100 meters in five years. In 10 years it was 7,850, in 15, past 10,000 meters. In conjunction with these, one might illustrate the extension of flight distance.

These two attributes were already present when the airplane made its first flight, or rather when its wheels first left the ground. They were only concealed within the crude make up of the plane. However, one must also say that in its subsequent development the airplane has come to change in essence. Many have given it a second birth as a machine. One can indeed say that as compared with the long and fruitless years which constituted the first stage in the development of the airplane the progress was extremely rapid within this second stage. The steps in progress have not slowed. The attribute of speed will probably be refined still more, even to the limit of human endurance. Perhaps an airplane will appear that will completely exhaust its mechanical capacities. Such is the goal of the second stage. However, through such development alone the airplane can become at best a machine that is simply extraordinarily refined.

2. Machines and spirit

and airplanes. Let us imagine for a moment that there were a perfect plane, a plane of completely realized capacities. Indeed, such an achievement would be a product of man's highest intelligence; therefore, one must consider human intelligence as fundamental as technical skill in the construction of a plane. Often when we speak of pilots we refer to them as "bird men" or "eagles." Such expressions are indeed largely symbolical in nature, yet it seems possible here to consider these symbolical terms as representations of fact. In many ways it is beneficial to consider the pilot as the king of eagles.

Although flying is a comparatively recent development, it has been long desired by man. Yet until the first successful flight gave direction to the effort in the form of a plane, man had not considered flight of another nature than the simple flight of birds. When our ancestors thought of flying it was in terms of the free and unrestricted flight of their dreams and fantasies; yet the plane as we now know it affords us no such flight. Moreover, even though an entirely new and revolutionary type of machine were constructed, it would still be unable to afford us the unlimited movement so easily conceived in the imagination. All machines are necessarily governed by scientific causal laws. Having their origin in human ingenuity, machines are likely to hold the promise to some of independent and unlimited activity. Only by constant awareness of the principle that machines are vigorously bound by natural laws, can this new form of behavior be most adequately realized. In other words, so long as we fly in a machine we are unable to become free, as we consider ourselves to be free on the ground, or birds to be in the sky. It is foolish indeed for man to believe that he can realize all his dreams by the gradual construction of better machines. Such a belief would be to feel that planes would eventually reach a state where they would never crash. Regardless of the perfection of the plane, there would be no "new mankind." Man would have acquired no innate power or ability. The creation of a new machine has promised only to the extent that man can achieve the most skillful technique of manipulating it. Rather than the complete realization of man's dream, a machine represents only the achievement of a part of that dream through human intelligence. As far as the realization

of man's dream to fly is concerned, the airplane is clearly limited because of its form as a machine.

Needless to say, the job of becoming a pilot is chiefly a matter of becoming the skilled technician who, while bound by certain limitations, knows well these limitations, and who can manipulate his machine in spite of them with maximum efficiency. There must be rigid fidelity to the natural laws which govern the machine.

As with all other machines, there were originally in the airplane many aspects of control that demanded direct human participation. That is, there was a great number of non-mechanized and non-automatic functions associated with piloting. The pilot of those days had to be extremely skilled both in the operation of his hands and feet. Relying on his own individual sensations, he had to control the plane by means of crude judgments of the inclination of the plane, its speed, and altitude. For this reason a great deal of effort was spent in attempting to develop the sense reception of the pilots to resemble that of a bird, whereas it could have been more profitably directed towards more skillful mechanical manipulation of the plane.

However, the nature of the airplane gradually became less that of a tool and more that of a machine. Such is indeed the true road of progress. Parallel with this the pilot's vague perceptions gradually became more specific. The decisions of the pilot slowly changed from sensory to reasoned judgments.

It is said that the present day airplane is still in the process of change. In front of the pilots' seat many types of instruments and gauges have been arranged. For the most part these are designed to afford the pilot an adequate analytical survey of the given condition of the airplane, of the engine in particular. This illustrates the fact that a machine cannot achieve capacity performance unless the pilot can maintain a constant check on potential trouble spots. Among these "gauges of control" are the so-called "piloting gauges". These are the instruments which perform mechanically the tasks of human sensation, or which indicate how reliably the activity directed and planned by the pilot is being carried out. For example, the compass and the altimeter are instruments which give mechanical expression to human sensations. Whereas the "control gauges" are expressions of machines as machines "piloting gauges" do not have a direct relation to machines in themselves, but merely act as perceptors for the prosecution of human plans. The fact that these two kinds of instruments are used by the pilot in conjunction even though they have no direct mechanical relationship, points to the fact that it is man that must make use of them, and direct their integration. It further demonstrates the fact that the airplane has by no means reached a stage of complete automatization -- it probably also indicates that the airplane has not yet achieved its fullest perfection. Indeed perfect mechanization, that is, complete automatization, is but one pole in the development of the plane; at that alone; aviation can never reach its ideal state. Yet though such is the goal for which we strive, it is to be doubted whether it is of possible attainment.

If man is to fly at all, there is no other course but that he do so by plane. Moreover, in order to fly a plane he must do so within the limits of the plane as a machine. However, as man endeavors to achieve his own broad plans he comes to "control" the plane in yet another sense of the word. In this control he comes to use the machine, perfected only to a certain degree, merely as another tool towards furthering his objectives. Take for example the case of the airplane used as a military weapon.

This planned control means first that even though the development of the airplane is directed towards perfection of the plane, it will probably fall short of any such complete automatization. In the long run, the fact that man devises mechanical activity to serve his plans is probably due to some extent to the fact that he is in some way unable to fulfill those plans. As for the specific goals of human plans only the most general of these have been mechanically achieved, as for example, speed, height, and distance. In order to achieve the various desires of man it becomes necessary for him to have some control over those aspects of his machines that are not automatized. Herein one can observe the true intention of mankind to make somewhat sure that he is able to restrain or "control" to a certain degree any complete automatization. By the automatic nature of the machine and the human purpose that it serves, the form of the machine is determined. In the union of these two factors one can differentiate the various types of planes.

In this manner, fighter planes, reconnaissance planes, light and heavy bombers, and passenger and transport planes were specialized. The plane of the first flight was simply the archetype; gradually the various types came to be differentiated. On one hand there was the development of the airplane towards automatization as a machine and on the other, there continued the gradual diversification of the human plans for its use. Indeed it has become now that one can hardly group all the different kinds of planes under a common name. However, complete automatization is never achieved since the more diversified human interests become, the more it must turn to new mechanical devices; and the more mechanical improvements are devised, the more human aspirations continue to expand.

That is, when one devises a penknife that is particularly good for cutting a roast, it is even the better prepared to wound one's hand. Similarly with the airplane: while it was created to satisfy a definite human desire to fly, it has taken, on occasion, the form of an instrument that does not directly express that will. It is this human "control" that brings about such inconsistent application.

It is probably very natural that the airplane should have become an important weapon of war so soon after its invention. War is after all the most violent expression of man's will, and it is often in time of war, when man is confronted with great need, that many new patterns of behavior are devised. Very quickly the airplane was employed as a weapon, and took on the capacities of an instrument of war. Indeed it has gone so far that various sub-types of war planes have been differentiated, some for quick,

light transportation; some for long distance transportation; some to be used as a weapon of heavy fire, or for ammunitions transport - each one developing its particular characteristics. At first it was only the matter of mounting a machine gun on top the fuselage, or of loading bombs under the pilots seat, to be thrown out at the appropriate time.

Certainly, the human application of weapons of war is most vigorously controlled by man; however, since the first plane seemed to be the first real success toward so long a desire, man could not bring himself to limit this machine in any way. Naturally, plans for the construction of types of planes for battle use that were at that time unconceived, such as fighters, bombers, and reconnaissance planes were kept secret by the militarists. Then it became clear that it was possible to effect a certain degree of militarization with the type of planes that had already been developed, without having to devise a new type of plane. Then once a particular use of the plane has become established as a method of warfare, a new type of machine is born. In this way mechanical weapons of war were developed before there was any general desire for war.

Thus, even though the development of planes as war weapons can be controlled as far as automatic mechanization is concerned, it is not possible to restrain human will. The development of the airplane proceeds in accordance with the balance that is maintained between the two factors, first to what extent the machine is a mechanical expression of human will, and second, to what extent the application of the machine is an expression of human will.

The balance between man and machine is reflected in the fighting power that is due to spirit and in the fighting power due to mechanical achievement. Both the capacity of the plane as a machine and the form of the plane in its application are determined by the relative strength of these factors. At the proper balance between these factors, the true character of national aviation is effectively expressed. But even more than the achievements of a nation's scientific technology, the strength and temper of the spirit of that nation determine the character of its aviation. Accordingly, in order to predict the future of the aviation of a country, or to determine its probable direction of progress one must first investigate the spiritual character of its people. In what way can Japanese aviation express itself most fully as the aviation of the Japanese people? How can this aviation become as great as possible? Which characteristics must be nourished and which tempered in order to do so? There is no doubt that such questions are of fundamental importance to the contemporary psychology of national defense and the psychology of aviation. It must be our first task then to attempt to understand the character of our national spirit.

But after all, why do we have to have planes that fly still faster and higher? It is quite common for people to feel that the airplane is able to go fast enough as it is, that the various improvements arise solely from the idle planning of aeronautical engineers, and that it would have been no particular matter even if these advances had not been made. However,

if actual fighting breaks out, the more the fever of war becomes intense the more the elevation of the capacities of the airplane is spurred on; and in turn, the demand for progress is urged on by the achievement of more mechanical ability. In this way the spirit of a nation's people becomes more fully manifest. As the airplanes of Japan continue to express the fighting spirit of the Japanese People they become more typically Japanese machines.

The long struggle for the invention of an airplane was indeed a crude and misguided process. It is hoped that man will not have to have again such a period of trial and speculation. However, it need not be considered that these experiences of the past should be without profit to us. The first phase of development led to the invention of the mechanical archetype of the airplane. Its various mechanical attributes which were at that time concealed within have been so continuously nourished and tempered by human planning that now the plane is in a second phase of that of mechanical improvement. However, now indeed, it is possible to visualize yet a third phase of progress; this lies within a true aviation of the Japanese people, and is to be achieved by the magnification of the spirit of the Japanese people and the maintenance of the most proper balance and harmony between the two factors, man and machine.

That the Japanese is always confident of victory in battles of swords or small arms is due to the fact that these tools have long been a part of the culture of his people. We must forge for aviation a similar strong bond of tradition. It must become a tool of the Japanese people. We must make it our art.

CHAPTER I

THE SKY AS AN ENVIRONMENT

In order to understand the various psychological factors related to aviation it is first necessary to become acquainted with the sky as an environment.

It is generally assumed in piloting a plane that one is always able to perceive correctly such things as bodily position and location. Yet one must realize at the beginning that perceptions made on the basis of one's surroundings in a plane are entirely different from those made when standing on the top of a mountain or a tall building in actual contact with the ground.

Of course, in attempting to consider the special conditions of the sky as an environment one should not neglect such physical factors as low pressure, low temperature and acceleration. The significance of these physical factors lies chiefly in the fact that they correspond in general to physiological changes within the body. Yet precisely due to the fact that they are physical factors, they can be experimentally reproduced on the ground, and the problems that arise concerning them can be resolved by direct mechanical improvement of the plane. Because the solution of the psychological problems related to these factors also follows such mechanical improvement, I shall not attempt to include a discussion of these conditions here. Rather I shall try to limit myself to describing the purely psychological factors related to flying, the conditions which basically determine the special circumstances which follow from the fact that man is in the sky. In other words, the first thing I shall take up will be the problem of the psychological structure of the sky as an environment.

In the Air and on the Ground

In no way is it possible to consider that piloting a plane enables one to be as "free as a bird," as we like to say. A plane is certainly not able to fly from one branch of a tree to another at will the way a bird does; instead it is limited in its flight to going simply from the runway of one airfield to the runway of another. It is not possible for the plane to stop and rest when it becomes tired, or to relax in its flight; it must absolutely maintain its speed above a certain point, if it wants to fly at all. The relative position of the parts of the plane is rigidly fixed so that it is even impossible for it to assume an unnatural posture. Therefore, it is necessary for the pilot to be constantly aware of just where it is he is flying, and in what direction he is turning, what angle of inclination he is maintaining, and at what speed he is advancing. In the last analysis, the pilot is always tightly grappled to the earth by such restrictions. He is never able to free himself completely from the ground or to experience any kind of freedom in a literal sense.

However, it is extremely common to find that when student pilots are taken aloft for the first few times and given a few turns in the plane, they become completely unable to determine in which direction they feel themselves to be turning, or at what speed they are flying, or where they are headed, or at times, even their own body position. In this situation they are accurately oriented only within the narrow limits of the immediate surroundings of their own seat. They feel themselves to be in a little world of their own, having neither east nor west, up nor down.

Even student pilots who have successfully applied the directions of their instructors to the extent that they are able to execute simple stunt maneuvers, have trouble in orienting themselves. Having merely correctly followed their instructions as to the proper movements of their hands and feet, they are often entirely unable to visualize in terms of relative position above the ground, what kind of arc they have just described. That is to say, the pilot masters only the vicinity of his own cockpit, without having any extensive mental control of his relationship to the sky as a larger unit.

Thus it is natural that for some time the student pilot will be to a large extent unconscious of the direction he is maintaining in flight. Of course, during this time it is of relatively little consequence if the pilot descends a couple hundred feed in altitude or navigates one or two kilometers in the wrong direction. In view of this fact, in pilot training the students are required to take enough altitude to begin with so that even with a relatively rough hand at the controls there is ample room for a fresh start and correction should the need arise. This kind of aerial environment where there is a plenty of "safety altitude" is generally considered the most adequate flying environment. It is an environment in which it is comparatively easy to fly about, and which is relatively cut off from the earth.

However, man actually never has such carefree security in the sky. At all events, the pilot has finally got to plant his feet solidly on the ground again. When one is faced with the problem of an actual landing, the jobs of being in the air until a landing is finally completed, and of flying about within a certain safety altitude are entirely different. In landing it is not possible to incline even a little bit to the right or left. The difference in altitude of a degree, indeed a half degree, or the difference of just a little in the flying speed has the greatest influence upon the success of the landing. The junction between being in the air with a safety altitude and being on the ground is indeed actually "in the air", if you mean by the phrase separation from the ground. Psychologically speaking, however, these two situations "in the air" are markedly different things. To the beginner, the tough and ugly part of the sky as an environment is chiefly this stratum of the sky that is directly joined to the ground.

It is essential that the three dimensions of the ground be strictly transposed just as they are to this middle level. After considerable training in the actual techniques of flying, the perspective of the ground comes gradually to be transposed to the sky that at one time had appeared so vague and formless. The aerial environment comes to be differentiated

and to acquire a Gestalt. This can probably be compared for example with the change in one's ability to find a picture in a book a second time, after having already found it once before. This process is a sensory adaptation to a new, aerial environment, and is generally referred to as acquiring an "aerial perception" or the "feel of a flyer." (Fliegerisches Gefühl - H. G. Gade.) It is only when this appreciation is acquired that aerial maneuvers take on accurate meaning, and accurate navigation becomes possible.

A second aspect of the environment of a flyer that is psychologically difficult for the beginning flyer arises when he is required to make a turn at very low altitude. That is, not that it is technically particularly difficult to make a bank without lowering the altitude, but it is just that while turning at a safety altitude he is often not aware of the fact that he is losing altitude in doing so. Thus, even though a pilot is able to turn at high altitudes, he may find himself unable to turn successfully at low altitude.

After all, even when the trainee is high in the sky, if "his feet aren't on the ground," he will not be able to become a successful pilot. I have already referred quite a bit to "safety altitude." By safety altitude I refer to the altitude in the vicinity of an air field that the trainee is required to assume as he quite literally circles the field. Naturally this procedure is adopted so that if some disturbance happens to occur to the motor or fuselage, the student can bring the plane to safety by gliding. Actually safety altitude has the shape of an inverted cone with the airport at its apex. Accordingly, since the term does not refer in fact to altitude as such at all, but rather to space, safety altitude should probably be more accurately termed "safety zone." However, altitude itself does become a problem in such operations as stunt flying and maneuvering. Moreover, if we consider the capacity of the engine and human altitude endurance, it becomes dangerous to fly above a certain height. Thus it is clear that altitude approaches a practical limit as it increases as well as when it decreases to the vicinity of the ground.

The Perception of Movement

The chief problems that are met by students in pilot training concern just how they come to perceive by means of their senses such things as bodily position, direction of flight, altitude, and speed. The problem is to determine whether or not the pilot's perception of these conditions corresponds accurately with his actual bodily position, direction of flight, et cetera, and if it is found that there is no reliable correspondence between them, to ascertain how they can be made to correspond. When we are on the ground and decide we should like to make a movement in a certain direction, if we attempt to put our foot out in front of us, the foot actually goes out in front. When we extend our hand to grasp an object in front of us that we desire, the object is easily grasped. Here we have no contradiction between our perception of movement and its manifestation, and completely adequate locomotor adjustment is possible. If on the other hand, we found that when we had intended to extend our foot to the front, it moved to the side, instead or if our hand made a great sweeping movement

when we had thought to make only a slight movement, we would quite naturally be greatly inconvenienced.

Take as illustration of my point an example familiar to all. When a person of normal vision puts on glasses which have a strong correction for nearsightedness, or when he looks through a pair of binoculars the wrong way, he has a great deal of difficulty in descending steps. Again, because the right and left directions are inverted by the range finder of a camera, many people find it difficult to rearrange the organization of their picture for a more artistic shot. And there are some of us who find that we must grope most awkwardly when we set one mirror against another to pluck an occasional gray hair from our head.

It might be well to refer here to a pertinent experiment carried out by a psychologist some time ago (Stratton, in the United States). He wore for a long period of time a pair of glasses with the prisms adjusted so that everything seemed to be upside down. Even though we in this country make a great deal of bowing so that things frequently appear upside down in a deep obeisance, still, such an experiment would be very difficult for us. Yet there is a great difference between merely learning to adapt as rapidly as possible to an environment that at first seems upside down, and learning to disregard visual impressions and acting only by the internal cues from movement.

However, what would happen if, for example, one were riding in an elevator while wearing glasses with prisms such that everthing seemed turned at an angle of 45 or 90 degrees? Would it feel as if the body were running sideways or slanted? That is, upon which sense channel do we depend, which one do we choose, when sensations of movement and visual perceptions are mutually contredictory? Many considerations related to this problem are presented in a report of Dr. Seiji Ogihara entitled "A study concerning the perception of bodily movement (Jiko undo no chigaku ni kanzuru ikkenkyu)", published in the 1936 issue of Psychological Studies (Shinrigaku Kenkyu). For example, using echelons of prisms, Ogihara distorted the verticality of his subject's surroundings by 45, 90, 135, and 180 degrees. The subjects were moved vertically in an elevator with varying speeds of ascent and descent. For a detailed account of the results of this experiment I must refer you to the paper itself, however it is significant for our purposes to observe Ogihara's conclusion that the perception of movement is altered by changes in the relationship of oneself to the structure of his environment. "In environmental conditions of uniform visual structure, perception of motion is determined by body sensations or by the acceleration given to the body, and in situations where there are differential visual sensations, the perception of motion is determined by the visual cues." This conclusion is in line with later comments in this book.

Some time ago the so-called "mirror drawing test" was devised as a type of native ability test in the United States, and was even used in this way within this country. The task, in brief, is to draw a given design without watching one's hand, but by looking at the design by means of a

mirror. The test can be quite simply set up without special equipment. Just such a mirror, pencil and paper as one might have on hand does quite well, although it is best that the mirror not be too large. The mirror is inclined at an angle of around 45 degrees in front of the hand and a design such as Figure 1 is placed before the hand. Conceal the hand by placing something like a ball of paper in front of it. Then take a pencil, and without looking directly at the hand or design, regard only the image in the mirror and trace between the lines of the design without touching the lines themselves.

If a relatively large prism is available a second interesting experiment is possible. First drew a simple maze like the illustrated in Figure 2. (I have said simple, but it doesn't matter, of course, if it is more complicated). Then while looking through the prism, enter at the arrow and draw a line by pencil to the dot in the center.

It most certainly behooves all those to try the above experiments who have not had this kind of experience before, or who think they can do them without any trouble, or who are unable to understand the consequences of the separation and conflict between movement and bodily sensations. I suspect that whoever it be that attempts them, he will exert a great deal of foolish effort. Since his hand does not move the way he thinks it should and the sensations of movement from his fingers indicate inappropriate directions, he will come to realize that what he sees reflected in his eyes is probably some form of anger. Normally, our internal sensations of movement, our sense of equilibrium, and our visual perceptions are entirely fused without conflict; but in flying they are often separate and antagonistic. The possibility of such conflict constitutes the essential significant characteristic of the sky as a human environment.

Various judgments and perceptions of this kind that are not sources of confusion to man on the ground, strongly and fundamentally influence human behavior in the air. For example, in aviation we make use of many gauges to aid in our judgments; but when these instruments are contradictory to the perceptions of the pilot, even though the gauge is functioning perfectly, the pilot sometimes chooses to rely on his own feelings and accordingly makes errors in the operation of the plane. Indeed, this situation is often the direct cause of aviation accidents.

From here, it is my plan to take up the judgment of bodily position, giddiness when pulling out, the problem of airsickness, and the judgment of direction and speed. I shall attempt to illustrate these phenomena from experiences we have all had on the ground, and to consider them from a psychological point of view.

The Judgment of Bodily Position

As one of the most striking phenomena associated with the psychology of flying I shall first attempt to deal with the problem of the judgment of bodily position.

Whenever we change our position on the ground we are afforded cues as

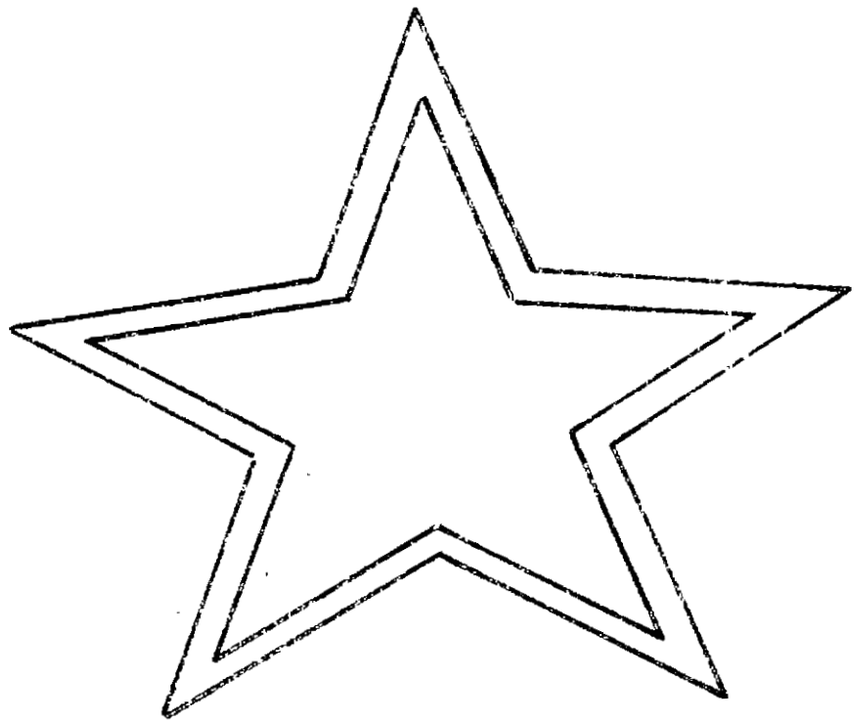

FIGURE 1

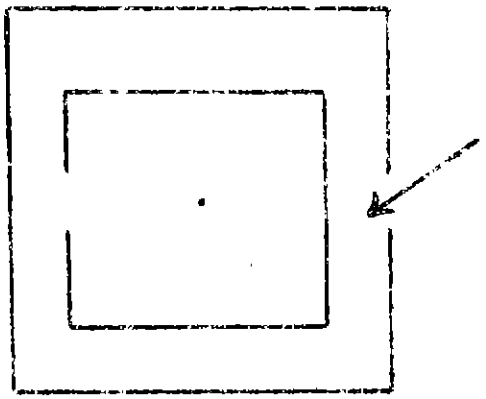

FIGURE 2

to the nature of this change from three sensory sources: changes within the three semicircular canals inside the ear which mediate our sense of equilibrium; changes in the visual angle of inclination of external objects as reflected in our eyes; and changes in the various internal kinesthetic feelings from all parts of the body. Normally sensations from these three sources are harmoniously integrated, and they enable us to make fairly accurate judgments of changes in posture. It is generally considered that the judgment of bodily position is mediated by the cofunctioning and mutual help of these three sensory sources, however among them the visual component is particularly effective.

Let us take an example to illustrate the role of vision in judging posture. Even though in the Army we often speak of "freezing at a rigid attention," if recording instruments are attached to the head of a person at attention and the amount of body tremor is measured, one will invariably find there is trembling at least over an area of a square centimeter. If, now, the subject at "rigid" attention is required to close his eyes, eliminating all visual cues, the amount of tremor will be found to increase a considerable extent. Experiments have shown that under these circumstances untrained persons with normal semicircular canals ordinarily have an area of trembling of around 30 square centimeters!

Then to illustrate the functioning of other cues than vision in making postural adjustments, if one sits with a heavy weight attached to one hand and foot, and then quickly tries to stand up straight, he will incline sharply to the other direction. This maladjustive response is due to the fact that the internal tensions from the parts of the body have become disordered, and there is abnormal representation of the various component body sensations which should be maintained in balance. In flying, these various raw materials for the judgment of posture are quite frequently present with improper representation.

The chief situation of this kind is due to the relative lack of stimulation of the semicircular canals. When we make a turn to the right or left in a plane it is necessary for us to "bank" the plane to the inside, just as when on the ground while running in a race, we incline our body towards the axis of the turns we must make. When we turn we make the axis of rotation smaller and the rate of speed greater, and this leads us to incline strongly to the inside. This fact is probably easily understood by those who are acquainted with the laws of centrifugal force. Nowadays, it is possible to indicate whether or not an airplane is executing a bank correctly by means of a rotation indicator. This device is commonly called "the ball" and makes use of the principle of the water level. A steel ball is enclosed within a fluid gauge, and if a turn is being properly executed--is properly inclined to the inside in accordance with the speed and radius of rotation--the ball will remain at the center of the level.

When "the ball", then, is at the center of the level in turning, movement of the lymph within the semicircular canals and various internal pressures from the parts of the body should indicate that the body is inclined, just as the gauge. However, rotation cannot be sensed by means of the semicircular canals alone. Many psychologists have carried out

experiments along this line, studying the sense of equilibrium by means of aviation and at the same time investigating the problems of aviation related to the sense of equilibrium; I shall spare you a detailed account of their results. In brief, however, it must be concluded that for correct turning and looping the sensations from the semicircular canals and internal receptors are largely inadequate; in such situations the body feels only that it is being forced downward.

Now even though the rotation of the plane cannot be sensed by the body when a correct turn is executed, the outside world is clearly seen by the eyes to be inclined. That is to say that in this situation the sense of equilibrium and the visual sense are severed and in conflict. Everyone who is inexperienced in flying is greatly struck when he encounters this phenomenon. Suddenly he looks out of the window and sees that the water and land features of the horizon are inclined. He sees the surface of a lake towering up as if it were a wall, without the water running out. Boats are still floating on an inclined sea. It is almost as astounding a thing to him as the miracles of Moses, to be utterly unable to understand how he has lost his spatial perception.

Certain investigators have called the factor due to centrifugal force the gravity factor (G-Faktor) and that due to visual stimulation, the sight factor (S-Faktor), and these are indeed convenient words to use. Aviators are utterly unable to judge their own bodily position by means of the gravity factor alone. Anyway you look at it, they must rely on the sight factor. Since these two factors are in harmony on the gound the judgment of changes in bodily position there can be correctly made. However in flying, when one of these factors is suddenly lost, as happens when the plane enters a cloud or mist bank and is plunged into darkness, judgment of the position of the body without the aid of mechanical instruments, is for practical purposes impossible. Moreover, with inadequate equilibrial and visual perception, it is natural that even the manipulatory adjustments of the plane control become more difficult.

The facts pointed out above have been relatively easy to illustrate, but there remain others that do not lend themselves to such ready elucidation. Such a phenomenon is the fact that the land on the horizon or the surface of the ocean give the impression of being sharply inclined only above a certain altitude. Ordinarily this experience cannot be had at less than an altitude of three or four hundred meters (about a thousand feet). Thus student pilots who at first train largely at three or four hundred meters often do not encounter this unique experience until they complete their early training. If you ask student pilots about the existance of such an experience, there are many who claim that they have not had it. Truly, I believe that is amazing.

When one climbs above a certain altitude the earth seems to become a world entirely separated from oneself. As the round horizon spreads itself broadly before one, its mountains and rivers appearing as shadows in a miniature garden, certainly the flyer becomes a creature of the skies that enjoys a veritable bird's eye view of the earth. In this situation

with the pilot standing as it were opposite the earth and being separated from the earth, it is relatively easy to incline the earth at any angle one chooses. On the other hand, when the altitude is below three or four hundred meters, the surface of the earth comprises the major portion of the field of vision. Since this seems nearly the same as when we actually move on the earth, one seems to remain himself a part of the ground environment. The rice paddies, the fields, the forests and houses, are presented to the eye with only a slight change from that to which we are normally accustomed on the earth. For this reason the unique experience of inclination does not occur.

Thus, the difference in the altitudes at which this illusion will arise depends upon the characteristics of the earth's surface in the visual field. We should expect then, that it would be relatively easier to err in the judgment of bodily position in those situations where the surface of the earth in the visual field is largely homogeneous, such as the surface of the ocean, or of a desert, or even when the altitude is comparatively low but the ground is obscured by mist or fog. Moreover in those situations where the plane is approaching a surface that is already sloped and is, say, covered with sand, and then a banking makes this surface seem inclined, one can have an illusion whereby he feels himself drawn to the sloped surface, since the relationship between himself and the slope is misjudged and the angle of inclination of the slope seems smaller than it actually is.

The range of altitude at which the earth seems to become a separate world must never, however, be confused with the safety altitude to which we have made earlier reference. The former is determined solely by visual sensations; the latter distinguishes that range of altitude in which it is possible to have a feeling of safety, as determined by the mechanical properties of the plane.

Airsickness (Part One)

The sensation I have just described of seeing that everything appears to be turned over inspite of the fact that one has not perceived a change in bodily position is probably very closely related to the experience of giddiness. We shall next attempt to consider what is known as giddiness, air and seasickness, or vertigo, from the point of view of the psychologist.

In physiology texts the following simple experiment is suggested for producing a good example of the sensation of giddiness. Stand in front of a large mirror and fixate for a period the image of your surroundings -- the ceiling, the wall, or the sliding door -- inside the mirror. Then if the angle of inclination of the mirror is suddenly changed without notice, a slight sensation of giddiness will be felt. Obviously a simple explanation of the cause of this giddiness based solely on the functioning of the semicircular canals cannot be given in this case.

Certainly here we can bring the gravity factor and sight factor discussed above into play with body tonus. When an object is fixated for

a time through a mirror inclined at a particular angle, it can be considered that a characteristic tonus or tension pattern is set up in the body which corresponds to the sight factor. Now when the angle of inclination of the mirror is suddenly changed, a conflict between the visual sensations and the particular state of body tonus is brought about, due to the fact that the body tonus is unable to change as rapidly as the visual sensations. Then the giddiness can be considered as the result of this conflict. Such ways of thinking that merely involve an abstract separation of our sense of equilibrium or body tonus, or which consider only the function of specific physical organs, are utterly unable to explain adequately the concrete facts. One must not forget that such facts associated with the judgment of bodily position are first explained only when body functioning is considered together with environmental conditions received by the visual sense department. In other words, in order to arrive at a correct judgment concerning bodily position it is generally necessary that all the operating factors be combined together without conflict.

The fact that our state of bodily tension is markedly influenced by data received through the visual sense is readily illustrated by common experience. For example, when watching a high-jumping exhibition the spectators themselves will often raise a foot at the jump, or throw their head to one side as they follow the jumper. Children that have to observe the dental examination of others, often open their mouths with an "aah" at the appropriate time, observing the deep obeisance of an adult companion, they frequently make slight bowing motions themselves. Even we adults are drawn in a bit by an expressive story, and wry our faces with the narrator. Even the infectious transmission of a yawn might have its origin in this way.

When the surrounding circumstances are made emotional, this tendency to empathy is even stronger. When a fan watches a soccer game, and the ball approaches the goal of the supported team, he repeats anxiously to himself "Don't go in! Don't go in!" Seeing the ball in the air, he rises to his feet. The player making the kick crooks his body in the desired direction. By no means are these examples only foolish exaggerations. Due to the fact that the environment with which we come into contact is made up of a structure of such forces, it is impossible to separate out completely from them the functions of the body.

Giddiness can also be produced by the irrigation of the inner ear with warm water. In such cases there is probably very little influence by the sight factor. The fundamental cause of giddiness is normally a compound situation where such stimulation of the organs of equilibrium and sensations of a visual source as described in the mirror experiment above are mutually operative. For the same reasons it is easy to produce giddiness when one has no definite point of visual fixation. In such a situation, the body tonus is relatively unstable since there is no fixed visual point of regard. For example, if one rises to a slight eminence in a wide and open area, and looks up so that the whole visual field is empty space, a marked sinking sensation and a feeling of shaky knees will be produced. This giddy condition arises due to the fact that since

there is no definite point of visual fixation, the body tonus fails to become set at a particular state of tension. It follows from this that it would be normally quite difficult to judge accurately the position of "directly up." There are many illustrations of this fact. In receiving the report of an air raid by enemy planes, nearly all the eye witnesses from various sections of the city claim that the enemy craft passed directly over their house. One should hardly expect the enemy to circle so assidously. Again, when bombs are seen to be scattered over a large area, nearly everyone thinks they are aimed to drop right on top of him. When leaflets are dropped from an airplane, even until they come quite near, it seems to all below that they will fall in their own front yard. Certainly this inaccuracy is due to the fact that the sky has no distinct visual structure. Because the visual factor cannot be definitely relied upon, the factor of body tonus is confused and leads to giddiness.

Evidence that our eyes afford extremely unreliable perceptual information can be sought in many sources. There is the lovely poem by Shimagi Akahiko:

> The clouds change so softly--
> One even begins to think the mountain is moving.

Again one has seen the moon come out from behind a cloud. Indeed, it is the clouds that are moving, but one feels also that the moon is moving in the opposite direction to the clouds. This illusion is more striking if the clouds take up an unusually large area. A situation very similar to this can be experimentally produced by seating one in a completely darkened room and moving a luminous point slowly before the eyes. The subject senses that it is his own body that is moving.

All of the above illustrations afford corroborating evidence of the fact that there can be a conflicting relationship between body movements and visual sensations; they further show that body movement and tonus is influenced by the visual perceptions to a fairly large degree. In this manner, if there seems to be visual movement alone without accompanying body sensations of this movement, and also if the reverse condition obtains in which a body change is perceived without the accompanying visual signs, conflict and strain arises between these two factors that lead easily to giddiness. Thus one is led to conclude that there might be various other individual phenomena contained within the overall pattern of giddiness. We shall come to find a close affinity between this condition and such things as seasickness and the delusion of losing one's way of which I shall speak later.

Many persons become seasick on a large steamer that are not in the least so affected when in a small boat. Similarly there are those that get airsick while riding in a large passenger plane, yet who are rarely so in a small craft with their faces exposed to the air. Let us attempt to consider why this is so.

It will not be surprising to find the explanation to lie in the seperation of the bodily motion factor and the visual factor, as we have before. When a ship is pitching and tossing it is best to look at the

thermometer that is hanging on the wall, or at the electric light fixture that is swinging with the boat. Everyone indeed realizes that the movement of such articles is a gauge of the ships rocking, but they are inclined to believe that without actually feeling the rocking of the boat directly, it is the looking at these swaying objects that leads to their sickness. Needless to say the very opposite is the case. We must recall to mind here what we have said earlier about the fact that the horizon does not take on the illusion of being inclined to the side in planes below a certain altitude. Inside the stateroom of the modern passenger liner we find ourselves in precisely the same surroundings as when we are in the average house. We see the horizontal lintel, and the cabinet and desk just as they appear to us everyday. Our visual perceptions are again limited to this environment, and there is no other standard present with which to compare them. Thus when we feel by our internal sensations that our body is rocking, yet see no signs of movement in our visual surroundings, we have again a separation of bodily and visual perceptions that leads to seasickness. In a small boat, however, where we are in the open and can see the curved gunwales and bow of the boat we are in, it becomes possible for us to use the open surface of the water as a standard for orienting our visual perceptions. We are not likely to get seasick in such cases since if we feel motion by our bodily senses there is no contradiction by the visual impressions that we take directly from the surface of the water.

The situation is almost the same in riding in an airplane. As one makes his way towards the exit after having landed in a passenger plane, he is apt to feel as if he is descending a steep hill, because the passageway is sloped so sharply to the rear. In fact, the inside aspect of the plane is entirely cut off from the outside so that this feeling is influenced by impressions from inside the plane, and not from a consideration of the fact that the tail of the plane is actually lowered. Then when the passenger has alighted from the plane, and sees another plane on the field, he is apt to be surprised that the inclination of the plane was so great.

A similar experience is familiar to all from riding in a jinrikisha that has its four walls enclosed by a hood. Not being able to come into adequate contact with the outside surroundings by the small celluloid windows in the front and sides, the passenger rides in a narrow, restricted environment. In such a situation when the carriage shaft is raised or lowered, the accompanying changes in body position are apt to feel strange or bizarre, since the visual surroundings change so slightly.

Such phenomena have been experimentally demonstrated. Although it has not been used in Japan, the so-called "Witches Swing" (Hexenschaucher) has been employed in various foreign countries. This device consists of a square box large enough to contain a man as subject. The box is supported on a rotating central axis. Once the subject is inside, the box is rotated in a manner unknown to the subject who is then required, at a given inclination, to indicate what he believes to be objective, vertical and horizontal directions. Together with the conclusion that the direction that is subjectively judged to be vertical is markedly influenced by the degree of

inclination of the box, it was observed that the results were affected by whether the interior of the box were unfigured or whether various circular drawings were made on the inner surface. It goes without saying that in the latter situations the judgments were more greatly distorted.

For a more detailed discussion of this subject I refer the reader to H. Kleint's Uber die Wahrnehmung.

Thus we are able to conclude that as far as the judgment of position is concerned, the sensory cues from the semicircular canals are extremely ineffective. Indeed at times it can be said that they become a hindrance as when they are in conflict with visual perceptions and lead to giddiness and seasickness.

Then let us take up another matter closely related to giddiness. This is the common experience of being a bit wobbly at the knees the first few steps on land after a ride in a boat or upon alighting from a long train trip. In this situation one is not so weak at the knees that he actually bobs up and down on the surface of the ground; but the relationship between his body and the ground is such that it certainly feels as if the ground itself were rocking. If this condition could be experimentally reproduced a fairly interesting problem would lend itself to study. The following little experiment offers evidence of this.

We can make use of the mirror drawing test apparatus mentioned earlier. Have the subject work at his task for some time--without kibitzers! When a person sets himself to trace the design of the star reflected in the mirror, he is not likely to learn the technique by theoretically reasoning the problem out or by figuring, for example, that "since the reflected image is the reverse of the real situation, it is logical for me to move my hand this way when I feel I should go that way." Instead the subject meekly learns the new habit by a slow trial and error adjustment to the image as he sees it reflected. After a bit of practice he finds that he is making progress.

The point that is of interest to us, however, lies in the process after the practice. When the subject has become quite proficient in the mirror drawing, have him immediately attempt to write a line of characters on ordinary paper. In this situation he will intend to write from up to down in the normal fashion, but when he comes to try to write, he will feel a strong resistance to the normal habit, and will probably have the urge to write from the bottom to the top. I have not personally investigated the degree to which this resistance is effected by various factors, for example whether there is a significant difference when a small mirror is used instead of a large one, but I feel certain that this impulse to move the hand in an opposite direction from that intended is a very real consequence of such training in mirror drawing.

In other words, if sensory-motor response chains become temporarily linked together in an unusual way, then this state of association becomes natural, so that if the former original condition is brought about, it will then seem unnatural. Following this line of reasoning, when we are on

board ship for a long period of time, our sense of equilibrium and visual sensations come to form a new type of union (the situation is probably much the same on board train). If this union becomes fixed beyond a certain extent, then when we return to what was the natural relationship on the ground, we feel that the surface of the ground is rocking, or that our bodies have sinking sensations. In this particular case, the fact that one does not feel that the ground is sinking, but rather that it is his body that is having sinking sensations (or at least such has always been my experience), is probably due to our strong previous personal experience that the ground just does not sink. Perhaps also we run into types here: one type that satisfactorily fixes the body equilibrium sensations, compensating by means of the visual sensations; and one type that effects the stabilization of their visual perceptions at the cost of their sense of body equilibrium. However, since this phenomenon of giddiness following riding in a train or boat occurs even when the eyes are kept closed, it cannot simply be caused only by the union and conflict of visual and equilibrial factors; probably other purely physical factors or motor patterns are in operation.

However, anyway we look at it the dimensional structure of our perceptual field, or whether we perceive things as up or down, is a comparative fluctuating thing. Even if one wears the Stratton glasses mentioned earlier (the ones that make things look upside down) for a period of time, things come to seem perfectly normal again. Then when we remove the glasses after this time, just as in the case of the mirror drawing test, the situation becomes as confusing to the subject as when he first put the glasses on. Indeed as far as the image of external objects reflected on our retina is concerned, it is normally reflected upside down. However, it is also possible that the actual vertical shape as reflected on the retina has no direct relationship to our experience of the verticality of an object. Such problems have come to be the source of much discussion in the most recent psychological journals, and again since it concerns more specialized fields, we shall not go into the matter in more detail.

There would be little purpose in relating here all the ways in which the mirror drawing test has been used in the past, but if we study carefully and critically the mechanisms involved in this test we may be able to deduce whether it involves essentially motor or visual factors. However, as to which is more suitable to the needs of the pilot it is impossible for me to say at present.

Airsickness (Cont.)

Yet there still remain other interesting but difficult problems that are closely related to the topic of giddiness. We have the fact that when one is himself at the controls of the plane he is not likely to become airsick, yet in the same plane if one is a passenger with another person at the controls he will often find that he is apt to become a little airsick. Then also we have yet to suggest possible counter measures that can be taken to prevent the occurence of airsickness.

The renowned war hero Major General Kato happens to be an acquaintance

of mine, and it is needless for me to add here that he is a fighter pilot of some genius. Nevertheless, he has remarked to me that when he travels from time to time by passenger plane when on official business, he often becomes to his embarrassment extremely airsick. Of course, as I have said before there seems to be a difference in the rate of occurence of airsickness for fighter planes and passenger planes, but I feel that even more important is the fact of whether oneself is at the controls of the plane or not.

It often happens in connection with the selection of air force personnel that whether or not the applicant is subject to attackes of seasickness is investigated. It seems almost common sense to reason that those men who become seasick should be rejected for air service. Yet the fact remains that even among the most superior pilots and air crewmen there are many who often get seasick on board ship. Then if it be remarked that the above situation is explained by the fact that a boat and an airplane are different things, one is unable to point out in what significant way they are different. Then it is often observed that on board ship the helmsman and other members of the crew do not become seasick. It appears that a sense of responsibility and perhaps other mental forces influence the onset of seasickness, but just why that should be so is quite difficult to explain. For my part, I am quick to recognize the existence of such factors that are difficult to explain, and I do not think for a moment that I am satisfactorily dealing with any of them.

It seems we should investigate just when this airsickness of being a passenger is most readily aroused. The plane climbs high in the sky and the pilot turns back to his passenger and says, now we are going to circle. Then he begins his circling. At this point the passenger finds he does not become airsick. No matter how many, or how wobbly, the turns are that the pilot makes, the rider does not feel airsick or nauseated. However, if suddenly and without notice the pilot changes from his circular flight to a straight line course, or if, having made up to that time consistent circling to the right, the pilot suddenly begins to circle to the left, the passenger then feels a pushing sensation in his chest. Yet again if the pilot notifies the observer of the above changes in direction before actually executing them, the observer will rarely be affected. An important point, then, in the difference between the occurance of airsickness of the passenger and the person at the controls, is the matter of knowing beforehand changes in movement that are to come. Whereas the pilot is able to make direct use of all his perceptions as to his own situation in the air, the passenger inside the cabin who sees only his immediate surroundings must often encounter a separation of the visual and equilibrial factors mentioned previously.

If, on the other hand, the passenger is able to know the plans of the pilot, by such simple statements as, now I'm going to change my direction of circling, then the passenger adjusts easily to the new change, and he makes anticipatory changes in his state of bodily preparation. If the body is alerted not to be off guard (and indeed the passengers feelings

of sickness resemble those of being caught off guard) then we can, for example, prevent the contents of the stomach from striking against an unsuspecting stomach wall.

Normally, the pilot at the controls is able to afford himself such bodily preparation. However we even find that the pilot who is himself at the controls becomes somewhat airsick when jarred unexpectedly by a bad air pocket.

If our preceding analysis has been correct, we should expect to be able to deduce from it effective counter-measures against airsickness. Of course, many medicinal drugs have been prepared to alleviate travel sickness, but it is not our purpose here to consider their physiological effect. Since we have considered giddiness from the standpoint of psychology, it is only natural that we propose its psychological counter-remedy also. As for myself, I have a method that I have effectively used up till now, even though it has been applied chiefly on board ship. Whenever the boat begins to rock, regardless of the size of the boat, I say to myself, everything that is rocking is making itself rock, and when the ship rolls to the right, I stand on my right leg, and when she rolls to the left, I stand on my left leg. This plan has had conspicuous results indeed: after having devised this scheme, I came to be almost glued to the table in the nearly empty dining room of the ship. At any rate, simply staying inside and staring at the walls of the stateroom should indeed make one very sick. It might well be that the reason the ship's crew is not more often made sick by the rolling is because in walking about the ship in the performance of their duties, they are able to look at the disturbed surface of the water. It looks as if they come to assume some sort of attitude in which they gauge the amount of rocking by looking at the surface of the water. Similarly when we are sailing in a small, open boat we are exposed to the appearance of the water, and the effect of the boat in restricting our sight factor is removed.

It is always a little bit uncomfortable to branch off into a narrow, bumpy, country road, but if one happens to be riding in a conveyance with which one is not familiar, it is quite easy to become a little dizzy. This does not necessarily mean that the conveyance itself is in poor condition; for example, if the chauffeur that one regularly uses happens to be off for the afternoon, and it is necessary to be driven by an unfamiliar chauffeur, even though the trip is not long enough to result in actual dizziness, one is likely to feel more tired after the ride than usual. When the automobile is driven by a chauffeur who is accustomed to his passenger, he comes to avoid certain special situations which seem to be sources of annoyance for the passenger. The driver comes to acquire a knack for avoiding these trouble spots. Moreover in the business of keeping to the left side of the road, or in situations where it is a tight squeeze to pass another car, all drivers have their own individual plan of approach. In the case of the automobile driven by a chauffeur to whom one is accustomed, it is relatively easy to anticipate in advance the movements of the car so that it is possible to make bodily preparation, and one quickly adjusts to the new situation. I believe this is the reason

why we do not get tired when we are driven by someone with whose driving we are familiar. On the other hand, to travel in a vehicle whose driver either is unskilled or who has driving habits that are unfamiliar, is extremely tiring. When we are riding in a car we are constantly meeting situations of some possible danger. When we pretty continually find ourselves saying, now he ought to turn this way, or, now watch out for that over there, the situations that confront us take on an emotional significance, and we who are riding in the automobile under such conditions feel strained and tense as if we ourselves were driving the car. When we think we are ready to make a turn, we bend our bodies in the appropriate direction. However at yet other times when we do not have such bodily preparation, the car makes unexpected movements. To cite my own experience in these cases, it is not a matter of merely becoming tired, but more than that, I find it is apt to lead to marked flatulence, stomach-ache, and after that, diarrhoea.

It is often the case that air force personnel who have duty inside the plane, but who do not themselves actually pilot the plane and who do not have a chance to look outside once they are in the plane, complain of airsickness the early part of their flight training. In time, however, they come to get accustomed to the characteristic movements of their plane. It is impossible to make a hasty judgment as to whether this process of becoming used to the characteristic movements of the means of transportation is a matter of coming to acquire an appropriate mental attitude towards the movement, or of increasing the amount of bodily resistance, or of developing a relative adaptation to the movement, but one must certainly feel that it involves some kind of adaptation to movement, or the acquisition of a mental set, such as I have just stated.

By the way, I should like to make a further comment that is somewhat related to this point. It is generally claimed that the mode of transportation that gives rise to the greatest degree of travel sickness is the moored balloon. The feeling of giddiness is especially intensified when there is a clear sky and a stiff breeze. On days of high wind the mooring line is stretched out taut, and the balloon revolves in a circular orbit with the line as radius; when the breeze is less the balloon sways up and down with turbulent movements. Indeed there is no clear point for visual fixation, with the visual field taken up by the large gas sack and the hazy sky. The situation is even worse on cloudless days. Just as in the case where one feels weak at the knees on looking into the sky on top of an incline, so here in a balloon floating in the air there is no fixed visual point by which to judge the movement.

I personally have never had the experience of riding in a balloon, but it is said that the sensations are more intense than those felt when one is suddenly sucked down by an air pocket in an airplane. For those who have not had this experience in an airplane, I might add that this feeling of giddiness we were just discussing is probably very similar to that sensation produced when the rapid descent of an elevator is suddenly stopped.

Sensing Direction

In our discussion of the judgment of bodily position we tried to consider a few of the special perceptual problems that are related to aviation; it will be my endeavor here to take up in a somewhat comparable manner the determination of direction.

I believe I have already pointed out the fact that after one or two turns are made by a plane, inexperienced passengers within the plane become immediately unable to hold the vaguest conception of the direction in which they are flying.

The irrationality involved in an erroneous perception of direction most certainly lies in some sphere of conflict between an individual's own reasoning and his bodily sensations. We are often quite apt to be unaware of the role the perception of direction plays in our everyday life, and it is likely to be our first impression here that the problems related to perceiving direction are of perhaps isolated interest to aviation. But it is undoubtedly true that without such awareness of direction as we maintain in daily living, we would find ourselves unable to function properly at all. It is impossible to sever and cut off entirely the awareness of direction from our normal activity. When the impressions concerning direction afforded by our five human senses are harmoniously unified with the external motivating forces from our environment, we have adequate and normal spatial awareness in our activity. This, of course, is very similar to what was said in the second section of this chapter concerning the judgment of bodily position.

At this present moment, as I am at work on this manuscript, I am conscious of the fact that I am turned facing my desk. The desk is in front of me, my book case is to my left, and the sliding door to my study is on the right. There is nothing remarkable in the fact that I feel that I am in the center of the room since I am at the moment perfectly aware of the spatial relations of my surroundings. Then it is possible for me to expand this awareness: my present position inside the house as a whole is clear to me. This is to say, I am able to point out almost without error the location of the entrance hall and the kitchen from where I am sitting. Moreover, I can also point out relatively accurately the direction of the train station or the seashore nearby.

However, if I were required to give the direction of Tokyo, which is around 50 kilometers distant and to which I commute to work each day, it is inconceivable that I should point in a direction opposite to the correct one; yet even so my localization has now become fairly vague. If I must give the direction of Harbin, Manchuria, to which place I have recently been, it would be of rather dubious accuracy. And as far as the direction of the Coral Sea where my brother was killed in battle is concerned, I am extremely uncertain. However, psychologically it can be said that I know where I am, even though the environmental range of fairly accurate spatial localization is somewhat narrow. In such a state we are able to live relatively easily and without a great deal of confusing uncertainty as to direction.

David Katz in his renowned book Animals and Men states that the remarkable ability of such creatures as the dog and pigeon to find their way home again is due to a keen awareness of the spatiality of their surroundings. When man travels it seems quite natural that he should often mistake the direction of his starting place since he follows roundabout and crooked roads, and has his mind occupied with other things. But if we were able to forge right ahead and not be bound to roads, it might be that we should find that our awareness of the way home is not inferior to the famed homing sense of the pigeon. It is true that we have a sense of direction -- are aware of the spatial nature of our surroundings -- to the greatest extent when we are in such areas as the home and town wherein we move freely and without effort. Such is our natural environment. Then as for the remarkable homing sense of pigeons, I wonder if they have actually attained more than a broader range of environment. If such is the nature of the sense of direction, it is something that we always have with us, and we are thus not apt to be clearly aware of it.

In order to understand more clearly this sense of direction, then, we should probably find it efficacious to bring to mind those experiences in which it is lost. We shall find introspection profitable in observing how our activity is affected in such situations.

Let us imagine the reader is riding on a subway. You alight at your destination and ascent to the ground level by means of the subway exit. You are in surroundings with which you are already familiar; you are in, say, a section of town to which you have come some ten times previously. The store to which you intend to go is located on an alley which enters to the left of a large building in front of you. You actually look at the large building, and without thinking turn and walk in the direction of the building. But suddenly it feels extremely unnatural. "Theoretically" you realize that you are advancing in the correct direction, yet you feel a strong resistance to doing it actually. Here then, we have a situation where one's awareness of spatial direction has fallen off from his visual environment. At least, the two are in disagreement.

Take another situation. You arrive at a section of town that is completely new to you. In transacting your business you walk up the street a ways, conclude your business, circle about and return to the station platform preparatory to boarding the train home. You look in one direction up the tracks and wonder when the train will arrive. Then from the opposite direction a train comes thundering in. And even though the train is announced over the loudspeaker, and the sign board corresponds with the arrival announcement and it is the right time for the return train, you still feel that this is the train that you took to get here. Reluctantly and in much doubt you board the train. Then after you have been riding on the train for a while your bodily sense of direction turns itself around by 180 degrees and adjusts itself to the direction in which the train is running. Certainly many people have had this experience.

Once you look at it, there are fairly many everyday experiences that illustrate this feeling. There is the feeling one has after hurriedly

ascending to the roof of a department store to look at a view that was highly recommended, or the sensation one has while walking in a large water conduit, after one turns about and sees the opening again in front of his eyes. Or the feeling is especially marked in those situations where the surroundings are spiral in shape, such as in the steps of a lighthouse, where cues from the visual field are affected. It would indeed probably be more accurate for those who use the phrase "to lose one's way" to say instead "to lose one's sense of direction." We mean by losing one's way such unfortunate activity as results when one becomes flustered in the night, and attempts to look for the door in a direction where it is not. But psychologically, this is no different from having lost one's sense of direction. Such losing one's way very often occurs after stopping in a large hotel and being led around all over the place in being shown to one's room.

If one closely considers the above illustrations, the following conclusion will be found generally to apply. If there is an unconstant angle in the direction of the line of advance, of if this line is somewhat winding or zigzag, as in the case of the lighthouse stairs, so that there is little difference in visual cues, or if even several right angles are made, one is apt to lose his way.

This conclusion can, of course, be experimentally verified by attempting to run a human maze. I remember there used to be an elaborate human maze that had been built in a public garden. The situation with that maze was such that if one went inside and strolled about a while, not only did one lose his concept of direction while in the maze, but also if one were lucky enough to find his way out at all, he would be entirely disoriented as far as direction is concerned for quite a while afterwards. Thus it is natural to expect that it would be extremely easy to lose one's awareness of spatial direction in an airplane since even when a turn is correctly executed, it cannot be directly perceived as a turn.

Then as for those situations under which it is easy to produce this loss of spatial orientation, we see that they are first those cases where one's sense of vision is arrested during the actual changing of direction, or where the object of visual attention has homogeneous surroundings. Then again the loss of spatial awareness depends in part upon the particular composition of our visual environment.

It is a well known fact that it is more difficult to walk in a straight line with our eyes closed or in the dark. In one section of the Air Force physical examination, the applicant is blindfolded and required to walk a few steps forward then back again in a straight line. Normally, if he goes a distance of 5 or 6 meters forward and back, he will be 30 or 40 centimeters off to one side upon his return. Yet as far as this test is concerned, even though the visual cues to localization are arrested, auditory spatial cues are afforded to some extent and it seems probable that the comparative lack of skill in walking backwards has some effect on the results. Then too, it is impossible to isolate out only those sense organs related to the

gravity factor, which, as I have stated before exert such a great influence on determining change of direction in an airplane. But even though the whole objective of this test were changed, still those pilots who successfully passed the test could probably not say that it requires any special skill to maintain a course in flying an airplane.

The structure of the visual field has a rather strong influence on the maintenance of one's sense of direction. When one walks on a broad, sandy beach at the seashore while looking for a long period of time only at one's feet, he will observe that the path he has made in the sand is surprisingly crooked, even though it was his intention to walk in as straight a line as possible. People who go gathering sea shells often find that they have lost all sense of direction because of their irregular movements in crawling over the sand, and because of their somewhat unusual body posture, and the homogeneous visual field afforded by the stretches of beach. If one fixates, as he walks, a strong pattern of stripes which slant off a little from the direction of progress, it is quite easy to change one's line of advance so that it falls at right angles or parallel to the stripes. Even though one may not actually change his direction in these cases, he still feels considerable resistance to the direction of his progress. This condition is even more marked if the stripes are in motion; imagine, for example the rotating pole at the barber shop. When one passes over such a field, as when crossing over a broad bridge above a mountain torrent, and at the same time slants his body to the right or left, a very singular giddy sensation of spatial relations will be felt.

When one attempts to ascertain the direction of his flight visually by looking at the scenery below, even though his sight is not obscured by clouds or darkness, it is natural that it would be very easy to lose one's sense of direction, since the earth's surface presents a fairly homogeneous visual field that does not have the north-south grid lines conveniently drawn upon it as on a map.

The degree to which men have this sense of direction is something that shows relatively large racial and individual differences. It is believed that these individual differences are present not only in the strength of the sense of localization, but also in the particular manner in which the direction is determined. It is well known by anthropologists that the culturally undeveloped races that inhabit desert or grass plains or thick forest regions excell other groups in their sense of direction. Various Samoan tribes are reputed to have the highest development of this sense, and anthropological expeditions have disclosed that they are largely an unintuitive and abstruse people. The situation seems to be much the same when we find that we are lost in places where children and country people who have never been in the city are found not to get lost.

The Japanese people have always on this island country lived a life of agriculture and crop cultivation, and in the olden days all the people were held tightly to their own land. Thus, different from other more nomadic peoples, their living environment was comparatively narrow, and accordingly the determination of general directions was not a particularly important thing in their lives. The terrain features of Japan are, as we

are all aware, exceedingly rich in variability, there being many mountains, rivers, and valleys, and to all these land features were given beautiful names. Thus when a person needed to refer to a general direction, it probably sufficed in his narrow environment, merely to indicate the name of the appropriate mountain or stream. Looking at our poetry we find that the words "north", "south", "east" and "west" are only very infrequently used. For example,

The bow moon passes into a cloud at the highest mountain top.
And hardly ever to a degree more than here,

In the fields of the east
The unloosed sun can be seen standing.

The Japanese people, being blessed with a land rich in changes, were able to determine for all practical purposes whatever direction they needed by referring to the east as the land from which the sun arose, and to the west as the land into which it entered at evening.

Similarly, with regard to the four seasons there has always been much variability in the weather, and in spite of the fact that the seasonal changes were of great importance for the cultivation of their crops, still astronomical data and the calender were not in wide use. Thus I wonder if it really was a comparatively long time that the Japanese were unconcerned with direction.

Moreover, I believe that a person's living environment exerts a fairly large influence upon the particular way in which he goes about determining direction. It is not difficult to think that those persons who have lived since their youth in the vicinity of a road which passed from north to south or of a stream flowing from north to south should come to orient their sense of direction in terms of such a mental set, so that when they considered the concepts of east and west, they did so in terms of a comperison with this north-south standard in their minds. In this way it would appear that there are individual standards of directional orientation for each person.

Let us suppose, for example, that we are attempting to get to the house of an acquaintance in a section of the country with which we are unfamiliar, and we have in our hand the guide map of the town to assist us in our search. We stand looking down at the map, yet there is not the least agreement between the directional axis within our mind, and our position as indicated on our guide map, even though we are looking at the places printed on it. Then as we mumble to ourselves, now why did they put up that sign post backwards, or twist our bodies, or turn our necks, we attempt to effect an agreement between our own mental axis and the axis of the guide map. If we were to regard the situation from the point of view of the person who actually prepared the guide map or who supervised the erection of the sign post, we should probably feel that they fit the circumstances quite well. In this manner, then, there are individual differences in the particular way one is aware of spatial direction.

When we try to use a map while flying in the air, we generally approach the problem by first looking at the ground, and then at the map, and by lining up the coordinates of the map with the actual directional indications on the earth. Sometimes, however, the pilot is unable to move his map, and he must regard it with the north side facing up. In these circumstances the directions of the earth and the map must be manipulated a certain amount within the mind of the observer. Here we realize that in such situations, the individual's particular method of determining direction and the ability to isolate and revolve directions in his mind come to be of considerable importance.

The most extreme cases of the loss of the sense of direction are those situations in which one does not grasp the spatial relations of the hands and feet or of the way one's body is extended, or in which even the distinction between up and down is lost. And indeed this situation is not as unusual in occurence as it may sound. This experience is often had in the middle of the first night spent in a strange hotel in an unfamiliar section of the country. Suddenly one is awakened to find that not only is he unable to realize in which direction he is facing, but also the awareness of up and down, right and left is completely gone, and he finds himself unable to move. This experience is especially marked when one is drowsy and only half awake, or when very tired. The hands and other parts of the body that belong actually to the lower half of the body are erroneously judged to be above one, and there is considerable anguish at being unable to move the affected parts. If the person has been told that there are ghosts in the room or that the house is haunted, in the middle of the night these feelings seem to seize the sleeper in the form of apparitions, particularly in rooms that are isolated and of unusual structure so that the determination of direction becomes difficult. Indeed one can see how from such rumors and frightful suggestions these experiences lead some people to believe in ghosts with all their heart.

Thus by comprehending the above examples we realize that the awareness of direction is as absolutely fundamental for aviation as is the judgment of bodily position with regard to securing accurate, steady, and reliable performance.

The Judgment of Speed

When one stops to consider it, the speed at which an airplane actually flies is exceedingly great. For a plane to have a speed of 360 kilometers an hour it means that the plane is actually travelling a hundred meters every second. Then it is natural for one who has never flown in a plane to imagine that at such great speed the world about him would look very much different from the way it appears as we slowly walk about on the ground. However, once one has ridden in a plane he realizes that it is not the confusing matter he had anticipated, but is on the contrary a rather smooth and calm experience. On land if one is looking at something some hundred or thousand meters away, one is unaware of the presence of objects closer than that. Movements within the visual field at that distance become almost insignificant. Many trainees that are in the beginning period of flying instruction, and persons making their first flight in a

plane are often impressed with this fact. The experience is the same as the feeling that one is barely moving at all while actually riding in a fast express train over the grassy Manchurian plain, where the field of vision is broad and open. This is in marked contrast to the impression of great speed one receives as one seems to whiz by elevated lines and house fronts on a much slower Japanese local.

When airplanes are flying in formation one almost completely loses any impression of speed to look at the planes flying to one's right or left. A similar situation can arise on the ground when trains on adjoining tracks move simultaneously in the same direction, as often happens in stations. Here, however, the experience is not so clearly marked as in the airplane, because usually the movement of the other train just above the tracks is a part of the visual field.

However if while peacefully enjoying the serence view of the earth from aloft in a plane, suddenly the plane enters a cloud, indeed the heart of the amateur is likely to freeze with terror. The clouds seem to be cut up into little pieces that come striking at him from in front at full speed. If the weather should suddenly become unfavorable, the novice feels as if his plane had plunged right into the center of the storm. However, to observe this plane from the ground it seems no more than that the plane has simply stepped for a moment inside one of those white fluffy clouds that stud a clear sky. But if the plane has a speed of 360 kilometers an hour, to the passengers in the plane it appears just the same as if the bits of cloud were hurled by in a storm with a wind velocity of 100 meters per second. It is hardly to be wondered that this should be quite a dreadful experience to the unseasoned flyer.

It is an extremely different thing from watching an air battle from the ground, to observe the battle while actually being up there in the sky. The view of a plane following in close pursuit is radically different from that of one diving in attack on the earth. In the former case the plane seems to be in extremely slow pursuit, due to the fact that one perceives only the relative difference in speeds. If, for example, the difference in speed of the two planes is 30 kilometers per hour, the plane appears in pursuit less than at the speed of an average automobile. Looking at the plane in close pursuit, tagging behind like a streamer, it seems to rise and fall smoothly, slowly inclining its body to fix its aim, and following almost fluidly behind. It is as if one were watching a moving picture of the engagment in slow motion. One is reminded of calm and serene grace of a match of kendo.

When the plane in pursuit has completed his machine gun fire, he suddenly seems to rare up, and casting off his adversary he darts away. The speed of the plane at this time is another story. It is accomplished so fast that one is tempted to say that the clouds obscured the view, although that isn't much of a comparison. Within an instant the plane has become a dot, and is sucked into the sky and gone.

Therefore, just as the rear attack by a plane flying in the same direction appears to be so slow, the frontal attack of the oncoming enemy

plane takes place with almost lightning like speed. If the speed of the two planes is 360 kilometers per hour a movement of 200 meters a second must be perceived; if the approach is at 500 kilometers per hour, the movement to be perceived is 280 meters a second.

Thus we must realize that the impressions one has of speed while in the air are quite different from those we would have of the same situation as viewed above our heads on the ground. Events in the air are always judged as being so much more or less in speed than the speed of one's own plane. Of course, this is just as true on the ground, but the amount of speed that becomes more or less is extraordinarily great. However, the important thing to consider is the fact that since in the air we are so far cut off from the earth's surface that we have no means, no gauge, by which to measure this difference in speed. When the speed is suddenly reduced, one can merely be aware of the fact that his speed is falling.

Try to consider, for example, the situation where two machines having speeds of 300 or even 600 kilometers an hour would go out to battle on some level area of ground. It is absolutely impossible to conceive of such an engagement. Actually, the sky is an extremely expansive environment in which to operate, and our task must be facilitated by some rather ingenious devices.

Thus we see that when we read various articles expounding on the violent air battles that are necessary in mending the rents in the clouds of war, one should hardly regard such conflicts with the point of view of one on the ground. As for how dreadful a thing air combat actually is, it must remain vague speculation for the man on the ground.

At any rate, when one is flying at a fairly high altitude it takes a rather considerable effort to acquire the feeling that one is really cutting through the air with such remarkable speed, since the earth seems to be passing so gently by below. In order to acquire some awareness of the speed at which one is flying, it might be profitable to apply the following suggestion. From your seat in the plane select some stationary part of the fuselage, such as the forward or rear edge of a wing, to be a point for visual fixation. Then without merely noting the movement of the features of the earth as they pass in or out of view, try to attach the appropriate meaning to the forests, rivers, and houses that you see. Man does not judge the size of objects alone by the size of the retinal image they produce. Thus, if one regards the objects on the earth's surface in the manner I have just suggested, even though one may actually be flying at an altitude of 3,000 or 4,000 meters, subjectively it will seem as if he were flying fairly low. With practice it may even seem as if one is just over the top of the forests, rivers and houses. We call the psychological phenomenon of judging the size of objects in this manner fairly independently of distance, the phenomenon visual constancy. A familiar consequence of visual constancy can be illustrated by referring to the common experience of trying to take a photograph of some friends with a background of magnificent scenery. When the negative is developed one finds to his great disgust that the friends have been reduced to the size of pin heads, and that the included birds and airplanes (especially

if a range finder was used) are completely hidden by the smallest shadow.

It is perhaps better not to consider the phenomenon of visual constancy as being most strikingly manifest in photographic situations, but the point is that when we look at the surface of the ground in order to perceive one's actual speed, we are using visual constancy another way. We have the phenomenon of mammoth vision. When one becomes so that he thinks he is flyig low over the forests, houses, and streams, he is more able to appreciate the great speed at which he is moving.

Of course, such efforts as the above may be no more than idle play for the passengers of the plane. However when the plane actually begins to come close to the surface of the ground the way one regards speed becomes an extremely important matter for the pilot. That is, the visual measurement of speed is an important problem at the time of landing.

However, the study of the visual determination of speed is extremely difficult to carry out at the time of making an actual landing. First, in landing the body of the plane is becoming progressively closer to the surface of the ground, which means that the distance between the ground and the observer is constantly changing. Then second, the angle formed by the line of approach of the plane and the earth's surface is likewise undergoing continual change. Without taking into consideration these changes one should hardly expect the judgment of speed under these circumstances not to be something of a problem.

Then we may ask what is it that produces the difficulty in judging speed while landing? We shall find that here too the particular characteristics of the objects as reflected in our eyes exert a strong determining influence.

It will be noted that if while traveling by train we observe carefully the effect of a change in the speed of the train upon our view of the regularly arranged cross ties or rail junctions of an adjoining track, we will find that even slight changes in speed are readily detected. This is due to the fact that we have become aware of the constancy of the distance between our eyes and the rails of the track, the space between each of the cross ties, and the length of each section of rail. Now if we were suddenly to ride over the rail system of a foreign country where the cross tie space and the length of the rails is different, our feeling for particular speeds would also probably change.

Then also with airplanes, if a pilot had received all his take off and landing training at a field where there was a grass runway and then were to attempt a landing at a hard surface or paved landing strip, it is natural that at first his visual approach to the landing (of course, here I cannot say only speed) will become somewhat disturbed and momentarily difficult.

In the first place, when we look at things that are moving, it is quite easy for our eyes to follow in the direction of the movement. This can be quite easily demonstrated experimentally. Paint a striped design on a belt and attach it to a conveyer unit. After starting the motor

attempt to maintain a fixed visual point at a certain part of the system. If this is continued for a while it will become quite clear that there is a tendency for the eyes to follow in the direction of the movement.

It could hardly be said that there is anything associated with the judgment of the speed of an airplane that moves slowly. In the situation above, the movement of the point of visual fixation is easy to bring about if the movement of the pattern is gentle and even. But on the other hand, if the belt is revolving so fast that the stripes merge into one uniform ground, then it is no longer possible to produce this movement of the visual fixation point. The effective sensation of the poem by Akahiko mentioned earlier

(The clouds change so softly--
One even begins to think the mountain is moving)

comes about because of the movement of the clouds, their relative size in the visual field, and the visual aspect of the mountain.

It is the general practice in attempting to make a landing to measure one's relative speed by looking at the ground to the left front of the pilot, or at least so it is instructed. It might also be possible to determine for the general average plane how far away that point should be at a particular time towards which the pilot is aiming in approaching his landing, by experimentally ascertaining the most suitable distance. If it were possible to have all the equipment we desired, we should also probably be able to set up fixed distance markers to aid in the judgment of speed while moving. By learning to make use of such aids, the student would most likely learn visual measurement in as easy a manner as possible and in time come to acquire some real ability in the judgment of speed on his own.

However, such a solution is not satisfactory since it only shifts the problem to the consideration of the structure of the visual field, the organization of the movements involved and the particular characteristics of the objects at which we are looking. Actually it is necessary for us to examine critically the particular mental set that underlies our looking at things.

It is generally held that people who have "shifty eyes" have personalities that are on the whole more volatile than average. Then again persons who quietly and intently observe their associates are said to be relatively contemplative, settled and serious. Accordingly then in the judgment of speed one should expect to find rather large individual differences in the attending frame of mind. With regard to those individuals who are relatively consistent in their approach towards things, it would seem natural that if such a person, for example, were found always to overestimate his judgments of speed, it would be possible to train him to make a constant adjustment to his estimations. On the other hand, where one has to deal with a rather emotional person who is quick to change his mood from time to time, it will appear that there is no consistent tendency in his judgment, since it will be at times over and at times underestimated. One would probably find that even with considerable individual instruction such a person meets considerable

difficulty in making accurate judgments of speed.

Here we run up against a problem that is not specific only to the judgment of speed but that is a matter for consideration in all jobs in general. In personnel selection when for example we give a qualification or aptitude test of the visual judgment of speed, and make use of only a small isolated factor involved in such judgment, the existence of any ability at visual judgment of speed becomes only an abstract functional capacity. Actually it is necessary for the test to reveal the individual personal attitudes concerning the work as well as the other characteristic factors which influence the performance of the task. It is fundamental in investigating the qualifications for a particular job to consider the individual attitude towards the work and what special meaning the work has for the individual being tested.

Judging Distance and Height

It is indeed an unpleasant thing for many people to look down from on top a ladder fifteen or twenty feet high or from the roof of a fairly high building. One has the sensation that he is going to fall over from the place on which he is standing, and this feeling is so marked in some acrophobes that they are absolutely unable to endure places of any considerable height. It is easy to imagine then how horrible some people consider flying to be in a plane some ten, hundred or even a thousand times higher than the unpleasant situations described above. They would be amazed indeed to make an actual flight.

Even the bravest pilots are probably completely powerless at the top of a wireless tower, or even on top a three story building.

When one views the earth from a plane, it appears, as I have said, to be a completely different world. There is never the least feeling that one is on an extension of the ground, simply higher than the rest of the places on the ground. If, however, one looked down from inside a plane and dropped out a long rope to the earth, he would quite likely become frightened indeed, having stirred up then a feeling of earthly height.

Looking down from a high place that is contiguous with the ground below is entirely different from the way one feels when looking down from an airplane, being completely separated from the earth. In the situation where one is connected with the earth, the things below seem to be small. However, if one is entirely cut off, the objects on the ground appear comparatively large. In other words, in the latter situation it is easy to bring about the phenomenon of size constancy of which I spoke earlier.

An illustration of this point is clearly afforded by the seats in a stadium. In the reserved seat boxes which jut out over the field above the grandstand below, one feels he is able to look closely at the contestants on the field. To those in the general admission seats of the grandstand, however, although they are actually closer to the field than those in the reserved seats, the players seem smaller and farther away. Similarly, when

one looks down through a splice in the clouds from a plane, the earth looks much closer than it is, and one feels that he really isn't flying so high after all.

It seems important to consider the relative comparison of altitudes. Let us say we are riding in a plane when in the distance another plane appears in view. If the plane is an enemy craft and an engagement is forthcoming it is an important matter to determine correctly whether the plane is higher or lower than one's own plane. Yet of itself this judgment is difficult to make. A comparable situation illustrates the point. When one is standing on a mountain peak, and sees another mountain top ahead that is separated from the mountain on which one is standing only by a deep gorge, it can often be extremely difficult to determine whether the peak is above or below him. In such a situation there is nothing before the eyes that can serve as a standard for judgment. Yet a simple procedure will enable him to make the decision. He could support his pocket watch from a string, and placing the straight edge of a piece of paper, on the line from 3 o'clock to 9 o'clock, he could sight alone this surface. Accordingly, if one sights along a level surface of the engine or wing on the side of the opposing plane, it is natural that the determination of relative height can be made.

In the air where it is naturally difficult to search about for objects to serve as some sort of fixed standard for comparison, many small bone-like structures will serve the purpose; such, for example, are the struts or stays of the wings of the biplane, or the front edge of the wing itself. Even these structures can be used since the height of one's eyes in the seat is for all intents and purposes relatively constant. It is perhaps after all a fortunate thing that in most elementary trainers there are as many supports and stays as there are since it is relatively easy to take a standard for comparison.

The planes used in pilot training often have ribbons attached to the supports or lines drawn on the upper surface of the wings. The students as they wander over the sky come to use these devices as valuable cues to fixing their position in relation to their companions, and governing their points of rotation or in learning how to come in to a good landing.

In the visual measurement of altitude, just as with the visual measurement of speed, when one has enough safety altitude differences in judging altitudes of 10 or 20 meters are of no great consequence. When such gross differences are involved, sufficient indication is afforded by the graduations of the altimeter. Again the trouble comes in that transition plane between this area of psychological safety and the dangerous area on the surface of the earth. In other words, the place where one must have the greatest accuracy in the visual judgment of altitude is from the time one decides to land up until the landing is completed.

Indeed such judgments relying on sensory cues as were formerly necessary can now be quite sufficiently made on the basis of mechanically accurate and automatic information, but I believe that true air men are not produced unless the student pilots are left to acquire this ability on their own in an elementary trainer.

Omitting the various specialized techniques that go into piloting, the one critical point in making a landing is the time when the pilot begins to "return" the stick, that is, when he makes the adjustment from the fixed angle of descent to that of the landing position. If this change is poorly executed, a skillful landing is impossible and considerable danger is involved. Many pilots are particularly troubled about this critical point. The time to begin this change of flight angle is basically dependent upon the visual measurement of a certain constant altitude.

A group of pilots once told me of the following plan they devised to help them master this critical point. They sit down on the top of a mound of earth around the same height as the critical altitude at which they should return the stick. They close their eyes and visualize in their mind's eye that they are gradually coming in from a higher altitude. They mentally lower their altitude by degrees until they finally think, "At last I'm at the height where I should return the stick." Here the students open their eyes and look at the airfield to their left front. Then with their hand they make the appropriate movements of returning the stick. Here it is clear that these pilots are not merely memorizing the visual aspect of the ground surface at a certain height; the trick of these students lies in the fact that they are calling upon the total kinesthetic set of their bodies when they imitate their descent in this manner. However, this kind of practice does not lead to such effective results to the same extent in all people. Unless the student is a person that makes predominate use of visual rather than auditory imagery, this sort of practice would most likely be profitless.

It is indeed a valuable thing for a pilot to be of the visual type. This fact seems to have been recognized for some time. Just as in communications work audials are more successful, visuals are clearly more suited for the duties of piloting. It is hardly necessary here to remark that the term "visual" refers to those persons who depend chiefly upon visual symbolization or imagery in learning things. (The term need never imply that one's visual acuity is particularly good. There are indeed audials that are hard of hearing; only consider the magnificance of Beethoven's work that was done after he had become deaf.)

Not only as far as the judgment of altitude is concerned, but also when it comes to the visual determination of speed, visuals are favored over audials.

In a sense the judgment of altitude is more directly concerned with the judgment of vertical distance, but now we shall attempt to consider the judgment of horizontal distance on the ground and in the air.

It is generally considered that if it were only possible to know the rate of speed, one could sense the distance traveled by multiplying this speed by the time of flying. However, actually man's senses are not developed to the extent that they can follow such logical solutions as easily as all that. If man's reactions were determined by reasoned relations, the pilot would feel at all times how far he was from his destination, and would

probably never be worried about such problems as running out of fuel when flying over unfamiliar ground. When they do not harmonize with more objective determinations, human feelings exert considerable influence on the judgments made. When these human feelings are unusually strong, the tendency is to ignore their subjectivity and to claim simply that it is the instrument that is wrong.

Probably the fundamental temporal units by which we gauge distance on the ground lie within the kinesthetic sensations we receive when we approach objects that we see to be a certain distance away from us. When old people who have lived in a narrow rural environment for their whole lives first take a ride on a modern train, they have no accurate conception of the distance they have traveled. Even though such a person is able to state correctly how far it is he has traveled, he certainly did not perceive this distance from the sensory impressions derived from his previous walking experience. The sensory units of time upon which he would base his judgment of distance on a train are necessarily different from those of walking.

In a completely analogous manner the sensations of distance in a plane must be entirely different from the sensations of distance on the ground. On a train, one is progressing towards his destination over a fixed track so that a given rate of speed results in a specific amount of progress towards the goal. In a plane, however, the pilot must himself guide his course towards his goal, and slight differences in direction lead to large variations in the time necessary to cover a certain distance. Still, when one's visibility is beneficial it is possible to see over a fairly large area, and if there are characteristic land patterns to follow, there is relatively little difficulty in heading for the desired spot.

Thus it would probably appear that just as we become able to measure the distance traveled on a train by the time consumed, so after we have become familiar with flying in a plane over a period of time we should come to appreciate the characteristic time units involved in flying.

Conclusions

The foremost conclusion to be drawn from the discussion above is clearly that as far as the judgment of posture, the perception of direction, and the judgment of speed and altitude is concerned, these judgments cannot be made in the air so that they are objectively correct by means of the human senses alone. Of course, it is true that in order to become a satisfactory aviator it is necessary for one to have sense receptors that function properly; yet even if one has perfect sense organs, it is not possible for him to achieve by means of them alone an adequate comprehension of the sky such as is necessary for the particular responses involved in flying. This means that adequate adjustment to the new environment of the sky is not possible through sensory channels alone. Indeed the fact that one has strong and healthy sense organs is as far as flying is concerned no more than the premise to the conclusion that "strong and health" illusions will occur. Thus we see that if our senses give rise to misjudgments in the air, then in order to achieve the most satisfactory adjustment to that environment, we must to a certain extent discard our own sense receptions,

and intelligently and rationally control our machine by objective, mechanical judgments. We must use our machine as a means of effecting this adjustment.

And certainly it should be so. Man is not a bird. The bird must face his environment without any sort of go-between by means of his own five senses, and through these receptors he must be able to grasp directly his aerial environs. Yet man must employ the medium of a plane to fly. We are not flying creatures; we have a flying machine, and we ride inside that which we have made to fly. It is only man that equipped with animal senses, and possessed of eyes like a hawk, and ears like a dog, and static sensors like all birds in general, is able to control this machine with the greatest skill, and to make use of such a technique with the greatest precision.

In the plane of twenty years ago there was great dependence upon such sensory functions. There were few instruments and gauges to speak of; the cockpit was no more than a crude seat exposed to the air. Indeed it is more appropriate to name the aviators of those primitive planes "bird men" than our own pilots of today. Of course, even now most of our elementary trainers are of such a nature that they can be controlled to a large extent by sensory perceptions. Accordingly, those students who seem to have a knack at this perception and who have developed good "motor nerves", often make conspicuous progress in early pilot training; they have a quick understanding and are permitted an early solo flight. However those who can easily display this ability from good perception and motor nerves, have the advantage only in flying the elementary trainers. When it comes to handling the plane they will actually have to use, as is the case in advanced pilot training, the success of these pilots does not continue at the same smooth rate.

Certainly the elementary trainer and the regular plane that is used in advanced training are similar in some respects: both types of plane have wings, and both have engines, and both fly through the air, and both control their line of flight by rudder and elevator adjustments. However, the piloting of an elementary trainer and the piloting of an advanced craft belong to two psychologically different spheres of operation. Specifically, once the theoretical rules of navigation and flying manoeuvers become a part of the subjects of training instruction, the control of the plane is no longer possible by direct external sensory perceptions. This kind of task is not properly handled simply by impressions from the five senses; it has come to require the use of higher functions. Here it is that the student of such conspicuous early success meets his first obstacle. That is, a change from intuitional to intellectual control has become necessary.

The need for progressively more rational control has grown in parallel with the mechanical progress of the plane. For flying in clouds and at night time where one is unable to see effectively the outside world, it has become extremely necessary that one's contact with the flight destination need not depend upon perceptions from the outside world. In such situations the pilot is able to execute maximally accurate control over his ship by instrument flying or by simply reading the indicator gauges with which his plane is equipped and by relying completely upon these.

It is precisely this psychological distinction that fundamentally sets apart the nature of the mental behavior involved in piloting. In psychology we reject as "operational concepts" (Leistungsbegriff) approaches that fail to take into account such distinctions and separate operations merely by their external appearances. We shall deal with such approaches again in the discussion of communications training.

After all, our environment as it appears to us is utilized in a completely different way in the invention of new modes of behavior, and in flying a plane our conception of the sky as an environment has come to acquire an entirely new meaning. The fact that man has introduced a technique as a go between in adjusting most adequately to his environment means in other words that he has made an analysis of certain factors in his experience and has delegated a certain part of them to the machine. Then this technique can be utilized as a technique only when it is clearly understood just which parts have been delegated to the machine. It is then possible by correctly examining the stages of the analysis of this environment to understand the operation as a psychological operation, without falling into the use of operational concepts.

Let us try to take an example to illustrate the point. In flight training lectures are usually given on dusk flying as an orientation to flying in conditions of poor illumination. Yet it is extremely probable that there is little transfer of the effects of such training to flying in the dark or night flying, unless it be in the way of increased self confidence. This is undoubtedly due to the fact that the two environments must be differentiated into two separate entities and the two operations involved are psychologically quite distinct. One might think for example, that in order to attempt to experience the feeling of being blind, all one would have to do would be to walk around a bit with the eyes almost, but not quite closed, and think, "Well, being blind is just being darker than this." There is indeed a certain degree of difference between the way things look in broad daylight and the way they appear at dusk, but it is merely a matter of degree; daylight and dark are in this respect two portions of a continuum. However, there is no continuity between dusk and night. Thus night flying is a completely different operation from dusk flying, and the process of adjusting to it as an environment should naturally take a different form.

Indeed correctly grasping the ways in which the adjustment to this environment can be differentiated and the ways it should best be differentiated, and then properly assigning the suitable parts to appropriate mechanical devices, results in a more precise clarification of the psychological form of the technique; thus man can come to make the highest use of his machine. Without this accurate differentiation one cannot hope for a harmony and balance between man and machine. Man has gradually come to delegate various parts of the operation of flying to specific machines. However, if this delegation to mechanical devices is based on a hit and miss selection of human functions, there can be no real development of the technique. Progress must be achieved by realizing the proper structure of differentiation of the human elements involved in the operation. It is in the determination of the structure that we find the duty of psychology.

This line of reasoning is as equally applicable to the methods of pilot instruction. It is proper instruction to teach the students that in an aerial environment perception and judgment are differentiated or broken into parts, and that the pattern of the structure of this differentiation must be the same as the differential relationship between man and machine. Only in this way can there be true instruction in the technique of handling a machine.

Thus we see that the approach toward pilot instruction as well as its goal must be different now from that of the time before the mechanical progress such as we have today had been made, even thoughit is true that the elementary trainers do not differ greatly from the planes of those days. Yet today instruction cannot proceed successfully unless the sense perceptions necessary for the student pilot of those days, are presented to the student as completely differentiated from his mechanical judgments. Presenting them as differentiated in this manner may indeed have been an extremely difficult as well as unnecessary task in the past, but in the present the method of doing so has become quite clear since we are able to follow the stages in the development of the technique of flying. Moreover differentiation has become absolutely necessary.

In this manner aviation psychology will be able not only to formulate a rational comprehension of the technique of piloting; but by systematically analyzing the sky as an environment and the process of adjusting to it, and by following the course of its differentiation, psychology should come to understand machines in their proper relationship to man, and to attempt a rationalization of the training of techniques in general.

CHAPTER II

THE STRUCTURE OF THE TECHNIQUE OF FLYING

The development of the airplane has been characterized chiefly by the progressive trend towards automatization of the various techniques involved in flying. Gradually such functions as landing and taking off, flying at the proper inclination, determining direction, and sighting, aiming and firing at enemy craft are becoming automatic. It is largely the job of the pilot of today to regulate the particular automatic devices, or perhaps merely to keep an eye on the various automatic indicators. If we observe the functions that have been automatized we can see that the technique of flying has been already differentiated into a number of fundamental unit operations. These unit operations make up the relatively independent psychological operations that comprise the separate subjects for study in pilot training. Psychologically speaking, piloting is composed of unit operations which form as a whole a single frame of tension.

As I have said before, the technique of flying has developed and become differentiated over a period of time, and certain of these differentiated parts have been transformed into completely mechanical devices and have become automatic. When this differentiation is complete, a function becomes independent as a completely mechanical operation; if the differentiation of the function is incomplete, the function must be performed by the cooperation of man and machine. In the future this process of differentiation of function will indeed continue even more, and still more aspects of flying will be entirely delegated to mechanical action; however because of the fact that the airplane is always utilized in the execution of complex human plans, a complete automatization in any literal sense, can probably never be achieved. This is because the airplane would become something very difficult to manage indeed if at least the temporal ordering of these automatic operations is not left to the liberty of the aviator. Thus it is to be expected that the substance out of which the technique of flying is built will greatly change in its specific nature in the future; but even so as a technique it will still remain a human technique.

The technique of flying can probably be defined as the technique of handling a plane in the sky, or better still, it is the voluntary activity involved in controlling a plane so that the mechanical ability implicit in the plane is correctly manifest. In other words, a machine completely prescribes the human acts possible in its operation by the various mechanical properties that it has. Thus the machine determines a matrix which governs flying; this is what is commonly considered the <u>laws</u> or <u>rules</u> of flying. On the other hand, man is made up of various human mental and physical characteristics, and in the way that he conforms to the matrical laws prescribed by the machine, he determines the patrix which governs flying. This patrix is what is commonly considered the <u>skill</u> of flying. The harmonious union of <u>law</u> and <u>skill</u>, of matrix and patrix, is the true culmination of the technique of flying and results in what may be termed a man-machine whole.

Since it is the skills of flying that manifest in the broadest manner human will, even while completely following the laws of the machine, these skills must have some versatility of nature to adjust to the various differences they meet in dealing with machines. Moreover these skills must be of a high resilience in confronting differences so that they can maintain their form as a particular skill. That is, even though the system of psychological forces that underlie the skill changes its nature with respect to a certain mechanical function, the whole of the skill must not break apart. Human volition must have a single coherence and consistency all the way from the inception of a particular plan to its enacted completion. Thus, problems related to the nature of human will form the nucleus of our discussion of the psychological nature of the technique of flying, and for the most part it is this subject that we shall take up in this chapter.

The Union of Acts and Perceptions

Just as the technique of flying is a system of tensions composed of various unit operations, so in turn are the unit operations systems of tensions formed of unit acts. We shall probably make much use of these terms, and we shall consider the unit act as the final element of analysis in the psychological consideration of the technique of flying.

The learning of the technique of flying ordinarily begins with the learning of these unit acts. Unit operations are formed from linking together these unit acts, and the technique of flying is learned then from the joining together of these unit operations. The two things one should keep in mind concerning this process of learning is, first, that the learning involves the perfection of these unit acts, and secondly, that it requires the acquisition of a system of tensions made from the linking together of these unit acts.

The first of these points, which refers to the perfection of unit acts, implies that only when these acts involve a perfect union with the perceptions of the aerial environment, can they become synthesized as the unit operations of the technique of flying. This means in other words that if one's actual perceptions in the air do not correspond with one's training in the various acts of piloting that one received on the ground, then there has been in effect no actual training in the basic units of the technique of flying, in any strict sense of the word.

When students are instructed in the very beginning of pilot training to try "to feel as if you are actually flying in the air", or "to feel as if you were an old hand at performing the task" we see the first step in the attempt to fuse and coordinate their acts and their perceptions. When the beginner is taken aloft in a plane for the first time he is given the command to move the stick in any way he should care. Thus when he moves the stick a certain amount, the student feels in what manner and to what degree the fuselage of the plane is inclined, or in what way the angle of the earth's surface is altered, or just how his equilibrial sensations are affected. The result of such practice is that at the same time as he

is aware of the perceptual changes which were produced by his acts, he is actually making the acts that will lead to these perceptual changes; here he is able to achieve a union between his perceptual and behavioral adjustments to the sky. Here we have the essential pattern of the job of flying. Accordingly we understand that one's experience of flying depends upon both the behavior involved and its perception.

For a long time these rough perceptions are used as standards for directing the unit acts, even after considerable progress has been made in training, and the student has become familiar with several subjects of instruction. Then after he has obtained a certain proficiency in these rough perceptions so that he does not have to make a great effort to acquire them -- here already some differentiation has come to be made -- at this point the student can first be instructed how to appreciate the manner in which the plane's angle of inclination and speed are indicated by the gauges on the panel before him. In this manner acts and perceptions are fused, but the perceptions are differentiated once again into sensory and rational elements. Each of these later must in turn be united with the appropriate unit acts.

However, even though in the long run the goal of training in the technique of flying is now the union of operations with rational judgments, when one attempts to plan a union involving rational material, this rational material must be expressed in abstract form; therefore if these rational concepts have no basis in sensory experience, it is quite easy for the link between these concepts and acts and operations to become an artificial one. Formerly, one was able to become a successful pilot if only a simple sensory link were obtained between act and perception; it was not particularly necessary to differentiate again this perceptual material and to bring in rational concepts. That is to say that simple perception was the final step in flying. In the present, however, much effort must be expended to introduce the proper rational concepts. As I have made clear before, it is beyond doubt that our training methods of today differ from those of former days because of the progress of this differentiation, and the need to unify acts with rational concepts.

However, the union of act and perception is never completed simply in the early stages of elementary pilot training. Even though ideally one disregards sense perceptions in order to achieve a union of acts and operations with rational concepts, still a proper union with these perceptions is fundamentally necessary. This means that the process of training is long and continuous. Indeed it is just such a purpose that is served by the instruction in "getting the feeling of flying" that I described above. The attempt is made at that time to indicate in what manner the two elements that have previously been unexperienced should be united.

I think it is appropriate at this time to take up briefly certain problems that are related to the instruments and gauges used in flying. Under ordinary circumstances the pilot receives information concerning his outside world directly by means of his sense organs, and he regulates his acts and operations in accordance with these data. However, this is

possible only when his communication with the outside world is extremely efficient, and in those situations where the conditions of his environment cannot be known directly, he has no other recourse than to rely on instruments. Therefore, gauges must have such a form that under any condition they can easily and effectively serve as substitutes for the sense receptors of the pilot. This refers not only to those instruments concerned directly with navigation proper, but also to the various gauges which indicate particular aspects of the condition of the engine.

In its earliest stages of development, the plane was equipped with only the bare minimum of instruments. For all other kinds of information the pilot had to depend upon his own sense receptors. However the development of mechanical engineering made it possible to indicate a large range of external physical conditions by means of gauges. As a result, the number of instruments used on planes was rapidly increased. On the instrument panels in front of the control seats of the large ships of today, a frighteningly large number of instruments are arrayed. Indeed the number of instruments on the panel has been taken as an index to the precision and excellence of the plane. However, these instruments are in function far from their original duty to act as substitutes for human sense organs. Each of the perhaps thirty or forty instruments on the panel indicates a different mechanical function; if all the needles moved in different directions, and each had a slightly different danger zone, the pilot would never be able to comprehend the information reported, regardless of how intelligent he were.

Certain attempts have been made to alleviate this confusing situation regarding instruments. For example, the instrument panel of one large American airship was designed so that the needle indicators of the various gauges all pointed down to denote a satisfactory condition in mechanical functioning. I believe this was indeed a significant step in the development of instruments. Since it is relatively easy to spot visually a line inclined at an angle different from that of many parallel lines, this adjustment meant that the burden of the pilot was significantly lightened.

Still other improvements of instruments have been proposed. One of these is the device which changes color with changes in the equality of mechanical conditions. Under satisfactory operating conditions the gauge is green in color. As a danger area is approached this color changes to yellow, and finally to red when actual danger is present. Another plan has been to set off an alarm signal if danger zones are approached. However, it has been the final goal of this effort to devise methods by which the number of gauges could be reduced. As for the present stage of development, it must suffice to say that we have arrived at this stage of "abbreviation." The automobile instruments, for example, have been extremely simplified. The goal is to devise those few instruments that will still enable us to fly, yet relieve us from the task of constantly watching all the gauges that indicate the condition of the engine. However, in order to achieve this it will probably have to be necessary to raise the mechanical level of perfection of the plane. Machines that do not operate safely without constant human supervision, at some point become a burden to man; an overburdening instrument panel leads to the physical and mental exhaustion of the pilot.

The Formation of Unit Acts

However, it is important to consider in some detail in what manner unit acts are formed, apart from the matter of their union with percepts that we have just been discussing. In pilot training when the student practices with the various training aids on the ground, or when aloft in a plane the instructor teaches him to use his feet by holding his hands from the co-pilots seat, the student is receiving training in these unit acts. In these situations there need not be a union with the appropriate perceptual material. This union is acquired with proper and normal flying.

Moreover, by the very nature of the test items involved, when we make a qualifications examination in order to select the best pilots, the investigation is based on the individual's performance of designated acts. If one inspects a report in the literature of vocational psychology, he can nearly always be sure to find some sort of analysis of a particular act the point of discussion. Many times he will find that the matter of the manner in which these acts are formed has been considered to some detail. The nature of the structure of unit acts is of importance first in the training of the various kinds of acts involved in a particular complex operation. Then, too, such an analysis serves to determine the ways a machine can be handled from the standpoint of the acts involved. This latter point can hardly be overlooked by the engineer.

Up to this time the most frequent type of test item found on qualifications tests for the selection of pilots has been that involving acts of coordination. In most instances this has meant the coordination of both hands or of hand and foot. Even though on the surface acts of coordination may seem to be trifling and artificial, they nevertheless are extremely important in the acquisition of the necessary skills in the technique of flying. Thus I shall try to orient my treatment of the formation of acts around these acts of coordination. In many situations that involve the operation of mechanical devices, as for example when driving a car, or using a lathe, or even in playing certain musical instruments, both the right and left hands as well as the feet may have different operations to perform; these separate functions each contribute towards the formation of a single whole. It is obvious that in flying a plane a precise, I even want to say delicate, coordination of acts is extremely necessary. It is the function of the right hand to grasp the control stick lightly, and to manipulate it forward and backward, to the left or to the right, as the case may demand. The action of the feet must be coordinated with that of the hand when they press upon the floor pedals. The left hand must manipulate the gas lever, or some other lever, at the necessary time. Unless these various functions are properly harmonized and unified, flying of any skill is not possible. With proper coordination these acts acquire a single completion, which is in turn fused with judgments based on external conditions or the indication of instruments, and the plane is made to operate efficiently.

It is fundamentally erroneous to consider the acts involved in flying as merely a complex collection of other acts. Consider for a moment the

simplest acts of everyday experience. For example, eating food is quite literally the everyday matter of eating rice and tea. This means that one takes his chopsticks in his right hand, and the rice bowl in the left, and chews the food with his mouth. The whole process can be broken down into at least three or four different acts. However, actually it is no more to us than the single act of "eating food." Yet really, I wonder why we should ever say that a particular act is a single thing. Even in the simple act of raising and lowering the hand, an extremely large number of nerves and muscles must participate. A single muscular contraction cannot become the unit for the formation of a single act. Even if we talk in terms of reflexes, and designate reflex action as the fundamental unit, it is in itself a chain of other reflex activities. Thus when we say a "single act", it is single only in that it makes up a single type or category; a single operation of the experienced pilot is the "coordinated act" which demands so much effort of the unexperienced student.

If one observes children learning to walk, it seems as if when they step out alternately with their right and left feet, they are trying to learn the coordination of these acts. When new born babies first make movements with their hands and feet often this movement is executed with both extremities together; gradually, however, the particular motions become differentiated, and complex movements come to be performed as a single act. Then again to watch young children trying to eat by themselves, the eating seems to be quite a difficult act of coordination. If the child is made to pay attention to his eating so that he chews his food well, he is apt to spill his food as if he had no hands at all. If he attempts to eat his rice while holding his tea in one hand, he is likely to upset his tea. By long periods of training such crude and disjointed acts of the beginning are moulded into a single act by being harmonized and unified; in this manner the act becomes firm and hard. Once its form as a coordinated act has become established it is not easily broken down.

Then let us try to consider the way in which a particular act is developed by practice. When an act is first attempted, for a while it is performed in its original manner, awkwardly and with gross and inappropriate behavior. Then with practice the previously undifferentiated activity that had no well defined structure, comes to be differentiated. With still further practice these differentiated acts become developed as a single system of behavior. However, these various systems are not differentiated separately and without relation to one another; they develop each so as to determine best the completed form of the single operation. This development is illustrated in Figure 3. In stage I the beginning period of training is portrayed. The whole appears as a homogeneous and undefined unity. In Stage II the whole is still crude, yet it shows evidence of the progress of differentiation. In this stage the parts do not harmonize and fit together, but in State III the whole can be seen to have a clear completeness, it is at a stable equilibrium, and has come to acquire the appropriate structure.

There are most likely various steps in the process of this development.

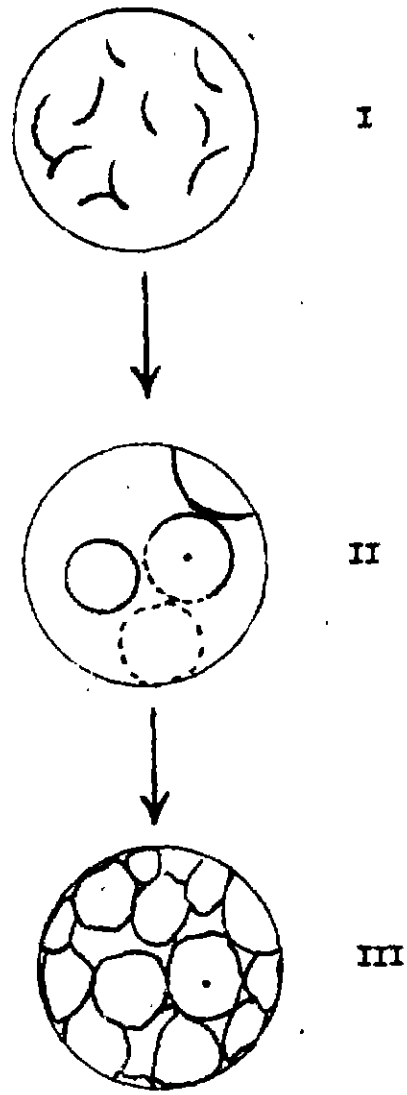

FIGURE 3

If an unnecessary response is produced by an early differentiation, it is pushed to the background, where it in time will become dormant and disappear. Undesirable responses are excluded, and gradually an appropriate structure to the union is produced.

One can experience this process of differentiation in many of the learning situations of everyday life. Gradually we grasp the task as differentiated, even though at the beginning no feeling of this differentiation could be felt; when we arrive at this stage of differentiation suddenly we feel we understand the nature of the task, and we can henceforth perform the task efficiently. Take for example the common experience of learning to swim. At first the coordination of hands and feet seems an impossible task; then when one reaches a certain stage he is suddenly able to swim. The stage at which the beginner suddenly gets the hang of it, is the stage at which the differentiation as a whole has been carried out, and resembles the final state of differentiation of the whole.

Once this stage of form differentiation has become established, the act will no longer be of the previous gross inefficiency even though one of the less important systems involved is altered. This is due to the fact that the form of the whole has become fixed. For example, the pilot is still able to control his plane when the stick has been bound by a handkerchief and held by the pilot's mouth.

Then also, if small children are made to perform some different activity with their left hand while they are attempting to write characters with their right hand, even though the movement of the left hand does not overtly disturb the act of writing the characters, still the child will be unable to do the writing. That is, in this situation the left hand actually forms a single unit within the act of writing characters, even though it appears to have nothing to do with it, and the single system of writing with the right hand has not yet become clearly established.

Qualification tests for the selection of pilots often make use of items involving acts of hand and foot coordination. In these situations, even though performance of the right hand only is required, the subject can be observed to make movements with his left hand as well. If his attention is called to this, this activity of the left hand temporarily stops but after a short while will commence again. If he then forces his hand to remain on his knee, it will become rigid and will in time begin movements of some meaning to the activity of the right hand, even though they seem to serve no advantage to the other hand. Then also, if one requires the subject to move his left hand in an unsystematic way, the performance of his right hand and feet will become incoherent. The above conditions can be explained by considering that each of the systems is at the time still undifferentiated and the structure of the whole performance is still homogeneous.

It has been thought that certain conditions lead to a tendency for some of the many nerve pathways with which man is equipped to associate

readily into a single sphere of coordination. It is possible to believe that the nerve groups which operate in the most effortless unit acts which we perform daily have each for themselves a particular affinitous, cooperative nature. This nature is reflected in the corresponding acts. On the other hand, there seem to be nerve groups that have a repelling and antagonistic relationship. Such an antagonistic relationship is well illustrated in our common experience by the fact that one becomes virtually unable to do other tasks if he strongly concentrates his attention in a particular direction. In the situation involving the qualifications testing of pilots that I have described above, it can be considered that concentrating one's attention on his right hand influences the other systems involved so that they become somewhat incompatible. However these attracting and repelling groups are derived to a large extent by training.

For example it is possible to think about other things to a certain extent at the same time as one is walking. However, in such situations it is possible for one's walking to be greatly hindered by the nature of what is being thought; further, if one becomes absorbed in the way he is walking, one's thinking about other things is not likely to be coherent. An excellent illustration of this point is afforded in the calculation races in childrens' field day exercises. (Note: The calculation race is one of the games often used in Japanese schools. In the race children are lined up at a starting point, and at a signal run to a designated place where they pick up a slip of paper upon which a number of simple arithmetic problems are written. The children are to complete these problems correctly before they reach the goal line.) Such situations illustrate the point that the potential power that man can call upon to perform an act is constant, and that therefore in performing an operation that involves two acts, it does not raise the efficiency of the whole to concentrate strongly upon one of them. Furthermore, when one becomes able to perform two acts skillfully together it is probably due to the fact that because of the effects of training the performance of each of these unit tasks does not require a large amount of power.

If a man is normal, he is quite able to attain proficiency in doing several acts at the same time. However, in relation to qualifications testing for pilot selection it is important not to overlook the fact that there are some people for whom performing two operations at the same time is an impossible task. In general, these may be divided into two types, the first of which is made up of those people whose human capacity or potential power is deficient to the extent that it prevents at the outset any division into two acts. For example when mental defectives look at a particular object, or attempt to do a certain task, it is not possible for them to perform another operation at the same time if they are to be successful in their undertaking. They often seem unable even to close their mouths or adjust their posture. The second type is composed of those people who, even though they have sufficient capacity, are able to direct it in only a single direction. There seem to be many people who adopt such a mode of adjustment over a long period of time.

We see, then, that in order for the operations involved in piloting

to be acquired to a state of efficient performance, first a certain minimal potential power is required; then it is necessary for the individual acts to be differentiated. Accordingly we should expect that these flying techniques could not be acquired by persons of inferior intelligence, nor likewise by persons who have adopted a fixed and rigid approach towards their work. Such an example can be found in that type of person who devotes much of his activities simply to the pursuit of scholarship. Even though these persons are capable of a prodigious amount of vigorous energy, and they can often point to a proportionate amount of success in their field, nevertheless, in many cases training in a new job or a new activity becomes a great difficulty for them. I shall speak of this subject again at a later time.

However, I believe that when men are still in their youth, such men are rare that already have such a disposition so that in order to perform a single task, they can reject all else and put their mind in only one direction. Indeed many of the scholars with whom I am acquainted at one time possessed superior pilot qualifications.

Thus this linkage of acts involved in coordination is somewhat similar to a musical performance; the total coordination is like the finished concert presented by a quartet or quintet of bodily functions. Some psychologists have attempted to study the development of coordinated activity by experimentation. Their effort has been largely directed towards ascertaining whether it is more efficient to practice the performance as a whole continuously from the beginning, or to add another part on only after the preceding part has been entirely learned, or to practice the whole after groups of two or three parts have been practiced together. Such investigations can lead to results of great practical significance for the training of pilots. Yet regardless of which method is followed, it is always easier to effect a union between parts that have mutually sympathetic natures. Then when other material is added on to this, it is the last that is broken off when some obstructing situation is encountered, even though the whole may seem to have been skillfully unified.

When practice is suspended for a while after a period of continuous pilot training, if the psychological pattern of the practical operations has not become set, the performance will regress in efficiency to its original state. At least those "assumed" acts that do not have a firm pattern are broken off from the whole. Thus it is a matter of considerable importance to the instructor just what aspects of pilot training should be given first so that they will stick with the student, or whether the first period of pilot training is in the rainy or dry season, or whether the days happen to be long or short. However, by no means does this mean that the days of rest during training have only harmful effects. Not everything that was learned is forgotten with time; the unessential material settles out so that only the fundamental content of the learned material is left. The continual piling on of experience in constant training is most certainly not always better than training with frequent rests. This fact has been recently demonstrated by several experimental studies in the psychology of learning. We must not forget that at times

it is more efficacious to practice the material to be learned only up to a certain point, and then to remove the learning situation for a while, allowing the fundamental pattern of the learning to become fixed. Of course, the difficulty of such a method lies in the difficulty of telling exactly to what extent the progress of the student has become fixed at a particular time.

Psychologically speaking, we consider the purpose of pilot training to be fulfilled when the student has learned the necessary acts and operations to such an extent that even though he does not fly for a long period of time, the fundamental pattern of flying a plane will not be destroyed.

They tell the story about how there once was a fencer who was renowned for his skillful cheek-cut, yet after his first duel he was completely unable to remember with which stroke he had wounded his opponent, and it was only after examining his adversary that he saw his remarkable skill at the cheek-cut. A similar illustration is afforded by the pilots who plan in detail their mode of battle the minute they first sight the enemy, but who only lapse into their customary fighting habits once the battle is on, and as a result are able to fight much better.

Thus even though a technique is formed by the joining together of several unit acts, it must acquire a fixed and hardened pattern; it is this pattern that becomes firmly attached to the accomplished technician. Accordingly we conclude that in learning a complex technique it is first important to consider the way in which the joining together of acts leads to the formation of the fundamental pattern of the technique. Further we see that it is more important to solidify the acts into a stable hardened form through simplification than to establish a whole having a weak form through over complication.

The psychological explanation of the formation of acts and of the process of learning these acts is indeed significant for those who are attempting to formulate a rational approach to training and learning the techniques of flying. Yet at the same time I feel it can be of use to the engineers who design planes, and particularly those who design instruments and plane equipment that are in direct use by the pilot.

It is relatively easy to point to an illustration of this point in our contemporary airplane equipment. With respect to the control stick--foot pedal--lever piloting mechanism, the airplane has never undergone a fundamental change since its inception as a type of transportation. We do not know to what extent this specific form imposes a burden upon the student pilot. Of course even though there may be certain irrational aspects to this mechanism, there are indeed also many rational ones. Then again, with the ever increasing capacity of the plane we do not know for how long the body position of the pilot can continue as it is today. Already studies in aviation medicine are asking for such a change in posture. Then if our present methods of equipping the plane are unsuited to a proposed posture change, we should have to determine the most satisfactory way of doing so. When one asks what is the best plan from the

engineering point of view, undoubtedly the best answer is to be obtained by the cooperation of the engineer and the psychologist.

Moreover, such things as the muscle strength necessary to move the stick and the foot pedals, and then range and location of movement, as well as the movement of the plane as a whole, all have certain standards at which man can control his operations most easily and accurately. These standards for the Japanese are different from those of foreign countries, and by taking these into proper account, it is possible to provide Japanese pilots with the most characteristic plane. In this case, we see that even though psychology has come upon an original idea, no matter how this idea is related to theory, it is reduced to a completely meaningless experimental study if it is not accepted by engineering. It is always necessary for psychology to go hand and hand with engineering.

Well, the conditions which determine whether a group of acts can form a pattern and become a single operation are certainly never dependent alone simply upon the type of neural activity participating in the activity. An operation involving the manipulation of a machine must always consider man and machine in a single situation. Children at play will often sit with their hands on their knees, and with one hand they rub back and forth on their knee, and with the other they ball up a fist and beat down on the knee. Since the place of the movement is restricted to the knees, the task is comparatively easy. Now if one takes his hands off his knees and attempts to do the same movements with his hands, the operation is markedly more difficult. Completely analogously, in studying the acts involved in handling a machine, the machine plays a part similar to that of the knee in the above illustration. It is proper neither to approach an operation only with a view to its mechanical aspect, nor to consider such acts without taking their relationship to machines into account.

I am not at liberty here to enter upon a psychological discussion of the characteristics of the plane equipment now in use; nevertheless if in attempting to design such equipment I should neglect a thorough consideration of such things as the direction, quantity and spatial nature of the acts involved, I would be greatly apt to over-complicate the plan of the machine and to provoke more frequent accidents due to forgetting the designated method of operating the machine. If one fits the doors of a house with knobs without regard for whether they must be operated to the right or to the left, he will find that in some cases he will have to turn the knob the other way in order to open the door. Psychologically speaking, in this case "the other way" means "unnaturally." Then when one discovers that the knob has been put on "the wrong way", since everyone else is also likely to turn the knob in the same direction, he will perhaps write a sign and hang it below the knob, telling people which way to turn it to open the door. Yet this kind of adjustment is often not particularly effective; the traffic signs set up as warnings along roads have by no means done away with traffic accidents. When there are aspects of machines and tools that run contrary to the quantitative and spatial nature of the acts of the man who use them, then these devices are likely to become dangerous instruments [illegible] to unnecessary errors in manipulation. It is entirely the [illegible] abstract from the concrete manifestation of an operation [illegible] of the muscles of various parts [illegible] to seek an example of this principle in [illegible]

We are all familiar with the game of very small children called "hand over hand" in which circular, revolving movements are made in front of the child's chest. Such rotary movements of both hands can be performed even by infants. Then what would happen if while such a movement were maintained with one hand, a movement in the opposite direction were made by the other hand? Indeed such a thing can hardly be done. Even when it looks like one is beginning to catch on to the trick of making the movements in this manner, after a few turns he will probably end up in the regular hand over hand pattern. Clearly, the ordinary hand over hand movement of both hands is contained within a single system of activity even in children; when the hands are rotated in opposite directions, the movement belongs to two systems that are distinct, unjoined and opposed. (Compare I and II of Figure 4.)

If one makes a similar movement with the arms stretched out at right angles in front of the body, palms facing each other and the left hand moving to the left front and the right hand to the right front, the motion is not symmetrically different from the ordinary "hand over hand," and the movement is very naturally and easily executed. (III) Even though such a movement involves some difference in direction, it is one that is often exercised, hence cannot be likened to the above mentioned reverse hand over hand. Moreover movements such as that diagramed in IV that are made from down to up and from in to out are felt to be more natural than when made in other directions.

Even though similar movement in the body joints is involved in these different types of activity, only the difference of whether the motion is parallel or at right angles to the body determines the two psychologically different types of movement.

Of course doing these kinds of acts is quite a bit simpler than making the same movements in the air when actually handling machines which require action in these directions. Formerly planes could be largely controlled and operated by these simple acts. However, even though the operations involved were uncomplex, one has never lacked examples of accidents that were chiefly due to errors in these operations. One can still point to equipment that leads to the performance of unnatural acts. Thus it is necessary to be aware of this relationship between the student and his equipment when it comes to learning these acts in flying, so that the simple acts can be quickly mastered and the complex operations acquired.

In the above discussion I have attempted to make the following points; first, that acts of coordination are formed from single "unit acts"; then, that such acts are first a collection of separate, diffuse acts which gradually come to acquire a single form; that a union of such co-sympathetic acts is broken apart only with difficulty even though the structure of the operation as a whole is weakened; and finally, that in performing these acts there are certain methods of approach that are most natural and appropriate.

However, many problems arise in pilot training in connection with acts to which men react with a certain fixed tendency. For example, even when

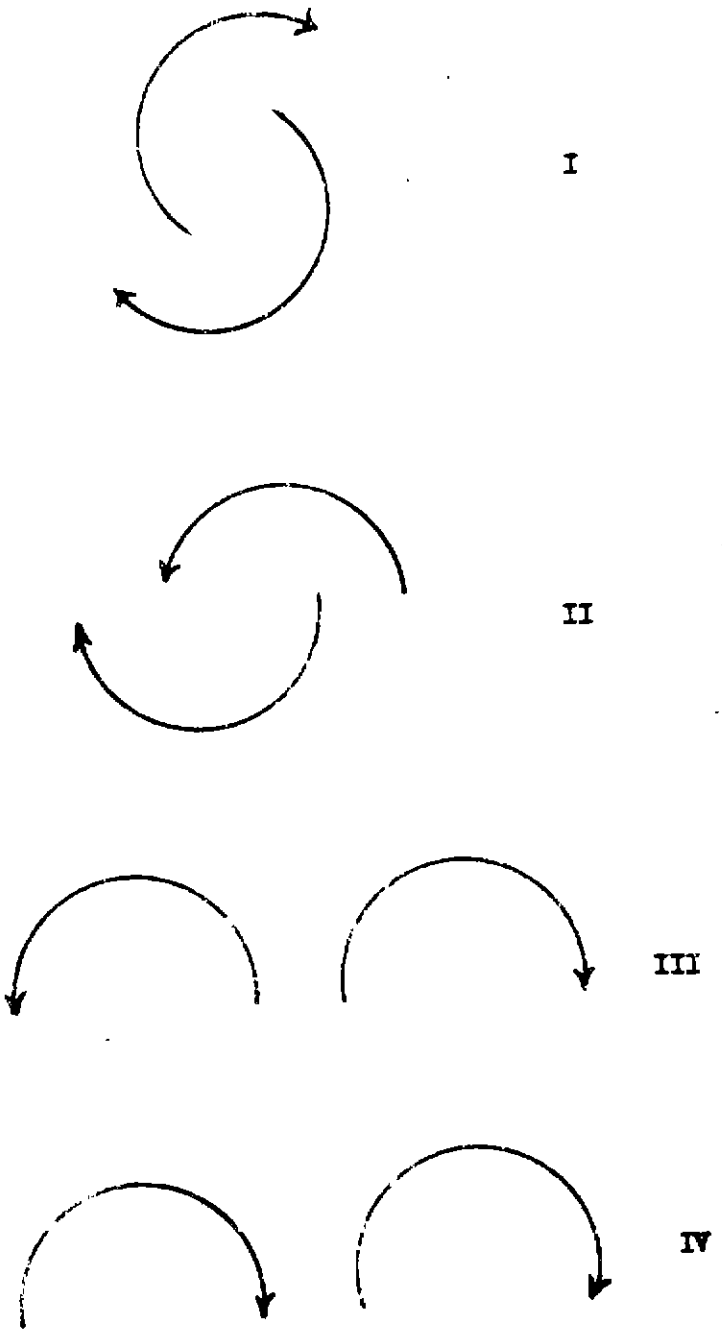

FIGURE 4

left handed persons consider that they have moved their right foot as far as they have moved their left foot, the distance moved by the left foot is apt to be considerably greater than that of the other. Moreover, there is likely to be a remarkably consistent difference in the distances moved by the right and left hands, when they have been judged to be equal. In educational language this tendency is termed individual bias, and when it refers to a bias that has already become hardened it is called a fixed bias. Individual bias often becomes a genuine handicap in pilot training. Ordinarily acts that are made too large or small can be quickly rectified by perceiving the amount of movement of the plane; but since a performance can be rectified only by some sort of union with visual perceptions, acts based on individual bias cannot be rectified. Therefore even when pilots of considerable flying experience attempt to perform certain acts, their performance is influenced by the bias that they have. This tendency appears most clearly in situations where the pilot is flying by instruments or in night flying, and leads to unrealized errors.

We judge that a certain direction is "straight ahead," or that a plane is "horizontal", or that the size of something drawn with the left hand is objectively the same as something drawn with the right, or that an object is symmetrical from right to left; but many times these judgments are grossly inaccurate. Of course it is necessary to try to relate these inaccuracies to various bodily tensions, but it is also necessary to clarify their psychological structure.

At any rate, the training problems of the discovery of these individual and fixed biases, and the appropriate methods for their correction await further study of the nature of movement; we must not forget that they remain pertinent problems for aviation psychology.

The Comprehension of Acts

The process of learning the techniques of piloting is a matter of the practice of certain acts or the mastery of certain operations, and in the final analysis is a process of pushing to the rear various unnecessary elements within the basic mental and physical functions with which man is equipped, of bringing out to the fore those that are necessary, and of building these into a single whole by practice.

Then, too any person who intends to learn to be a pilot will make some conjectures as to just what kind of business the job of flying a plane actually is. Up to the time that he actually takes the control stick in his hand, he revolves in his mind various speculations concerning how it will feel to manipulate the stick. Of course, here we are apt to meet a great deal of individual differences, but still, whoever the student happens to be, he will have formed some type of mental attitude towards piloting which causes subjective functions to participate in his learning of the various techniques. In other words, here the subjective nature of piloting comes into play.

However, this subjective piloting, or the mental attitude towards piloting, is bound to be different to some extent from the actual piloting

that the student will experience. Indeed there may be persons whose mental picture of piloting corresponds fairly well to actual flying. On the other hand, however, there may also be persons whose previous conception of flying is in great discord with actual flying experiences. If this conflict happens to be particularly great, the student will not rapidly progress in the beginning of his training and will often appear dull or slow. Thus one might conclude that it is best not to take the chance of making a poor guess, but to avoid getting one's mind set, and to approach a new job pretty much as a blank page. The poor efficiency of training which does not grasp the vital points of actual work, and of preparatory education which cannot be reverted to actual experience, can be explained in this manner.

However, even though we can indeed say that it might be good to approach the study of piloting in some such "blank page" condition, it is almost impossible to turn to any new skill with a completely neutral attitude; it is not possible to avoid at least some inappropriate preconception of the nature of the task. Then if such misconceptions cannot be avoided, one can conclude that whether or not one can readily change his attitude should have a large influence on the speed with which he could acquire the technique. Thus, once training has begun, it is better if the student is able to make whatever revision of his previous attitude is necessary and to grasp as quickly as possible the characteristic nature of his new work. However, it seems that there are some men who are simply unable to revise their mental attitude once it has become established. Persons who in this manner tenaciously adhere to an established frame of mind, or who fail to grasp the characteristic nature of a new task, are commonly said to be hardheaded, or "to have rocks in their head." We know from common sense that "hardheadedness" is a great handicap to learning a new task.

The saying that "you can't train them to be pilots if you don't get them while they're young," refers to the fact that hardheaded persons who are unable to abandon an idea one it has become adopted and who have lost their mental resilience, are unsuitable for the study of a new technique. However, even though one say it would be better to have an open mind towards a new technique, this never means that it should be without content; generally one must have a head that has completed its development. The best time to begin the study of the techniques of piloting is just at that time when mental growth or development is complete, but not yet hardened. Some maintain that this age is in the neighborhood of sixteen or seventeen, others hold it to be closer to twenty-four or twenty-five. However this matter is indeed difficult to determine easily.

Then, what are we to make of the fact that even though we select to be pilots only those persons who have no defects that could ever be considered defects, on the basis of detailed tests of man's various functions, still not all of these men are able to complete successfully pilot training, but drop out along the way? Everyone realizes that these tests are still inadequate in many ways, but it is probably true that so long as these tests are analytical in nature to the extent that they test only a single function, the tests will not be entirely successful. This is due to the fact that these tests do not measure a man's ability to adapt to a new task.

In learning a new task, in spite of the fact that there are slight defects in some functions, the influence of these defects can be covered up by the structure of the whole if it has been successfully formed. On the other hand, even though one may have more than enough ability in each of the separate functions necessary to perform the task, if these functions are not skillfully integrated with the total form of the task, the operation will not be adequately performed. Here the student excells in the unit acts to no avail, and they are utilized in vain.

A certain pilot of my acquaintance lost the sight of one eye during the war. It indeed goes without saying that both eyes perform extremely important functions in piloting, for example with regard to the judgment of distance. However his flying performance is beyond all comparison with that of many pilots equipped with the sight of both eyes. Then again the case of the famous American pilot who had only one eye is still fresh in our memory. If I am not wrong, I believe that he had had only one eye to begin with. The short of the matter is that if one can succeed in grasping the characteristic nature of the whole of piloting as a single task, even though a single element is lost, its function can be replaced.

We can find examples to illustrate our point from everyday experiences. Once one has learned to swim, the techniques involved are not easily forgotten, even though if one were to clasp his hands together and bind his feet, he would be able to swim just about as well as a sledge hammer. Man is somewhat inferior to other animals in this respect; certain investigators report that if a dog looses two of its legs, it is immediately able to walk on its other two. Yet in man's abilities there is a certain plasticity so that even though there may be slight defects the form of the whole can be assumed with the action of other functions.

Then on the other hand we have the condition where we say that one has nothing but brute force. Or we run across pilots that are almost too powerful. These persons put all their available force into performing a task, regardless of how delicate the required operations may be. They do not know how to distribute their strength, and are unable to expend it appropriately. Therefore they give the impression of being awkward brutes. Such brute force can be successfully utilized only in those tasks of simple structure where it is sufficient merely to expend one's natural strength.

Such situations often occur in elementary pilot training. At first, many pilots concentrate their attention solely upon the manipulation of the control stick. They do this very much as if they believed that the airplane was controlled simply by moving the stick alone. They hang on to the stick as if it were their life line. The instructors must teach them to hold the stick as if they held an egg in their hand. However, when some sort of trouble comes up, they lose entirely any sense of holding the stick lightly. In this situation these pilots refer their whole bodily attention to their hands, and are incapable of manipulating the controls with their feet, or of keeping an eye on their instruments. For this reason experienced instructors try to take the emphasis of pilot training

away from the hands, and to distribute it also to the feet. In other words, it is necessary in early pilot training to grasp the whole form of the manner in which body strength is utilized in the techniques of flying.

To repeat, then, in order to counteract any general bias which the beginner may have towards piloting, it is necessary for the instructor to make the student psychologically aware of what kind of task flying a plane actually is. He must teach the techniques not the laws of piloting.

In learning to ride a bicycle, for example, it is certainly more effective to be taught how to ride down the street looking straight ahead, than to be taught the manner of pressing one's foot on the pedal. Then, again, in riding a bicycle it is important to keep the back relatively relaxed. However, if one were to teach the laws of riding a bicycle, certainly the single act of pressing on the pedal would become an essential element. But here we are carrying our need for instruction in laws to the extreme. In order to teach riding a bicycle as a human technique, one must drill in the operation as a whole: "While keeping the eyes straight ahead, press on the pedals, being careful not to stiffen the back." In actuality, the job of riding a bicycle is the job of riding a bicycle, and not one of pushing on a pedal. Accordingly one should not expect to get very good results in such cases if he were to teach simply how to step on the pedal. Training in laws does not suddenly become training in techniques.

It is necessary to get across to the student the core, the essence, or the "hang" of the total operation. One need not consider this core or essence as some kind of mystical property to be attained. It is simply a matter of coming to grasp the essential nature of the job of piloting in its psychological and structural relationship to man.

Then again we ask, what kind of structure does piloting have as a technique?

If one were to ask a pilot just what sort of a job is piloting, he would probably reply, well, you do this with you hands and this with your feet, and you have to keep your eye on such and such a gauge. In other words, he would probably relate some systematic arrangement of individual unit operations. This system of unit operations forms what might be called the backbone of the techniques of piloting.

Then if one were to ask the pilot to explain each of these unit operations one by one, he would again go into detail, but finally he would have to say, "Well, it's difficult for me to tell you how it is; in order to understand it, you've got to try and do it yourself." Here we can see how the single technique of piloting is constructed. Learning the order and system of these acts is largely the job of the "head," while learning the acts themselves is the job of the "arms."

In performing a complex technique the proper sequence of the unit acts in the system must be maintained. If one of the operations is omitted

or the proper order of some is reversed, then the whole of the technique of piloting is not formed. This situation is one of incorrect, or wrong piloting. On the other hand, one must also guard against performing the individual acts with too much speed, or to too great an extent. In such situations, the problem is not one of something incorrect, but something unskillful.

It is possible to understand the serial order of these unit operations, or the proper sequence of these operations, and the content of the unit operations themselves only to the degree that their essential difference in this regard is realized. Now if it were the nature of mankind to be aware of his environment only by rational means instead of by muscular and organic perceptions, it would probably then be possible for man to grasp the contents of the separate operations as a series of even more detailed acts. For example, in such a situation if one asked a normal man to move his hand just a trifle, he would not assent to do so without first ascertaining to what degree or how many centimeters it is desired that his hand be moved.

Here we run up against the attitude of trying to reduce all intuition and technique to rational laws. This attitude attempts to extract the single techniques from our traditional arts and by reducing them to laws to make them more objective. However, in instructing the techniques of handling machines, one deals with intuitions that can be neither explained nor understood in terms of laws. It is the function of this training to plan the proper unification of the techniques and laws involved. However, if one try to understand a technique by means of intuition alone and there happen to be aspects of the technique that can be more objectively expressed in terms of laws, the proper differentiation of the various parts of the technique cannot easily be effected; this becomes a hindrance to further training and is likely to lead to specific weaknesses in the technical skill of the student.

Even though the Japanese people seem to surpass other races in their ability to perceive things by intuition, we are apt to rely too heavily upon this trait; there is a strong tendency for us to explain by means of intuition even those things which should most appropriately be expressed in terms of laws. Such proverbial attitudes as "one learns by doing" or "experience is the best teacher", when carried too far block the progress of the spread of technical training, and hinder the development of machines. Thus it behooves us to be sufficiently aware of the necessity to maintain the proper harmony between intuitions and laws in the training of a complex technique.

As I have just stated, it is clear that the techniques of piloting can only be performed when the proper sequence of individual unit operations is maintained. However, this does not mean merely the temporal arrangement of mutually unrelated items. These separate units must come to possess a large overall coherence. If there is no sort of bond or connection between unit acts and operations but they are merely aligned one after the other in a temporal series, then in order to perform these separate activities, it is necessary to do so with a conscious plan. However, in order to

become skilled in piloting it is by no means necessary that one perform each of the unit acts and operations consciously or with directed attention. In other words, the technique of piloting is a task which hangs together as a single whole.

Formerly psychology used to make its explanations in terms of more or less well defined mental images. For the most part it was considered that acts were directed by conscious visual and auditory mental images or ideas and that behavior was controlled by means of the reception and distribution of groups of ideas. However, it is certainly clear that most of our daily activity is not of this nature.

It is true that in the early stages of pilot training, the student often gives the mental command, 'now I do this," as he performs a unit act or operation. However, this conscious approach is by no means permanent. Those flying instructors who have been imbued with the old psychology that employed only such concepts as "the power of attention," often feel that correct operations can be performed only when precise mental images have been formed. "I know well," they explain, "that in order not to make a wrong movement, one must concentrate his attention on what he is doing." And, indeed, it is not difficult to think that the greater the degree of attention that is directed towards a task the more accurately can it be performed.

However, consider the following experiences. Often when we are writing something if we concentrate intently upon a character we have just made, we end up wondering whether or not there really is such a figure, even though we may be looking at a character with which we have long been familiar. In such situations all the characters take on the appearance of living creatures, each with a peculiar kind of facial expression, so that we finally become unable to write at all. Then too, when we have to write a summary of our past occupations for such things as job applications and we try especially hard not to make mistakes, we are very apt to put down some completely outlandish figure or to omit entirely an essential character, so that the job could probably have been more skillfully done if we had just written it off naturally. It is possible to interpret such situations by considering that in concentrating the attention upon writing the individual characters, the behavior pattern as a whole is destroyed and the unit acts become disrupted.

Moreover, I at this moment am writing characters in the first draft of this book; but I am pursuing a particular idea and am merely expressing this idea as I write, so that I am never conscious of 'writing characters" as such. Writing characters here is indeed an individual unit act, but it is an act that is contained within a voluntary behavior pattern. This behavior pattern is a whole that has a characteristic tension such that my ideas are expressed by means of sentences.

Consider also the illustration of attending to every particular foot movement involved when walking up and down stairs. If this were done, a completely unnatural chain of events would result. Then also when one effects that he is walking with great skill, the individual acts involved

become disassociated so that the whole behavior pattern cannot be skillfully executed, and the walking becomes awkward. When raw recruits are taught analytically how to march, the actual performance is quite crude and becomes that humorous activity of merely extending the arms rigidly while stepping along.

Thus we can understand that the mastery of complex acts and operations is not simply a matter of analyzing out their component parts and attempting to link them together. In order to walk it is not necessary to make a conscious mental effort to move the feet. We simply walk. For the most part we walk to reach a certain destination. Then also, when we commute to work each day we do not feel that we are setting out for a destination, but rather that we are going to work. We are usually only aware that we leave the house and get to our destination at a certain time. Indeed we find that the times that we ask ourselves "What am I doing now?" or "What am I supposed to be be doing now?" are precisely the times when our work has not been running smoothly. Such situations often occur when one has for some reason been unable to absorb himself completely in his work.

In the process of learning a new technique, one first performs the individual operations consciously. They are executed by actively recalling the learned order of the acts involved. While doing this, the several acts become connected and form a single operation. Such operations are flying in the air, taking off, and landing. Gradually, these operations do not have to be consciously initiated as such; the unnecessary acts settle out in time so that at the time of mastery of the technique, the various operations are performed as a whole. Only when there is some obstruction that blocks this performance or that disturbs the established mental equilibrium does it become necessary to plan consciously what must be done; it is at these times that the form of the whole or the union of the acts and operations is liable to destruction.

Thus we can make the following conclusions concerning the training of a new technique. First, it is necessary to get across to the student the continuity, or tonus, of the job as a whole, and to harmonize the mind of the trainee with the structure of the system of forces which make up the job. Then, it is necessary to drill the student in detail upon the fine points involved in the technique.

The Structure of Techniques

In the sections above I have dealt with the problem of the nature of the acts which are the basic units of the technique of flying and with the ways in which they should be acquired and their capacities realized. I should have made clear that it is not possible to understand the nature of this technique without considering these unit acts as the fundamental element that can be differentiated from within the single system of body tensions which comprise the technique of piloting.

The job of learning to fly is a matter of adjusting one's will to the unique and defined matrix of the laws that regulate flight and of acquiring

a patrix of technique of sufficient elasticity to allow one to perform within these laws. Therefore, the strength of human will has a determining influence on the process of learning the technique.

There is probably no other technique in which mechanical laws so strongly prescribe man's activities as the technique of piloting. There are many activities which once they have been initiated can be temporarily discontinued for a while should one's will so desire. If something comes up that one does not understand, it is perhaps possible to ask help of someone working nearby.

Of course, in almost all occupations there are certain units of organization that one is not likely to interrupt voluntary. It is as if one has shoved his boat off from the dock. Even though one often closes a half-read book to take up another occupation, one will probably choose to wait until he has completed a half-read paragraph, or certainly a half-read sentence. Indeed, at the moment I am working on this manuscript; but should the children suddenly come in and say that dinner is ready, I would probably yield to my desire to continue to a good stopping place. Thus in working, systems of body tensions are set up in accordance with the attitude one takes towards the work and the whole is completed with these as basic units of organization. However, in contrast to piloting, the units of tension of such tasks as above are small and separate; therefore the whole can be divided into these parts. If this division can be made at will, or the units have an arrangement that is voluntarily ordered, then the operation will be easy from the volitional standpoint, even though the acts of which it is composed may be difficult to execute in themselves. In other words, in learning such operations, since man is not closely bound to the work and he can alter the performance of the tasks much as he might desire, volitional training as such is not necessary. The play of children is of such a nature.

We can temporarily refer to such occupations as piloting which strictly regulate human performance as compulsory tasks. Compulsory tasks, then, are those tasks in which the necessary techniques are prescribed to a large extent by laws. As a concrete illustration, consider the airplane which unlike the automobile cannot be abandoned pretty much at the will of the operator. The pilot must necessarily be obedient to the laws that govern his plane from the moment the wheels are separated from the runway until they rest again on the landing strip. The whole of the occupation has a single coherence that must not be severed. Until the pilot has finished his job, he cannot abandon his duty no matter how bad he may feel or how tired he may be. While on the job the pilot cannot "take a sigh," as it is commonly put. If he "takes a sigh" while flying, the single system of body tensions becomes separated into two disjoined parts; if unusual circumstances arise here, accidents are likely to occur. It often happens that after having met trouble in the sky, and having been successful in skillfully keeping the plane aloft during this time (throughout this time he had obeyed the prescribed mechanical laws), the pilot attempts his landing; yet with a sigh he relieves his tension and gives rise to one of the drastic [illegible]. In other words, it is absolutely necessary to maintain the relation of

flying up until the very end of the operations of piloting. The above implies that many accidents are due to a lack of volitional adaptability on the part of the pilot who is unable to submit himself entirely to the regimentation of such a compulsory task.

In aviation the compulsory nature of these tasks is extremely stringent. I mean by this that failure to adhere to the laws of piloting is a direct threat to the life of the pilot. Such a degree of compelling power is not often seen in other occupations. Particularly are there few others in which the threat to life awaits for so long in constant ambush.

On the other hand however, the job of piloting has a fairly clear and precise psychological structure. Of course once the task has been undertaken it is not possible to relieve its tension until it has been entirely completed, yet it is possible for the pilot to understand the extent to which this tension must be maintained in piloting, unlike other jobs. Thus when one undertakes a particular flight it is comparatively easy to adopt a suitable mental attitude towards the work it involves. Needless to say the flying time of the plane is regulated by the quantity of fuel which the plane is carrying, and this enables the pilot to know that his time of flight will certainly be limited to this extent. Thus we see that the task of flying is a burden for the pilot because of its persistent tension, but at the same time this compulsory nature enables the pilot to form a definite mental attitude (Einstellung) towards his work. Of course it is undoubtedly true that the restrictions of flying time lead to more complex and cumbersome military planning; still I wonder with what mental attitude the pilot would begin his flight if there were no mechanical limitations to his flying time.

Actually, one does relieve tensions to a certain extent while flying. This occurs upon the completion of a unit operation. There is no question that some tension is relieved, for example, at the end of the bank in executing a turn. However, such relief disturbs the underlying tone (Grund) of the tension of flying hardly more than a ripple. On the other hand this relief of tension in the completion of unit operations forms a necessary connection between successive operations, and it is here that lurking accidents, taking advantage of these weak interstices, creep in. Still they are no more than slight disturbances of the underlying tone of the whole, and can hardly be compared with the relief of tension that follows alighting from a plane.

Thus we see that the task of piloting is forceful. It is precise and concrete. It is extremely significant that it is a task that precisely regulates human will, in particular the forceful will of young men. It is for this reason that the military Training Command states that duty in the Air Force is "excellent practical mental cultivation."

Such a characteristic fundamentally determines the nature of piloting as a mental task. Similarly the volitional structure of the men who are able to adjust to such a task has a precise nature. The character and personality of the pilot which balance the characteristics of the task of piloting in turn should have fairly common similarities with the character

and personality of the youths who have a desire to fly and to make flying their primary occupation.

Thus we have seen that training in the technique of piloting demands as prerequisite first, a certain amount of intelligence in order to learn the individual acts, then adequate functioning of the bodily parts, and now a special psychological attitude; but since the techniques of piloting prescribe beforehand the volitional requirements of the trainees in its precise characteristics, the most important single factor in piloting aptitude is the volitional structure of the pilot. Still few objective methods for the investigation of character and personality have been conceived. Such tests have been employed to some extent in Germany. Consider for example the Kraepelin Series Addition Test. In this test the subject is required to make continuous addition of such sums as 5 - 7, 7 - 3, 3 + 9 .... etc. The addition is continued for around the period of an hour, at the end of which time a work curve for the subject is graphed, plotting the quantity of work against a certain unit of time (Kraepelin used 3 minute periods in his graphs). The test has been somewhat improved by certain Japanese investigators, and it is now possible to observe such characteristics of the subject as his method of initiating the work, his stick-to-itiveness, his excitability, the efficacy of training, his mental blockings, his perserverence, his susceptibility to fatigue, etc. The way in which these characteristics appear in piloting have been investigated. The work curves of pilots who have frequent accidents or who seem simply unable to grasp the knack of flying have characteristic patterns. In other words, the ways in which the student can subject his will to the requirements of the task will vary from person to person; thus the volitional nature of the student determines in large part his success in learning the technique of flying.

Whether man is volitionally innately suited to certain occupations, or whether the will can be conquered and altered by man has not been definitely determined, but whichever it may be, it can safely be said that for piloting an elasticity of will and balanced way of life are absolutely essential.

I shall consider this matter in detail at a later time but there are various different kinds of airplanes that must be flown by pilots, each differing in its time and range of flight and its method of operation. Accordingly the several types of planes differ in their psychological nature. It is a part of the duty of the flying instructor to observe adequately the daily life of the students under his command; he should observe their volitional nature as well as their special technical abilities, as for example whether they are skilled at flying solo or in formation. Then, speaking particularly of pilot training, basing his judgment on both observations, the instructor decides who will be attached to fighter and who to bomber duty. Also it is the usual practice for the students themselves to express themselves concerning this decision of the instructor, since after a certain amount of training they become conscious of the feelings they have towards the various types of work. Moreover, even if

the students are actually transferred to the type of service they did not regard most suitable for themselves, their increased volitional strength that has been tempered by pilot training, will facilitate the acquisitions of a suitable mental attitude towards the new type of work.

It could hardly be maintained that in the military life one is able to do pretty much what he wants, when he wants, and how he wants. When an order is handed down, the soldier must be willing to obey it regardless of the nature of the work it entails, and, if need be, to risk his life in the execution of that order. Volitional strength is indeed necessary for such devotion to duty. Training in the strength of will is most rigorously, thus most effectively, carried out during actual flight instruction, but it is furthermore necessary that this training be carried to every phase of his daily life. Thus pilot training is not carried out at the airfield alone. It is necessary to make the whole life of the student the life of a pilot. Training a pilot can never be regarded as a matter of simply adding on the technique of piloting to a given type of student; it is a matter of making a man into a pilot. In that pilots are made, the techniques of flying become a part of them.

Thus in this country, as well as in America, pilot training involves volitional training in the rigid insistance upon discipline. Student pilots are required to sleep in barracks and to comply with many regulations for living in the group. Orders for the day are prescribed and all are required to comply with their instructions. Such living habits inevitably result in tempered volitional strength. It seems fitting to recall the old Japanese proverb, "For fine sons, let them travel." Travelling is unquestionably a psychologically compulsory task. Once one sets out on a trip, one must keep at it until the destination is reached. The point of the proverb seems to be that by tempering the will, we gain strength to withstand the stormy waves which will beat upon us in the future.

It is getting so that I am constantly repeating myself, but I should like to stress the fact once more that pilot training requires indeed a most rigorous discipline of the will. Therefore, if there are aspects of the personality that are weak or brittle, they cannot withstand the pressure of such compulsory training. Even though they are extremely small in number there are some men who develop mental breakdowns in elementary training due to previous character defects.

When one considers pilot training as not merely drilling in the techniques of piloting, but also as training in the methods of warfare, one sees that the goal of the student pilot is the mastery of a discipline. Our country indeed has old traditions within this discipline; it should be our effort to plan our pilot training to follow in this line.

The Structure of Techniques (Cont'd.)
(An answer to some questions)

I have stated before that piloting a plane is a compulsory task that is composed of a unified system of body tensions. It is natural then that this compulsory nature should be expressed by the unit acts and operations

of which the system is composed. Thus we should expect that just as pilot training must be volitional training in order to learn the technique of flying, so in a certain sense must there be volitional training in order to learn the particular acts involved. Thus we meet for a second time the problem of the training of unit acts; we shall consider the learning of unit acts as it is related to the "secret" or "knack" of flying.

It is often said that certain people have difficulty in learning to fly because they seem unable to grasp the "secret" of flying. There seem to be pertinent implications here of the literal translation of the Japanese word for "secret" which is "breath." When we perform certain acts it becomes necessary for us to control our breathing. In instructing students as to the secret of good rifle shooting, it is largely a matter of teaching them the best way to hold their breath and when to take their breaths. Volitional control is taught by training the student to regulate in a precise manner his method of breathing.

In order to consider the learning of unit acts let us draw our examples from training in calligraphy. In practicing good penmanship it is normally fairly difficult to draw the character exactly like the model. However, when we say that it is difficult to do so, we mean that it is difficult to reproduce the character just as desired because of one's previous writing habits; the "secret" of the writing is different. However in trying to paint characters on a sign, one's own style of writing is quickly abandoned and it becomes somewhat easier to draw the characters in the plain form of the model. In this situation, the writing is hardly an expression of one's personality; one is able to suppress to a certain extent one's individuality in writing and to submit to the compulsory task of writing the characters as prescribed by the model.

These various "secrets" are not only forms or abstract patterns one has learned but are rather things that have a certain strength of persistence in their influence. Therefore, if one does not suppress these individual tendencies, the unit acts involved in piloting cannot be faithfully reproduced. In training in calligraphy one must accurately copy the form of the model character even though one has already developed a certain normal style of writing. When one finally becomes skilled in penmanship so that the reproduction of model characters is extremely accurate one has acquired the secret of the task; that is, the old individuality has been suppressed allowing a new one to be born. Here we come to see why penmanship is a <u>discipline</u>, rather than an <u>art</u> and how it becomes a method of mental training.

In the operation of writing a single character there is a delicate underlying tone of tension and relaxation for each dot and stroke of the brush; the skill of writing comes in grasping this tone, which is the "secret" of the writing. The situation is exactly similar with respect to the acts of piloting; each has a delicate underlying tone and hue. The "secret" of flying gives a certain delicate hue to the acts of piloting; this is so definite that instructors are able to sense from what elementary training outfit the student has come by the feel of his control of the plane. Similarly one can tell the school of penmanship

of a person by looking at his writing. Individual characteristics are revealed by such delicate acts; it is indeed for this reason that the judgment of personality by means of handwriting can be made.

It is often considered that orientals are unusually keen in grasping an individual's personality by means of seemingly insignificant acts, and I think that there is a quite legitimate foundation for such an opinion. If our people did not have an unusually sensitive nature it would seem unlikely that the art of calligraphy and the appreciation of form in beautiful writing should have developed. Thus we should expect us to seek such delicate subtleties even in the art of piloting. It may indeed be true that there is little interest shown along this line in foreign countries, yet this is probably due to the fact that in those countries the ability of the people expresses itself along different lines.

The Japanese call their keen appreciation of subtle forces intuition. Moreover, the intuition of the Japanese is commonly considered to be the epitome of intuition and an unanalyzable appreciation of nuance. Yet I feel that in such countries as Germany the effort would be to make this intuition as scientific as possible. The proponents of graphology (Graphologie) attempt to explain personalities in terms of the results of a scientific analysis of handwriting. Even though graphology is indeed gross when compared to the delicacy of the so-called intuition of the Japanese, it has still become systematized and made universally applicable to a certain extent. Such an approach toward scientific treatment must be acquired by the Japanese people. A great criticism is to be made of those persons that feel that the skills related to machines, to say nothing of the arts, should be forever transmitted from generation to generation as innate traditional secrets.

Here we begin to enter the territory of skills. The colloquial words we use in Japanese to refer to especial skill in performing jobs seem to be somewhat significant. When we refer to skill in delicate manual work we speak of the trick of doing the task. In speaking of skill in coordination of more gross bodily movements we talk of good nerves. To refer to skill in a general occupation we speak of the knack of doing the job.

When calling attention to particular skill in piloting one often says that such and such a pilot certainly has good nerves. Yet the expression "good nerves" here does not refer to any particular excellence of a nerve itself, or to the speed of nerve conductance but rather calls attention to the ability of the pilot to grasp the subtle nuances and fine points of flying. But here we are getting back to the secret of flying.

In other words, as I have stated above in the section on understanding acts, those persons who seem to do unusually well have rapidly grasped the delicate aspects of the form of their work, and these they assimilate as a part of their personality so that they are able to perform their work without exerting useless effort. Consider an example of such a person.

I am acquainted with a man who in his youth had been chosen the best

all-round athlete of his school. One day after he had just been elevated to this honor, he was called upon to deliver a message on bicycle to an office some distance away. Now even though this boy had been selected the best all-round athlete of the school, it just so happened that he did not know how to ride a bicycle. However the boy, too embarrassed to confess he could not ride a a bicycle, mounted the bicycle without a word, and rode off on his errand. Of course, at first he was afraid of the danger involved, but he found that he was already a bicycler after only riding a distance of ten or twenty yards. Accordingly, the boy delivered his message and returned without incident. In other words one can say that together with the natural ability this boy possessed as an all-round athlete, he also had a keen sense of awareness that enabled him to grasp at once the delicate nuance of the psychological structure of the task.

I have emphasized before that in order to learn a task it is not only important to have sufficient natural ability, but it is also necessary to come to grasp the form of the job; yet I feel that our discussion of the knack of doing jobs has demonstrated this point again.

In order to clarify the psychological nature of the knack of doing a a job we shall next consider the performance of those persons who are said to have a shallow approach. We say that persons are shallow in their performance if they seem unable to put themselves entirely into the job as a whole, and grasp instead only the structure of one small aspect of the work, that is, a single part differentiated from the form of the whole. These persons adjust only a small system of volitional tension to their work so that they become skillful in this part of the work alone. Shallow workers temporarily like to appear to be working at a particular part of their job, especially in front of other people; but in case of difficulty they never attempt to carry out the whole job, and when there is no difficulty they do not pitch whole heartedly into the entire task.

Thus when shallow students try to learn to fly, they make rapid progress at first. When the operation of a different type of plane is taken up, they seem to be able to control it as soon as the instructions are given. Indeed these students are more prone to accidents than others, but they are not apt to be serious ones. These students make flying a manual task without attempting to penetrate to the core of the true technique of flying. In other words, the attitude of the shallow student favors a rapid, skillful approach to the individual parts of a single compulsory occupation, yet not to the occupation as a whole. Such an approach does not lead to the unification of man and machine and results only in superficial performance, not skillful flying.

The Japanese people have a language rich in words that describe such levels of performance. The key words of this section - knack, trick, shallow -- are only a few that could be mentioned.

The Japanese people accordingly respect those persons who approach the study of an art with their whole personality. One sees the similar derivation of the Japanese words for knack and expert. Originally the Japanese word for trick was the word for tool, if one submit his argument to the sea

of words. The Japanese are indeed conscious of the true ability necessary to enter one's true self into the learning of an art.

I consider this last section the reply to a long standing question by a superior officer.

The Level of Aspiration in Techniques

I have stated earlier that it is necessary for the student to adopt some sort of mental attitude towards piloting; that is, he must set up the proper level of aspiration. If this psychological level is too high, if there is too great a distance between the students mental level and the actual ability that he has, the mental attitude will become a dream which if not realized will lead to disillusionment. However, at the same time, if this mental level is too low, the student easily achieves his goal of progress and he does not seek further development.

At any rate, in order to insure the maximum performance capacity of a student it is necessary for him to establish the proper level of aspiration. When one considers the matter, one often finds that some students who regularly feel that their performance is poor and that they are not good at all as pilots are actually among the more superior students, and that among those that are continually full of self confidence and who feel fairly satisfied with their work, there are many poor students. The difference here seems to be in the height of their anticipated level of performance, or in the way in which their personal goals appear to be realized and fit in with the actual laws of flying, or in the degree to which the height and content of the standard of aspiration that they have established happens to be appropriate.

When one practices jumping down from a high place, he probably finds that he cannot bring himself to jump off of a rather high place right at first. He usually finds it better to start at a comparatively low height and to increase the height gradually from there. At a height of a few feet once can make a good adjustment to begin with; then the height is gradually increased by an unnoticeable two or three inches, and one finds he is able to perform the task if the changes are made gradually. But even though the height be raised by almost imperceptible amounts, at some point or other he must reach a certain height where he feels that he is really very high in the air. Now if he tries to jump, it will probably take as much courage as it would have from the original high place. My point is that in difficult work, or work that requires some amount of courage, one must make such a jumping off if the work is to be done at all.

Here we meet the problem of <u>courage</u> and <u>self confidence</u>. In those situations where one must strike out for a higher level of performance, courage and boldness may indeed be needed, but it is only in this way that self confidence can be acquired. In pilot training it is extremely necessary to have the proper self confidence in one's ability with respect to other tasks than the learning of simple skills. If one compares the airplane of today with that of twenty years ago, the great change in its

capacity is immediately apparent. Of course, the increase its capacity does not signify by any means a proportional increase in difficulty of control, however in that relatively small processes have come to effect large results, the new capacity of the plane has increased the strain upon the pilot.

It might seem natural for some to think that if one had developed a certain amount of self confidence concerning one's ability to make a successful landing on a particular runway, and if one could use a plane with which he were familiar, then it would probably be equally easy to land the plane when the speed is increased only slightly. When one considers the matter from a logical point of view, the length of the field is always constant regardless of the speed of the plane, thus one should expect the pilot to execute a landing with increased speed with the usual self assurance. However, actually the situation is not so, but the end of the landing strip seems to rush up towards the plane, and the pilot at first is apt to become somewhat taken by surprise. He suddenly feels that the task of landing has become almost beyond his ability. Yet in such a situation, if the pilot resolutely determines to go in and make the landing with increased speed in spite of his feeling of trepidation, to his own surprise he finds he is able to land perfectly well; he is then henceforth confident of his ability to make a successful landing under such conditions.

This power to forge ahead in spite of feelings of hesitation is extremely necessary in pilot training. Not only does it become the propelling force of the achievements of individual pilots; in many respects the progress and development of aviation techniques as a whole depends upon this power.

Once many centuries ago a certain section of the country spread about among its archers the record distance that an arrow had been shot in the community. But once some person had established a new record at, say sixty-six yards, everyone felt that they too would be able to attain that mark, with the result that only among the warriors of Nabeshima did men of great strength of bow appear. Self determination and courage are forces that extend man's abilities. They draw out man's latent resilience of will.

Flying a plane of the limited capacities of the planes of twenty years ago was a matter of some daring and determination. Yet the elementary trainers of today are normally of much the same capacity as those early planes. Here we are able to appreciate to a certain extent the remarkable resilience of human will.

If in the strength of human will there were no ability to forge ahead with great strides or at least to push on steadily, in order to acquire the ability to fly the contemporary planes of high capacity we should probably have had to start with the old, poor capacity, easy to operate planes of former times and to follow the development of the plane step by step in our training. If such were the case it would actually be necessary to use the outmoded trainers such as we employ today.

Yet I suppose there are some good points in making use of these outmoded planes as we do. At least when the student learns to fly even the simplest type of plane, he developes confidence in his ability to "fly an airplane" as such. Completely ignoring the matter of whether or not training of this type aids the student to grasp the fundamental structure of the technique of flying a plane, it at least serves the purpose of giving the student self confidence, and thus might enable subsequent training to proceed more smoothly.

It seems as if I am constantly getting side-tracked, but along this line one can see how even glider training would be beneficial to beginning trainees. The confidence one has that he can fly in a glider is at least better than the realization that one has never before taken his feet off the ground. Then it might be profitable to have these students practice in a glider that has been equipped with an engine. When they have mastered such flight it is just a step to flight in a real airplane, since the students can be encouraged by being told that planes are no more than gliders with engines in them.

If such psychological techniques are skillfully applied there is no reason why learning the technique of piloting should not be comparatively easy. However, then such training might appear to some to be rather padded and soft. Yet it must be said that something seems to be defective in those persons of urgent and desperate spirit. They are not apt to do particularly well in pilot training. However, it is by no means the objective of the psychologist to relieve man of the necessity of making any effort at all. Psychology is interested rather in the application of human effort if it is clear that once this effort has been made it can become the basis for further progress.

However, even though nothing interferes with the training the job of making use of a number of trainers of varying capacity until finally the regular plane the pilot is to fly is reached demands in itself just that amount of time and that amount of industrial equipment; if the pilot is given such training at the sacrifice of the labor of the thousands of workers who must produce these trainers, the person who learns to fly these planes must in turn voluntarily whip his will and temper his volitional resilience and exert a proportional amount of effort, if need be.

All young men who apply to admission to the Air Forces or some other branch of military service wonder at first what kind of work these services hold in store for them. Then they ask themselves if they will actually ever become as technically accomplished in their field as those who have successfully gone before them. Many of these young men undertake to find the answer to this question, and by their earnest effort do so. Needless to say there is the greatest difference in the world between these young men and those who in comparable situations judge themselves incapable of ever becoming a skilled technician in the service, even though they may have equal ability. Having an expanding view of one's own capabilities is the necessary premise to the complete realization of these abilities.

It may be that having an expanding view of one's abilities is largely

innate within the personalities of some men, however there are many instances where this clearly depends upon stimulating environmental circumstances. There are many cases where persons have felt themselves unable to make a beneficial move successfully, yet when external conditions give slight proddings to the heart the result is not only successful performance of the desired act, but also increased self confidence in other fields as well. The first attempt is just as effective in leading to self confidence even when it is a daring act made in desperation to conceal one's own inability and cowardice. Moreover, daring that is forced on a man, or that is made because of conscious competition with associates is equally as efficacious. Once the person is made to take the dare, all previous feelings of inferiority disappear and a positive, constructive attitude towards the task can be adopted. The development and expansion of one's capacities requires considerable attention, and must be obtained from living in an environment of fairly strong outside stimulation, at least during the course of training.

This method of developing self confidence is often employed in many fields. In pilot training, for example, the student is trained in a fairly easy trainer and comes to acquire a considerable amount of self confidence with regard to flying. Then the student is shifted to airplanes considerably more difficult in operation. The acquisition of a positive, outgoing approach is absolutely essential in the preparation training for pilots.

If one looks at his own past he will be aware of a certain number of strides forward. By this process man's volitional nature is forged. Then by evaluating his progress in the past, man is able to prepare for the next stride. Indeed these forward strides seem only parts of individual biographies and personal histories, but by the daring acts of the sum of the men in aviation the level of achievement of the technique as a whole is constantly being elevated.

Even though the history of aviation is still young, the Japanese people have already made valuable contributions to its development. As these continue to build up, the level of aspiration of the Japanese people is raised even more. The work of the ancient gods of war is being reproduced in the achievements of the thousands of men who devote their lives to aviation, and indeed equipment suitable even for the gods of war has become possible. Historical developments in Japanese aviation are promised by these workers. The proud survey of the contributions of Japanese aviation is a privilege afforded only the Japanese people. We must endeavor to raise even higher the level of aspiration that we have today. In order to do that, we should carefully examine the past achievements of our own people.

CHAPTER III

THE DEATH OF A PILOT

To My Brother:

As one would expect, when we read the report of the explosion, we received a great shock. Yet in many ways what we felt was somehow different from just the simple feeling of grief. Rather there were mixed feelings of pride in that we knew he had died in satisfaction. However, often when we think of him, we wonder if perhaps at the end he had said some final phrase, as he let his body sink beneath the waves of the Coral Sea. Perhaps it would have seemed natural for us to feel a touch of sadness that there was no way for us to know this. However it seems to me that such feelings imply the lack of a true tacit understanding between us on this earth, and him.

I cannot help liking to think that he died with a cry of Banzai! at his lips. It is easy to think so. However, whatever I can say it is only the imagination of a person of this world. In order to preserve his memory as truly sacred it was necessary for us to establish with him a tacit understanding based on truth. For a long time we were disturbed with this spiritual problem.

Nevertheless the thing that most strongly pushed forward our pitiful search for truth was the words of his companion-in-arms which we received after almost a half a year had passed: in the final moment he shook his wings. The affirmation of his acceptance of death in this manner was the source of great joy to those who survive him living.

We, of this world, were most easily able to believe that he died with such spirit after having been shown worldly things. That is indeed proof that we are people of this world. However, in the long run the ultimate faith we should bear in him should be a faith that surpasses these worldly demonstrations; at the same time that faith should imply his trust in us As this tacit understanding is realized, his death is transformed into sevenfold reincarnate life.

Japanese warriors have solemnly taken oath of the words they should cry out at the last. Many warriors have companions-in-arms that verify their final hail. If this strong cry is unfinished, his companion will shout it in his stead. If the dying warrior affirms this pledge merely by a final smile, the sanctity of his last can be carried back to those who await his return. However all the flyers who have become of sacred memory have not been able to have some witness to transmit back the final cry, as did my brother. Who can testify to the valor and heroism of their end? Yet, those that survive, and his one hundred million compatriots, and those that have gone before do not begrudge these flyers the acknowledgement of their death as the death of a hero.

These flyers hold their faith hard within themselves; in order to

carry out the tacit understanding with their country men based on this faith, they must go out each day believing in their hearts, "Everyday I live dying, everyday I live dying." They do not hold this belief merely because there are many dangerous aspects of flying. No man is able to predict the time of his death. Only the Japanese people respect as they do achievement in this world, the honor of that end and the sanctity of that death. It is held so in their highest tradition.

The Road of a Pilot

Because of the implicit psychological characteristics of the art of flying those men that study to be pilots must come to effect a change in their whole personality. The task of learning to fly is not a matter of simply acquiring the techniques of piloting in addition to one's other abilities, it is more a process of a person's becoming a pilot. The art of flying should manifest itself in every aspect of his mind and body.

Moreover it is not only a matter of making the techniques a part of the man; it is likewise first necessary to make the man a part of the techniques. It is necessary for the student to direct his whole purpose to acquiring these techniques. Only when these two aspects are mutually carried out can the training of superior pilots be achieved. This implies that pilot training is not the simple learning of an art; one must conceive of it as the education of the whole person within a single discipline.

In our country it has long been considered that learning an art is in fact the long process of learning a discipline. Even those who become skilled in the various techniques of the military discipline can be considered artists; then too, when Yanagiiki Tajima writes "the art of conquering others is the art of conquering oneself," he means that the military discipline should become one with the flesh and bone of the soldier and not merely hung about him as a cloak. Such thorough assimilation of an art is of value in all arts as well as in military discipline. Take for example the youth who desires to become a carpenter. At an early age he must submit himself to be an apprentice in the house of a master. But here he is not taught how to handle the chisel and plane at once. For a long period of time the apprentice must run errands, sweep the house and do the cooking for the master. In his apprenticeship the student learns only by watching the master and the skilled workers perform their tasks, and if in his heart he wants to learn and is willing to apply himself, his apprenticeship can be very profitable. If the boy is unable to endure the period of apprenticeship, he does not possess the qualifications that would enable him to become a master himself. Through this process the student is given a foundation within his whole personality for the work he must do.

Thus the apprentice in learning his trade does not simply add on his skill; he assumes the dress of a carpenter, takes the speech of a carpenter, and acquires the whole outlook and demeanor of a carpenter. In effect he becomes a carpenter. It can be further thought that those arts that are acquired without great effort, neither require great effort in performance.

Learning to be a pilot is a task that requires even greater sufferings. Only after many great hardships have been endured can a fighter be perfected

Since actual experience on the field of battle is the best training for the fighter it is necessary that the everyday training of those about to enter battle be as nearly equal to the condition of actual combat as possible. The daily training of the round faced youths who aspire to be pilots is likewise combat from morning till night. Finally they are trained to feel that flying is an aerial mission they must perform, and they develop the burning spirit to be ready at all times to lay down their lives for their Empire. Just as their yellow winged planes, they become the weapons of their Emperor. Such is their spirit, and the outfit to which they belong is the clan where it lives in tradition. Their everyday training is the hard work of seeing themselves as part of a larger whole and of perfecting themselves as fighter pilots. This is indeed the road of the pilot.

There is a particular Japanese pride in becoming a pilot, and by means of this training a true pilot of Japan is born. Only when a man faces a difficult task is his true character revealed. A man first comes to know himself when he is confronted with serious work. Before pilot training, just as he can not conceive of what kind of work piloting really is so he can not know his own nature. One knows what piloting is only in meeting hardship. His technical skill progresses as he conquers these difficult tasks, and in doing so he comes even closer to perfection as a man.

As his training progresses the young soldier is made to realize that his training is not merely the drilling in a technique, but the training of a discipline. The first step in the training is to show the student how to put his life above any question of life or death. No weakness of spirit can be tolerated. All the feelings of inferiority with which the young man may have been possessed must be irrevocably discarded. The weaknesses and short comings of his character and ability are clearly exposed before him. These must be overcome by combating them directly. By the mutual effort of instructor and trainee, the weaknesses of the student are clearly defined, then by the effort of instructor and trainee these defects are overcome and destroyed. Feelings of inferiority (Selbstminderwertigkeitsgefühl) that may be concealed within the student are brought to the fore and are beaten and forged so that it becomes possible for him to adopt a proper approach towards his work. Thus he says in the service of his Emperor, "I shall die," and he has acquired the stomach to accept this role willingly.

The following quotation concerning preparation in the military discipline is from The Guard of the Capital, by Mori Oge.

'It is possible to make a comparison of the road of the Warrior with other ways of life. Consider the situation of the common slave. One should think that such men would be constantly tormented by the misery of the life they are forced to lead. Yet they bear this existence with calm. When a man is first reduced to this state for a long time he is unable to forget his plight. Then, even though he is continuously aware of it, it does not appear to him as something terrible. Then finally as he adopts the ways of the slave, it becomes as nothing to him."

Miyamoto Musashi has praised these words as describing the true military discipline.

If we examine the quotation we see that there are several stages within the development of the mental attitude of the warrior. It compares the bleak destiny of the slave to the problem of life and death for the warrior. At first, the warrior is unable to forget his fate. Then when the second stage is reached, even though he is aware of the question of life and death, it no longer seems terrible to him. Finally the problem becomes as nothing to him, and he has achieved the highest state in the military road.

However in the case of pilots, unlike slaves, there must also be technical skill and ability. It is not possible to become an artist without perfecting some technical skill. The perfection of the fighter must lie in the complete union of the techniques of fighting with the mental attitude of the fighter.

I wonder if it is even possible to become a skillful fighter without the proper mental attitude, even though the acts involved are extremely simple. The story is told of a certain fencing master long ago who had to give some last minute instructions to a completely inexperienced boy who was about to engage in a real fencing match. The master instructed the boy only to close his eyes and to brandish his sword above his head until he felt his opponent assault him. At this time he should bring the sword down with all his might. This, indeed, was an extremely simple skill. The master told the boy that if he brought down the sword as he had told him that he would always strike his enemy over the head, and could thus never be defeated. When the duel came to be fought the boy did as he was told and closed his eyes. He flourished his sword above his head and let the blow fall with all his might. When he opened his eyes he saw his enemy before him, defeated.

In the story above, the boy was told to brandish his sword above his head and then to let it fall with all his might. This is indeed an extremely simple technique. However, no matter how simple one considers it to be to wave a sword over his head and let it fall, it is not something that demands no skill at all. The technique is simple, but it is still a technique and must be perfectly harmonized with the man who makes use of it. This union involves the formation of a mind-skill whole which is necessary for the maximum strength of performance of the technique.

No matter how uncomplicated a skill it may be, if it is a part of the technique of flying it can never attain the simplicity of merely brandishing a sword over one's head. At least it takes a period of several months before one can say he is able to fly a plane. To some this might imply that flying is not a particularly individualized technique. Yet if one listens to the battle accounts of actual flyers, they often report that even though they intend beforehand to employ the next time in combat a particular technique they had long practiced, when it comes to the time of the fight itself, the pilots resort to their usual skills as always. As a result, their most natural techniques become their greatest strength.

Let us consider the battle situation where a fighter plane has run up against heavy air opposition, and the pilot has finally exhausted his last bullet and must resort to the final move of driving his plane head on into the enemy craft. It has often been reported that just at the last moment the enemy realizes his fate and quickly attempts to swerve out of the way, only to have the plane get out of control of the pilot and crash to the earth below. I wonder if this extremely simple technique of heading straight on for the enemy is not of comparable simplicity to flourishing a sword with the eyes closed. Here the technique is no problem, nor is the mechanical operation a problem for the pilot. It must be said only that the pilot has the will to fight. This example illustrates the fact that in the long run piloting must be a human problem.

Those men who when faced with a battle of life and death react with straining and tenseness once it becomes apparent there is no hope of victory, or indeed who choose to flee by the one last remaining avenue of escape, can never attain true victory. Those men who, facing a battle of life and death, discard all life and death, cannot fail but win. Even though his body is destroyed his is the victory of the spirit. It is because of this victory that we know our present enemy shall never defeat our armies. Fighting while keeping an eye to possible roads of escape as if one were fighting to avoid a conclusive battle to the death, and while relying on mechanical power and trusting to chance, is a compromise of life in that one does not consider the fight as a willful struggle between men; it is a flattery of machines and of chance.

It is always possible to gain the offensive position in battle by charging unhesitantly into the final scene, and by forcing the enemy to the issue. The position of the offense in battle is unquestionably advantageous. The pilot is not conscious of his courage as courage; he has only the will to fight; he is entirely absorbed within his fighting. Here he achieves the unification of mind and skill. As he discards his body and the question of life and death, his fighting becomes truly of its simplest and strongest form. I am reminded of the words of those who sometimes reject the spirit of the old militarists. "It is held that the arts must afford some physical benefit to their master; it is not so for the samurai. The samurai destroyed his body through his art. Indeed it is true that those who master an art should be called true artists. However, one should consider the samurai not as artists, but as samurai. Even though the samurai attained some perfection in their skills, still these skills led to their destruction." However it must be felt that one who would criticise the unification of mind and skill and to tear them apart in this manner, is most probably himself a person of little skill who is attempting to conceal his own weakness with words. Indeed for the samurai a blood stained training was necessary.

The Guard of the Capital states that at a certain stage of development one normally understands that his fate is fixed and it does not seem terrible as before. Yet here preparation as such is divorced from the self, and so long as this understanding is conscious as understanding, the final stage has not been achieved. This last is possible only when one's fate becomes as nothing. Even though I speak of the unification of mind and

skill, if there still remain a mind and a skill to be united, there is no unification. In a "preparation of death" and an "attitude of resignation" there is still mental preparation. The crystal clear mental state of readiness and the unification of mind and skill is attained only when the brave warrior of an attack company says merely, "I am going."

Pilots who turn their planes to the front lines make the same report of their departure to their superior officer as do the trainees who turn their planes to the area of practice. In early training the students are instructed with the strictest discipline in the standard procedure for reporting departure to their commanding officer. They are strictly trained to make this report even when their mission openly defies death. Even at the front line it is offensive to hear one say that he is going out to die. If this were said at the front line it should probably also be said as one goes up to fly in elementary training. The words "I am going to die" are rather the demonstration of a strong remaining tie between life and death.

It is my endeavor merely to try to develop within men of a concrete world that know only action, the finest achievement of the warriors of old. Yanagiiki Tajima writes the following passage in A Militarist's Biography.

"The wood man and the flower bird. A man made of wood sat opposite a flower bird. He had eyes like the flower bird, yet he could not move like the flower bird who had a heart. Since wood man had no heart, it is quite right that he should not move. One should be like a man with a heart and not like wood man. A man with a heart should not be the same as a tree. A man with a heart should not be like the bamboo tree. When the tree looks at flowers , it does not do so alive with the heart to see flowers. It must only gaze without heart."

The great beauty in the fencing code of Yanagiiki probably lies chiefly in his broad and enlightened approach to learning the art. Certainly the art of fencing requires a firm harmony with the mind.

It is said of Yanagiiki that once when it became known that he had said there was great strength in the military code, a group of nobles approached him and asked him to take them with him as pupils. He replied to them, "You are indeed persons of great knowledge in every field. It is therefore proper that I should become your teacher in the search for truth." When they heard this, the nobles then asked, "But, how is it you will become our teacher if we are wise in every field?" Whereupon he answered, "We shall drill in the military arts. If a warrior has obeyed his leader ungrudgingly throughout his youth, he will finally ask no more when he will die. You are all well prepared, except for this."

This is the same attitude that was expressed in The Guard of the Capital. "I say no other than that it is wrong even to close one eye. This is the essence of my military code. This point has escaped many up till now. It is not enough to use a wooden sword. The code must become as a thing that cannot be torn away."

Concerning this point the Zen Buddhist Takuan has stated:

"Where indeed does one put the heart? If one leave his heart with the forces of the enemy, he will find it again in the sword of the enemy. It is said by some men that if one has no place to put his heart but turns it in unto his navel, it is transformed by the enemy so that it must be fought together with the enemy in the battle. It is the teaching of Zen Buddhism that if the heart is turned unto the navel, it cannot rise but must sink. Where does one leave his heart? I say, the heart should pass throughout the entire body; extending broadly over it as a whole, it becomes a single great heart."

Yanagiiki Tajima has pointed out that this necessary mental attitude is developed over a period of rigorous training; yet we must not forget that it is acquired only by severe mental discipline.

Since they afford such rigorous mental discipline simulated air battles are invaluable in the training of the road of piloting. These battles afford an opportunity for the unification of mind and skill, hence the technique that is acquired in this way becomes the most natural and valuable tool of the figher.

The Special Characteristics of the Different Courses

The final state towards which one should aim in the road of piloting is the complete unification of man and machine as outlined above. However until this state is reached it is necessary for the pilot to train in one of several branches of piloting. These are for the most part training in fighter, bomber, and reconnaissance planes.

Everybody who has had service in some kind of military unit is probably well aware of the rather striking differences in character among the various branches of the service. In the infantry there is the infantry spirit, and in the artillery there is the spirit of the artillery corps. Some manifest this characteristic spirit with much show and boasting, others do so more modestly; some express this by conspicuous individual achievement, others by concerted group effort; but in the long run by whatever means it is manifest it becomes most clear and distinct. Also among pilots such noticeable differences in group spirit are found; the various fighter and bomber squadron spirits are so marked that if one sets foot inside a particular service unit, he can perceive this characteristic as if the outfit had a distinctive odor. The traditions of the fighting units are steeped in this scent. As the pilot breathes this atmosphere over a period of time, he becomes a stronger fighter of that particular outfit. In this manner the traditions of a unit are passed on to new pilots as they are assigned.

As I have pointed out before, when student pilots receive their basic pilot training, their instructors take careful note of the personality and ability of each of the students committed to their charge with a view to deciding which of them are fitted for fighter duty and which for heavy bomber duty. It often happens that the judgments of the instructors in this matter coincide directly with the self evaluations of the students themselves. The students are often well aware of those subjects in

which they are especially well fitted and of those that are points of weakness for them. The fact that different pilots find themselves better suited to certain jobs than others is another way of saying that these abilities are in some way expression of the personality of the pilot. Therefore if the instructor determines the service a student should enter after mature consideration of the characteristics and abilities of that student, it is natural that a given unit would be composed of persons of largely similar characters, and it is not difficult to see how such a characteristic spirit should come about.

However, the basis for the difference in characteristic spirit lies in the function and use of the various types of planes. These differences in function demand in turn differences in the functional capacity and operational design of the plane. In other words, the basis for the differences in spirit depends upon the different ways of fighting of the various units.

It is indeed true that the fact that different pilots have different personalities and have each certain characteristic abilities is the foundation upon which the determination of the type of branch to which the pilots will be assigned is made; but in the beginning of training there is normally so little specialization of interest that there is considerable leeway afforded in the selection of an appropriate branch. However once the student is assigned to an outfit and receives the indoctrination and training of that outfit, and once he fights and meets opposition with the members of that outfit, his personality becomes attached to the unit, and he becomes a fighter pilot or a reconnaissance pilot down to the marrow of his bones. At this point even though the pilot has the natural ability to become another type of pilot, his spirit is no longer adaptable to such a change. This spirit becomes his pride and his honor, and he firmly assumes the tradition of his branch. The pilot then makes every effort to live up to the particular reputation of his outfit.

It would probably be to little advantage here to describe in detail the particular methods of fighting employed in each of the branches of training. However it is indeed important to be familiar with the factors which influence the mental organization of the pilots of each type of service as well as the way in which the structure of the mental union with the necessary skills is effected by these factors, in order to understand the pilot's approach towards life.

First, we shall take up the fighter squadron. It can generally be said that the planes in use by such fighter units are primarily single seaters of high speed and wide range of maneuverability. Here already we can see the psychological forces that influence the fighter pilot. Since the plane is a single seater, the pilot himself must do not only the piloting of the plane but also the necessary navigating and firing. The implication of the fact that he is alone in the plane is primarily that as far as the performance of the plane is concerned, he has the sole responsibility. Furthermore, he is able to alter the movement of the plane pretty much in the way he wants to. He is restricted for all intents and purposes only by psychological considerations.

Thus we see that the fighter plane becomes in effect a one-man fighting

unit. However it is absolutely necessary that many battles be carried on with many planes acting in cooperation. If a fighter pilot is particularly skillful it is often difficult to prevent him from attacking just wherever he feels it is the most advantageous time. However in such situations it is not possible to permit such an uncoordinated attack. Even when other planes have been sighted and it has been confirmed that they are not friendly planes, it is often not possible to enter the attack at once. On the other hand, if the pilot should be afraid of fighting, he is at liberty to abandon the battle if he so chooses. Of course this attitude is a complete denial of the attitude of the air warrior. Such a person is strongest when forced to operate within a rigidly controlled group.

The high speed of these planes also points out an important psychological characteristic of the fighter pilot. Assume, for example, that the fighter pilot discovers an enemy plane approaching him at a distance of about 6,000 meters away. (It might be helpful to the reader to think of a height of 6,000 meters from the surface of the ground.) If, then, the speed of both planes is 500 kilometers an hour, the time that remains for the pilot up until both planes have begun combat is approximately 21 seconds! The twenty some seconds that pass from the discovery of the enemy till the actual clashing of arms can probably be effectively compared to the experience of close combat at night. In these 20 seconds the pilot must determine all the necessary steps to permit him to enter the battle in an advantageous position.

Once the fighter pilot enters the battle it becomes a confused scuffle of machine against machine so that it is often even difficult to discriminate between friendly and enemy craft. Thus in a battle of fighter planes each individual must take the full responsibility from the identification of the enemy to successfully contact with him. The victory depends upon the superior performance of each plane. If one inquires as to how the complex judgments and decisions of one pilot are communicated to the other planes in the battle, this contact is made by the extremely simple signals of shaking the wings and body of the plane, and by concise wireless reports. Thus it is necessary for the members of a fighting squadron to have such mutual understanding as enables them to form a strong group in which all the planes and pilots have become unified.

If one remark that today all fighter planes are equipped with wireless sets to facilitate control in the sky, it must be replied that the use of wireless in battle is limited to such simple communications as is sufficient to commence the attack, or to report the discovery of enemy craft, or to signal the coordinated termination of the battle. It is inconceivable that the wireless be used in the coordination of the complex and rapidly changing phases of air battle. The unification of the individual planes in battle is achieved only by something of a tacit understanding

Yet one might inquire as to how the command plane can have communication, for example, with the pilots of foreign countries employed by the government, when they pretend not to hear if the command of the leader is opposed to his own, or when they break ranks upon the encounter of superior enemy craft, claiming engine trouble. Indeed, as for the ability of the

leader to ascertain the real condition of the pilots of his command, it leaves the realm of the difficult for the impossible." (From Beaten Down by Matsumura Kijiro.)

Tacit understanding is the ability to transmit to others volitional material without the use of words. Even though it is possible to transmit simple messages of volitional content by contemporary mechanical means, as for example by wireless radio, this communication is seemingly entirely different from volitional communication on the ground where one makes much use of the rise and fall of vocal intonation and the situation surrounding the making of the remark. That is to say, the simple, clear command of the instructor "Do it!" over the wireless, is entirely effective in revealing the desire of the instructor, and the student will in all probability perform as directed. However in battle such simple directives are not enough, and if the instructor must communicate his desires by such things as movements of the machine, it is necessary for the student to derive the will of the instructor simply by "the look of his wings." Here we see where tacit understanding is necessary. Tacit understanding is not possible without the complete mutual awareness and real psychological unity of the members within the flying unit. In the coordinated movement of the planes of a squadron about the nucleus of their leader, it is not possible to see the leader with the eyes or to hear him with the ears; however more than by seeing with the eyes and hearing with the ears, the pilots and their leader must be bound together by an even stronger mental tie.

This mental tie is by no means composed of the ability to interpret strategic mechanical signs; it is rather something more direct and profound, something that grapples together a spirit and a spirit -- a life and a life. The mutual understanding between men who fight must be more profound than that in any other phase of life. This mutual understanding is not based on such instinctual forces as bind mother and child, and brother and sister. It is founded within one's spirit. That is, this tie must be stronger even than natural and instinctive forces.

This is indeed a striking fact. The duration of a hard and furious battle in the sky seems like but a flash of lightning to the pilot in combat. I wonder if this spiritual union into which man summons whatever power he possesses is not indeed man's supreme state. Men who have had such experience probably have an association and understanding based on an unequalled noble bond. It is only by virtue of this strong mental union that pilots are able to effect the assistance of another plane in critical combat with the enemy, without considering the danger involved to their own lives. Many war examples continue to accumulate illustrating the action of this mutual bond because this mutual understanding has become a strong point in the tradition and spirit of aviation, and is being constantly assimilated and passed on.

It seems hardly to be necessary to say that the duty of the fighter pilot lies in the thorough and complete death and destruction of the enemy. The firearms with which the plane is equipped are in nature instruments of attack rather than of defense. Then too, the nature of the movement for which the plane was designed is for attack rather than for flight. The

planes of the bomber and reconnaissance pilot have a somewhat different character since a measure of defense is necessary. The spirit of the pilot should accordingly reflect the design of his plane. The battle of fighter plane against fighter plane is on a plane similar to the lance against lance, sword against sword combat of older times. The pilot, and especially the fighter pilot, in mechanized aviation must come to rely to a large extent on his own strength. Here lies the most popular aspect of fighting for Japanese men, and accordingly the number of men who apply for fighter pilot training is always great. However this strength of the Japanese people, if wrongly used, can become their weakness. (A fighter pilot once made the following remarks to me: 'One must have a certain fear in the fighter plane. When one sees the enemy, he seems unable to do anything but to grapple with him at once. This is one's greatest happiness. It is indeed impossible to conceive of the kind of courage that is necessary for those who fly the bombers and reconnaissance planes. Until they have completed their mission these pilots must hide themselves and adopt an attitude of defense.") Thus the Japanese people must be strong in the ability to resist the urge to rush in at once upon the enemy, and to carry out with perserverence their calmer duties.

Then, there are special individual characteristics which mark the duties of the reconnaissance pilots. As I have stated before, it is necessary for these planes to avoid encounter with the enemy as much as possible and to direct their activity towards maintaining the greatest possible secrecy. Then again unlike fighter planes the reconnaissance plane is often required to operate alone. One can easily imagine the duty of the scouting pilot. He must make a long flight above enemy territory over which perhaps no plane of his nation has ever flown before; or he must operate only within a small area in order to maintain direct communication with ground forces.

Furthermore, it is not necessary with reconnaissance planes, as with fighter planes, to maintain direct communication between other planes. However between the pilot and the observer the cooperation of a blood alliance is necessary. The situation is such that the two are unable to enact concerted action; the pilot probably feels that his function is of use chiefly for the observer, while the observer, even though he is aware that his duty is the object of their mission, is probably conscious that the pilot cannot move just as he might desire. Thus we see that the cooperation between pilot and observer is not entirely parallel to that among members of a fighter squadron, however this cooperation is of such a nature that if the mutual cooperation is lacking the functional value of each is precluded. If we can compare the relationship among members of a fighter squadron to a brotherhood, it might be possible to conceive of the cooperation between crew of a reconnaissance plane as something comparable to the relationship within a marriage.

Then let us next consider the type of work of the pilot and observer of a reconnaissance plane who have to comb the interior behind the enemy lines long before the actual land attack has begun. In order for the flying range and cruising speed of the plane to be increased its weight

has been drastically reduced. Even the firearms of the plane have been curtailed to the greatest possible extent. We have seen that speed is indeed a valuable weapon of attack, yet at the same time it can be a weapon of defense with regard to warding off the pursuit of the enemy. In the fighter plane, of course, the advantage comes with a view to attack. However in the reconnaissance plane the reverse case holds. It is quite natural that the type of courage needed to execute the duty of the reconnaissance plane should be entirely different from that required of the fighter squadron. Many reconnaissance pilots have tried to express to me the indescribable loneliness of flying the skies over enemy ground for long periods of time. They say that they try to conceal this loneliness by humming their favorite tunes for long periods of time as they work. Then when the reconnaissance plane finally reaches its destination its objective might be entirely fulfilled in an instant by the achievement of one photograph. Yet the reconnaissance report has very little direct significance to those who must make it. Based upon this report, moves of strategic importance must be made, and if the important facts are not revealed by the key photographs the move is apt to be unsuccessful. Thus the work of the reconnaissance pilot and observer becomes more difficult in that even though they must remain fairly well hidden, critical and essential work must be done.

The task of having to have a negative approach towards direct attack in the accomplishment of one's duty is (for the Japanese, at least) more difficult to maintain than the positive attitude of hunting out the enemy for battle. It has become necessary for the performance of reconnaissance work that the plane be concealed, yet at the same time, the entire job cannot be done only by hiding. It is just that by means of hiding the ultimate purpose of the reconnaissance mission can be more easily and efficiently fulfilled.

One might conclude from the discussion above that those who must perform reconnaissance work need not necessarily have a particularly cooperative nature but rather that they should be independent persons who do not waver in their determination to perform their job. However the essential psychological characteristic required for this type of work is that the individuals concerned be able to lose their own personal feelings within the broader objectives of the army as a whole and to reduce their own feelings to nothing. Here true courage is necessary. Compared to this courage that of tracking down the enemy and grappling with him, and of forgetting one's fear in the intoxication of his activity is indeed easy to acquire. Yet this courage must become as nothing to the reconnaissance pilot.

Finally, to those brave men who in a single plane pierced deep into the enemy land and did not return, we pay the greatest reverence. The final moments of these heroes must remain a mystery even unto the end. It is our honor firmly to believe theirs was a magnificient end, truly worthy of their courage.

Next we shall consider the bombers. It is indeed not possible to lump together under a single name all the different types of bombers that are

in use today. One can name just to start, heavy bombers, light bombers, dive bombers, superfortresses, and so forth. Each of these different types of bomber differs considerably from the other types so that each should manifest individual characteristics and capacities. Here, however, I shall restrict my discussion to the heavy bomber since it is somewhat representative of the group as a whole.

One might ask for what reason the word Heavy * was applied to this type of bomber. This name may perhaps apply to the weight of the plane, yet at the same time it is a suitable word to describe its relative bomb load, its performance capacity, its passenger load, its defensive fire power, and its cruising time. These characteristics alone could be said to determine the necessary mental outlook of the pilot.

Again, it seems almost unnecessary to say that the function of the bomber pilot is to discharge effectively his load of bombs and to crush the fighting power of the enemy. A bomber pilot of my acquaintance has described the procedure of releasing the bombs from the hatch simply in the following words:

"Truly only at that time does one not regard his bomb load somewhat affectionately. One says simply, 'You give the word.' Then the bombs are released, one stares after them as they fall towards their target; then he begins to pray..."

In order to drop merely one load of bombs on Hawaii the bomber pilot and crew must live confined to an aircraft carrier for many weeks. Throughout this time they study the aerial topography of Hawaii to such an extent that it appears constantly in their dreams. They have flown over many mountains in their imagination and have dropped their load of bombs many times in anticipation. One can easily conceive of their extreme tension as they approach their target and their corresponding satisfaction when the job is well done. The climax of the whole mission comes in the simple pushing a button and pulling a cord by the bomber. The core of the mental attitude of the bomber crew lies in the fact that all must participate even in the release of a single bomb; this fact increases their spirit and affords them a strong appreciation of their mutual responsibility.

In the heavy bomber the mutual cooperation of many men is entirely necessary. In the various parts of the plane there are the pilot, the copilot, the engineer, the wireless operator, the navigator and the gunner. The successful performance of the bomber as a whole depends upon the absolute maintenance of the functioning of each man. The relationship between these men is indeed one of sharing pleasure and pain and life and death, and a firm bond of tacit understanding must be established;

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* In European languages this type of bomber is called Schwerer Bomber or Heavy Bomber.

yet in essence this mutual cooperation is of a different nature than that of the members of the fighter squadron. All the activities of the men within a single bomber must be directed towards a common goal, yet at the same time their functions are separate so that if one member runs up against severe opposition the other members of the crew cannot afford him direct assistance, as is often the case among fighter pilots. If adequate cooperation is not achieved within the bomber as a unit it amounts to each man's risking his own neck. I should think that under such circumstances mutual psychological coordination would be relatively easy to effect.

In this way we see that in the bomber plane a fighting unit is formed out of the union of many individuals; this plane in turn must act in concert with other planes. Of course, single plane bombing raids are made at times, but it is usually the case that a large number of planes will organize within a tight group in order to form a strong network of fire. Such a bomber squadron is by no means of the same loose construction as the fighter squadron; when the battle begins each plane does not break out into immediate struggle with the enemy. When a bomber group encounters enemy opposition it becomes necessary for its planes to maintain even more strongly their established formation. Even though the enemy concentrates its attack on one's own ship, it is not possible for that plane to break away from the formation. The duty of the bomber must be entirely directed towards the successful completion of the bombing mission, and direct contact with the enemy attack must be limited largely to defensive battle with the weapons with which the bomber is equipped. Here we see that a strong ability to disregard one's personal inclinations becomes necessary.

The fighter plane is capable of carrying out its plan of attack by means of agile and adroit maneuvers. Indeed the fighter plane is endowed with such a nature. In the case of the bomber, however, even though it be free to do whatever it can, it is able to execute its movements only in a most leisurely fashion. Thus we see that the bomber crew needs a calm, deliberate, perserverative courage, quite different from the violent courage of the fighter pilot, who must deal precipitous blows upon the enemy. The bomber crew must be able to control their will or, in other words, to have a large amount of self control.

Then, too, the characteristic length of the bomber's time of flight determines to a degree the particular type of courage required of its crew. On the long flight, after the control of the plane has been delegated to the automatic piloting device, a great feeling of tediousness is likely to arise, until the objective is neared. The distance to the target can become indeed a great mental burden. During this time the psychological strain of the activity to follow often becomes apparent. It is clear that whether this period is used actively to strengthen the efficiency in the attack by, say, objective consideration of the plane of approach, or whether it is exhausted in the idle speculation that often leads to fear, depends for the most part upon the character and mental outlook of the particular crew members. Here we see that devotion to duty and good training are both necessary. Yet regardless of the particular kind of mental attitude they adopt, the wings that support them carry them closer and closer towards the objective. In such situations one's attitudes towards life, and towards death are openly exposed.

In the paragraphs above I have attempted to present an outline of the psychological characteristics of the fighter, reconnaissance, and bomber branches of pilot training. It should now be quite apparent that such attitudes as maintain that the piloting aptitudes and qualifications for the various air services are determined primarily by the mechanical nature of the particular planes employed, are indeed superficial in outlook. Furthermore, attitudes that consider that these aptitudes depend only upon the applicant's skill in performing the operations of flying can be considered at best as narrow approaches based on the abstract opposition of man and machine.

When one confronts the problem of how easily a fighter pilot can become accustomed to the duties of a dive bomber pilot, or of how well a bomber pilot can perform the functions of a fighter pilot, it seems certainly inadequate to consider the problem solely from the standpoint of the mechanical capacity and necessary control operations of the planes involved. Of course we probably should not concern ourselves too greatly with such problems. However if we consider these matters solely from the standpoint of such capacities, and skills, we seem inevitably to run up against permanent and unalterable elements. At the end of elementary pilot training all student pilots have had roughly the same training, and possess in general the common feeling "Now I can fly an airplane." It may be that after a student has studied for some time special courses towards a particular branch of flying, he will still be able to change without great difficulty to another type of plane. However, when one recalls that it is not possible to make such a change by the simple addition of a new technique, it might be concluded that accompanying such a change must go a corresponding change in the life attitude of the pilot. When reconnaissance pilots who have previously flown only on solitary missions are transferred to fighter or bomber units where group flights are necessary, if these pilots attempt only to fly with the other members of their group without trying to grasp the basic mental structure of this group operation, these pilots would be unable to make a satisfactory change. Cooperation, initiative, and self effacement are, of course, moral precepts that should become a part of each flyer, however until such a stage of general moral perfection has been achieved it is necessary for the student to acquire the appropriate mental outlook by groping his way forward by means of the characteristic emotional flavor of his particular unit. When the pilot concludes his elementary flight instruction it is probably no great matter into which particular branch the student is directed, since at that time his emotional outlook is still unsettled. Then should the student continue in his devotion to duty he may reach the stage where no matter what he is required to do, he will be able to do it fairly easily. However those pilots who have become adjusted to a certain type of piloting, make its characteristics a part of himself; indeed this is fortunate since it produces men firm, strong, and of suitable personality within each branch. Thus we see that it is profitable to keep these men who have become adjusted to a particular branch within that branch; in this way the unification of their minds and skills will continue to be strengthened.

The Pilot's Attitude Towards Life

The proverb goes, "[illegible] only a plank between a sailor and perdition." In such [illegible] life of the sailor is often [illegible]

Some persons, however, are apt to adopt a similar phrase to describe the attitude of flyers. In a certain sense the proverb is not applicable, yet in another sense it is. If one refers by the proverb to a shiftless and indulgent way of life it is incorrectly used; if however one sees in the saying an expression of a principled and strong outlook towards life its use is appropriate. Those persons who can find wasteful and wild living in the simple, sturdy, and candid lives of those who live calmly but uncertainly, probably do no more than reveal their own weakness.

When a sailor steps one foot out into the waves of dissipation, he is indeed so cut off from his way of life that he must of necessity assume a vacillating attitude towards life. The true life of a sailor is the stalwart virile life of the brilliant sun and the bluegreen water. That there is only a plank between himself and perdition is his chosen road. Yet even in saying that it is so, should he fear it? Even if it were feared, their life could in no way change before its destiny. On the contrary it would only make their life unhappy. This perdition is friend to the sailor.

Their life is a continual struggle with the sea; they make use of the keenest intuitions from the movement of a bit of cloud or from a brief spurt of wind. However they employ such signs not in fear of the ocean, but in order to know the ocean. When one says that these are things that resemble fear, it must be answered that they are only the feelings of reverence in the submission to nature and destiny. Such an environment demands the concerted energy of the whole body, and sailors throw their entire life into their violent environment. Such a principled attitude towards life permits human beings to be very happy.

When they return to the land from the sea, again a life of warmth and peace unfolds for them. Then just as they threw their entire selves into their environment of the sea, so they pour themselves into this warm environment. They pour the loneliness of their whole body into their wives and children. They are taught by their fierce life on the water the attitude of life of giving themselves entirely into the places where they live.

I think that flyers are taught a much similar approach from their environment in the sky. When the pilot is flying or fighting in the sky his whole mind is absorbed within his flying. One might almost say he flies without a mind. Perhaps even more than for a sailor, a delicate intuition becomes necessary. Even though I say delicate, I do not mean in any sense weak or fragile; this intuition is of the subtle differentiations of the power of life. Here there is no life and death. Perfect flying is not possible with half of the mind occupied with life and death.

"My sight is a mass of turbulent whiteness. Clouds and the wind." Yet such things as seize the heart on the earth do not affect the pilot in the air. Sky, clouds, fields, mountains, oceans -- all appear as if one were entirely torn apart from the earth. Merely by the stimulus of his environment, the flyer is entirely severed from contact with the inconsequential tatters of the ground. If the pilot is unable to

divorce himself from the earth beneath him and to lose himself entirely within his environment and continues to bear the troubles of the ground, his successful life as a pilot is not possible.

Certainly those persons who are able to live within a clear, simple and powerful environment are the happiest of men. The average life of the man who lives on the ground presents indeed a confused and chaotic picture. Our earthly environment does not afford us a pattern of life to which we can adopt a consistent and clear cut attitude. The typical city dweller has a dual mental approach towards living. His effort and his happiness are divided and he is accordingly able to enjoy only half of his living capacity. When he is at work he is thinking about playing, and when he is at play he is worrying about working; and groaning within such a dual or triple environment, he is beset with feelings of shame for much of what he does as fun. Such a person who is unable to settle his worries, who looks upon much of his life as if it were great burder, who has only the joy of a dual life, is apt to look upon men of the air and sea as if only a plank stood between them and perdition. It seems almost amusing that he should consider a virile life an indulgent one; it is rather an expression of distorted envy.

Thus we see that the most satisfactory pilot is not one who merely has the necessary physical capacity to endure the rigorous demands of flying or who has sufficient technical skill to enable him to perform the functional operations of piloting. The man who aspires to be a pilot must be able to adopt a sincere, lucid, and penetrating mental outlook. In olden times when the Japanese warrior went out to battle he first cut himself away from personal encumbrances and by means of ceremonial rites received a spiritual rebirth. Accordingly in order that the warrior could be able to leave his home at any time for the battlefield, the prudence of leaving his personal affairs always in order was extremely necessary. His whole life was built around spiritual purity and clarity which enabled him to express in his behavior on the battle field his complete personal capacity. It seems unnecessary to state that a similar state of preparedness becomes extremely prudent for those who serve in the sky. Flying instructors must not fail to provide their students with sufficient training in this spiritual preparation.*

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* In advanced training maneuvers the trainers are instructed to 'divorce yourselves from concern for your relations and devote yourselves wholeheartedly to public service; your personal affairs must be left in order, so that there would be no inconvenience after death." This spiritual release from obligation is especially necessary for Air Force personnel. "Leave behind all tenacious entanglements with personal matters. If you sever yourself from the encumbrance of those you love, your spirit will become clean and your training happy, and you will be able to perform your duty with joy and enthusiasm."

An instructor who believes that the personal ties that are attached to the soldier can never be entirely cut will probably not be able to engender the proper mental attitude in the students under his charge. Rather both student and instructor will feel together that the bond cannot be broken. When soldiers weep and are sad, they weep together; when they rejoice they sing their joy together. A true instructor teaches his men to relieve their unhappiness by sharing it with each other. He shows each man how to free himself of sadness by enlisting the aid of the others in his outfit. If an instructor is lacking in such power, even though he be especially qualified to teach others a particular skill, he will not help his men to develop the most advantageous mental attitude towards their work.

In the training of a person who fights, such personal contact between the teacher and student is extremely necessary. There are few countries that need such contact to so high a degree as does our country.

It is quite easy to feel that flying is the most dangerous type of occupation that man has devised. Furthermore one is indeed quite accurate when he says that if one makes a single wrong move in his judgment of control of the plane, it is liable to be a fatal error. However it seems to me that this kind of "danger" is faced by us all many times each day. The pilot indeed handles a complex machine, yet I wonder if it is a great deal more complicated than many of the familiar modes of communication we employ in our every day life. If we humans were subject to the blocks and hindrances to voluntary movement as often occurs in the fantasies of certain of the mentally ill, we would not only be unable to pilot a plane but we should be unable to walk safely across the street.

Does the proper human avenue of approach lie in the minute scrutiny of acts as fundamental causes of all the ill-omened consequent phenomena that arise? If man had such a consciousness, he would indeed be unable to effect a single decision, but would decline and pass away before completing a single thing. Perhaps an objective approach that considered in advance the antecedent causes of all effects would be praised by scientists, since a true scientific inference cannot be made without such a rigorous examination of antecedent conditions.

Of course, even for flyers, and for people on the ground in general for that matter, a scientific attitude in the consideration of antecedents is extremely useful. However this consideration must not be directed towards stifling the ability to carry out the act in question. This consideration must be directed towards promoting an increase in management and control. Piloting should never involve performing acts of ill omen with a shrug of the shoulders; one performs these acts simply on the basis of his own strength. (This point is made by Dr. Max Dimmeit* in A Basic Study of the Psychology of National Defense.)

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* The phonetic spelling is ji-mo-ma-i-to.

A student who in the midst of pilot training feels that he is a constant target of unfavorable signs should certainly give up the desire to become a pilot. As a rule, people who consider themselves subject to such forces are not apt to believe in human freedom but feel rather that there are insurmountable obstacles in the path of many of man's goals. Such persons should probably draw the curtain to their whole life. It seems to me these people have abandoned from the outset the treasures to be had from living and that they travel a road of progressive decay. Similarly in the case of the pilot, if he adopts such an attitude towards life that he feels that he is playing a game of tag with chance, sooner or later he will meet a situation where the achievement of a desired goal is blocked, and being strengthened by this in his unfortunate conviction, he will become blind even to the opportunities that remain open to him.

Opposed to this there are among pilots, even among those that are in some way handicapped by a physical defect, those men who firmly believe that there are always usable opportunities before them and who accordingly are continuously broadening themselves and making conspicuous progress.

However the fact that even though one has exhausted all possible moves, everything must still be achieved, is a natural part of the life of a fighter much more than of the peaceful life of the ordinary man. That this is natural for him, the flyer must be deeply aware.

In the thirty years since the beginning of aviation, especially since the outbreak of the present national emergency and war, we have known of the many heroic deaths of those who fly. Some men exploded as with a shake of their wings they hurled themselves into more powerful enemy opposition. Some men fell to the earth while groping their way back, piloting with their mouth, having tied the stick with a handkerchief after they got a bullet in their body. Some men fell in their plane with the wave of a handkerchief as a parting signal. There are those who exploded with their faces triumphant with pride at a successful shot. There is the young lieutenant who having landed in enemy territory lost his life trying to fly an enemy plane. There are those who tapped out Banzai as they were about to explode, and were lost. We can remember our silence at reading these reports. There were many who chose to end their life even though they were not wounded. We do not have the art to know directly what they cried out at the last, or what they thought. They expressed all words within a slight movement of the wings, or a little toss of the hand to a friendly plane. Even those who are able to transmit this most successfully can do no more than use the electric waves of the wireless. We do not have the art to know to what extent the end of the many airmen who did not return was a sublime one.

That we can only believe. Moreover those heroes probably believed that we are able to believe so. There must be a silent sacred contract between us in this world and those heroes. It is here indeed that their death becomes something eternally enduring.

Do not forget them. They are not fallen flowers for whom all roads were blocked. In truth their death was the level road of their own choosing; their spiritual victory was not dependent upon some overpowering obstacle.

CHAPTER IV

SOME PROBLEMS OF COMMUNICATIONS TRAINING

Just as when we consider the movement of various parts of the body we are apt frequently to regard only skeletal and muscular functions and to fail to take into account the operation of the nerves, so when we attempt to consider the problems of aviation we are apt only to think in terms of piloting and maintenance, and to forget the matter of communication. Then, perhaps, it may be wise in other ways to regard the function of the nervous system and that of communications as somewhat similar.

It is true indeed that many airplanes fly by over our heads each day, but at the same time the radio waves of the aviation wireless system are flying by with incomparably more speed. Of course, communications is a technique that has established itself in its own right, regardless of the development of aviation, but on the other hand aviation would not be able to survive if severed from wireless communication. It is not possible to define communications merely as the link between ground and air or between the various planes in the sky, yet if the directions and information transmitted by wireless were stripped from aviation, the resulting situation would be comparable to stripping the human body of its nervous system.

The means of communication that are in use today have been made automatic to an incredibly large degree. Signals can be transmitted and received at a previously unimaginable rate of speed. However this increased mechanization by no means implies that man has been entirely relieved of his burden in communication. On the contrary, a progressively more important part of the job of communication is being allotted to man; it shall be my endeavor in this chapter to consider some of the more important human problems in communication, especially those that concern communications training.

A New Theory of the Technique of Message Reception

The central problem related to training in radio communication concerns the technique of receiving and transmitting messages. This technique involves essentially the learning of a code (usually the International morse code), and drill in receiving this code and in sending it by hand.

Several years ago Leonard Koch, a German psychologist at Braunschweig, made a significant achievement in the psychology of learning working with message reception. * Since Koch's new theory has had a considerable

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* L. Koch: Arbeitspsychologische Untersuchung der Tätigkeit bei der Aufnahme von Morsezeichen, zugleich ein neues Ableseverfahren für Prüfung. (Zeitschr. f. Psychol. u. Charakterkunde Bd. [illegible] Heft [illegible], 1936. [illegible])

influence upon our own communications training, I shall try to consider some of the problems of air communications training in this country at the same time that I present his theory.

Koch's theory is concerned with the most efficient method of learning to receive messages. His conclusion states that if message reception training is carried out from the beginning above a certain speed of message presentation, a subsequent lowering of the rate of presentation will result in a decrease in the efficiency of the message reception. This extremely interesting conclusion is rather forceful evidence for some of the hypotheses of the so-called Gestalt psychologists.

Koch's study had its basis in the occupational investigation of the sending and receiving performance of a skilled radio operator. The chief problem with which he was concerned dealt with the effects upon the performance of an operator who was able to receive at a rate of from 80 to 100 words a minute if he were required to receive messages transmitted at a markedly lower rate of speed.

It is probably not necessary for me to state here the fact that the form of the communications code has been internationally standardized so that regardless of whether the message is transmitted at a slow or fast rate, the temporal relationship between the dots and dashes, the inter code space and the intracode space, and the punctuation signs have been established by convention. For example, the Japanese sound "i" (dot-dash) must have the temporal structure that is illustrated below. (Figure 4a) The actual "sounds" of the communication are transmitted as dots and dashes, yet in order that these sounds may be meaningful then temporal relationship must be fixed. In between the two sounds of a single code signal there must be an interval equal in duration to the length of one dot; this the intracode space. To indicate the completion of a single code signal, there must be an interval equal to the duration of one dash, which is in turn equal to three times that of one dot; this is the intercode space.

Consider, then, what happens when a skilled operator is required to send a message at a speed much below his usual rate of transmission. It has been found that in such circumstances the sender will completely distort the conventional temporal relationship of his code: the intercode spaces are greatly lengthened, and there is even a tendency to shorten the length of the dots and dashes. In other words, in order for the sender to understand the message he is transmitting as meaningful, it is necessary for him to make an appropriate adjustment to the connection between elements of the message. The situation can be elucidated by using speech as an example. When we are asked to speak slower we do not lengthen the sound of each word or pronounce the remark with a uniform lengthening of temporal units, leaving a uniform space between each word. One does not say, "It --- seems --- as --- if --- it --- were ---a --- good --- example." If the phrase were to be made any clearer by a slower repetition it would have to be said, "It seems ... ... as if ... ... it were ... ... a good ... ... example." Even people who are shoveling in food and attempt to speak while chewing can be well understood if they speak in the latter manner.

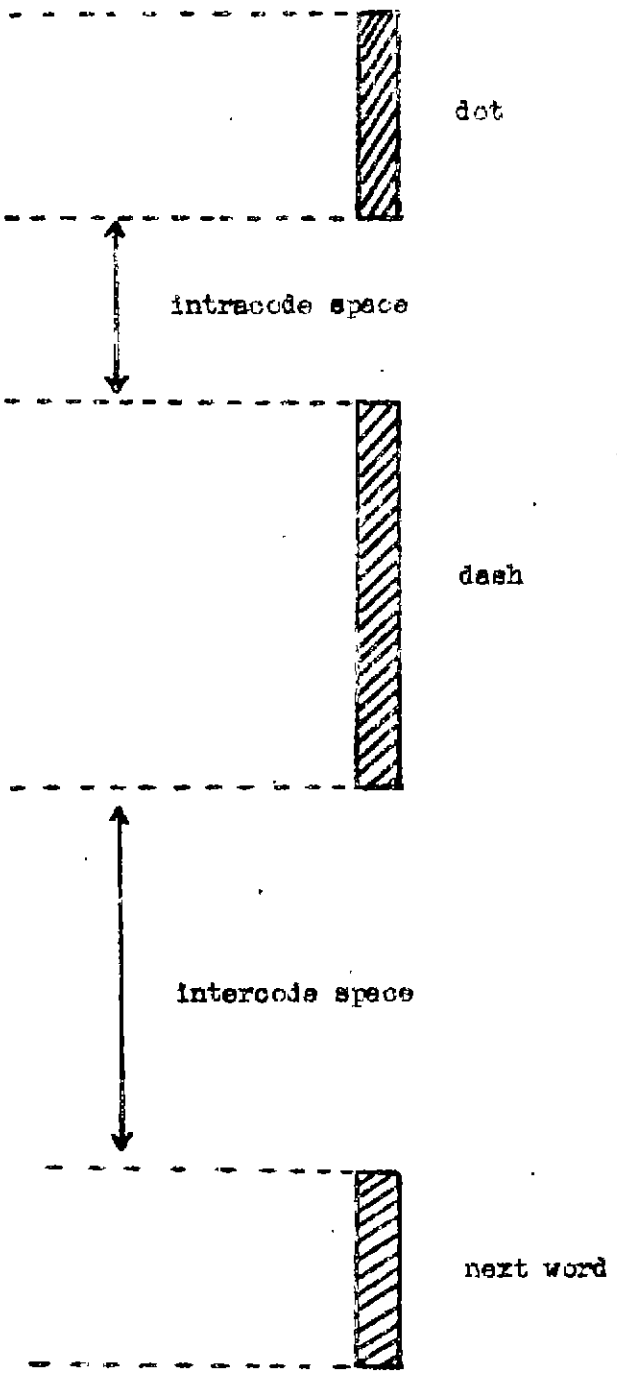

Figure 4a

A similar phenomenon has been demonstrated with respect to message reception. That is, if the message has a certain closure within its structure (one that does not conform to the conventional international standard), slow messages can be received fairly easily; however if the message is uniformly extended as a whole, the accurate reception of the message becomes extremely difficult. For example, if the speed of transmission is reduced to a rate of 25 words per minute, the accuracy of the reception is reduced to 30%; at 50 words per minute, there is 90% accuracy, and only when the rate is above 60 words per minute does the accuracy reach 100%. (Of course, this rate of transmission for these figures is based upon code for a European language.) The data of Koch's experiment are presented in the following figure. (Figure 5).

The general tendency seems to be for people to think that messages that are transmitted at a slow rate are necessarily easy to understand, and that training in message reception must start with a slow rate of transmission and progressively increase in speed. Of course, in a certain sense this method of training is more pleasant than otherwise, at least the beginning of the training period seems easier. In order to make the learning easier in this way it is necessary to lengthen the intercode space. However, if the intercode space is lengthened so that a code with a prolonged intercode space becomes understandable then the student will have difficulty when the rate of transmission is stepped up.

I think we have already touched upon this point in connection with pilot training. To take another familiar example, in learning to play the piano no matter how proficient one claims to have become with one finger, he still is not going to be a skilled pianist. Similarly in learning to use a typewriter, if a beginner attempts to do so by any sort of hunt and peck system, he will not be able to achieve the efficiency of being able to use all ten fingers while keeping the eyes on a manuscript at the side side of the machine. It must be said that the methods employed in learning these techniques 'naturally" differ widely from the psychologically most efficient method, and regardless of how efficient one becomes with these self-styled methods, they are fundamentally inept.

The unfortunate contemporary approach in psychology whereby these techniques become generalized to abstract constructs of playing-the-piano, using-the-typewriter, and receiving-radio-messages, is know as <u>operationism</u>. If one played the piano with only a single finger, regardless of how accomplished he might become in this act, he would be unable to express the richness of a concert of a Kemp or Cortot; after 10 or 20 hour's practice in flying a plane one would be unable to fly in the skilled manner of such war heroes as Bong and having learned the Morse code by flash cards, one is certainly unable to appreciate the psychological activity involved in the message reception of a skilled operator. These acts do not represent merely the first stages along the continuum of mastery of these techniques; they are rather tasks of a fundamentally different nature from the refined technique which they may superficially seem to resemble in form.

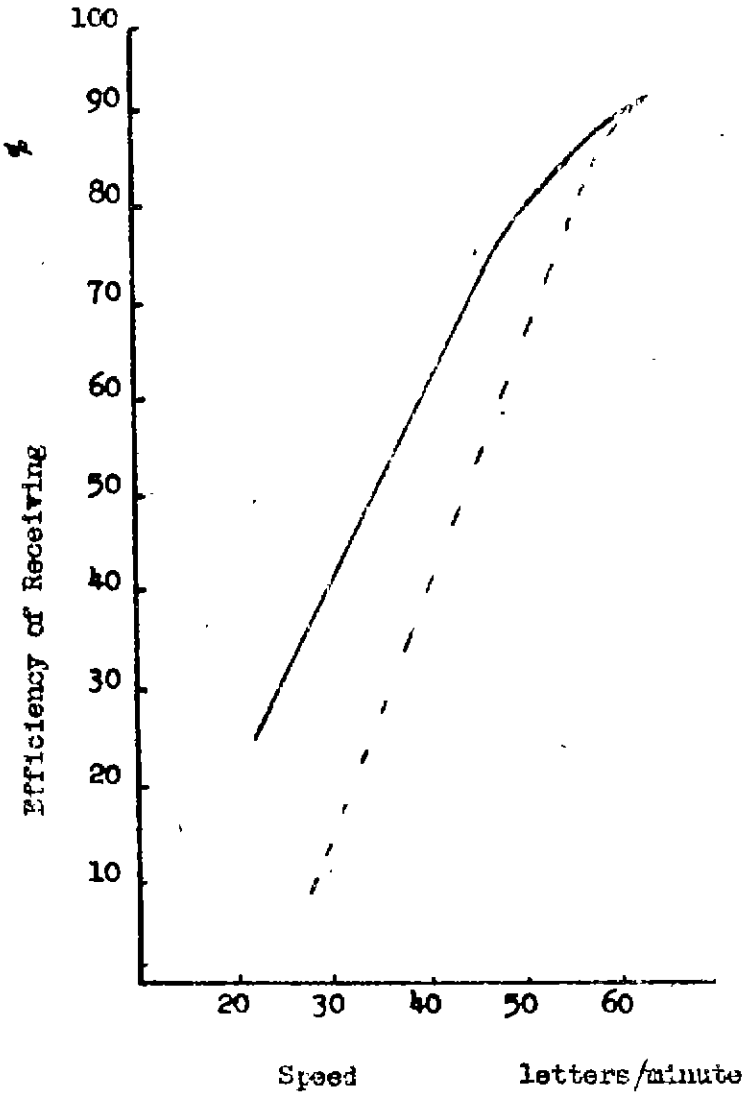
100
90
80
70
60
50
40
30
20
10
%
Efficiency of Receiving
20
30
40
50
60
Speed
letters/minute

FIGURE 5

As one can easily imagine, if in the beginning of message reception training the temporal separation of the individual letters of the message (the intercode space) is prolonged, the learner will make use of the comparatively extended intercode space so that he says to himself 'That was dot-dash, which means it was 'i', and that one was dot-dash, dot-dash, which means it was 'ro.'" In other words, the learner introspects upon the form of the code as it is learned, and he receives his messages by actively calling the meanings of the code symbols to mind. Indeed such a beginner attempts in receiving a message hastily to manipulate some sort of mental notebook and bring the code symbol to mind and check it by this notebook. However as the training period advances, the rate of transmission is gradually increased up to a point at which the code units are coming in such rapid succession that this kind of mental juggling becomes no longer feasible. At this point most learners will fail to continue their increasing proficiency. Here it becomes necessary for the students to adopt a more adequate approach, and to discard the method of reception they had been using up until this time. In other words, even though in both cases we are dealing with the construct "messages-reception," the function has become a different psychological operation.

If one should inquire as to about at what speed of message transmission this change in approach becomes necessary, he would find that according to Koch's study this mental shift takes place at about 60 words per minute. (Of course, this figure is based upon the rate of transmission of a European language. When converted to Japanese code which is necessarily longer due to more complex word structure, this critical rate becomes somewhat slower.) It is indeed interesting that this rate coincides exactly with the lowest rate at which a skilled operator is able to receive with maximum efficiency.

We should expect, therefore, that an extremely efficient method of message receiption training would be to start the training at a rate of transmission of around 60 words per minute. In this way the progress of the training would not become bogged down halfway. This conclusion is one direct consequence of Koch's new theory of learning.

A similar situation is met in foreign language training. In this country foreign language training consists almost entirely of reading lists of words and learning them, so that when foreign words are spoken the word must be recalled and its appropriate meaning brought to light. The fact that this situation is so widespread in Japan can probably be understood in view of the fact that the primary purpose of foreign language training in this country has been to develop skill in reading books for individual progress in learning rather than to acquire a spoken fluency in the language. However as a result of this approach, even though they are often quite proficient in the ability to read foreign books, the Japanese are likely to find speaking a foreign tongue to be quite out of their line. The situation is almost the opposite to the plight of most of the natives of the coastal provinces who although they are able to speak are entirely unable to read. In speech one adopts a characteristic speed of speaking so that in English "it-is-a-dog" sounds like "it's a dog." In order to learn to speak it is necessary to become accustomed to the rhythmic movement of the language as a whole;

indeed it is common knowledge that speech education is particularly essential for Japanese in order to learn to speak well. In speech the sounds of the words must present their meaning directly. There is no time to translate the word by the use of another learned list. A direct grasp of the meaning of the word from the sound is always necessary.

The situation is the same in learning code, and the presentation of code at 25 words a minute is accordingly unsatisfactory. The rate of presentation must be at least above 50 words a minute in order to insure that when the code is understood at this speed it is grasped directly. I repeat, the operator must attain such a degree of proficiency that he pronounces his words in terms of dots and dashes. When the letter "i" is presented to him in code he should repeat it back as "dot-dash" instead of as "i". Conversely when the operator hears the sound "dot-dash" its meaning as "i" should come directly to his mind.

At this point the students in the former communications training programs over the world should have been faced with quite a problem if the speed of message presentation were stepped up to this level. This is, if the students were drilled in the code by the use of flash cards or written material alone, and the speed of message transmission was maintained above 50 words a minute from the start, the students would still have a marked tendency to try to manipulate their "mental notebook" within the intercode space of 50 words a minute. That would indeed probably result only in increasing in vain the confusion of the student.

If one considers the various procedures that have been employed in this country to facilitate the memorizing of code, probably the first method to gain widespread acceptance was the "similar sound method." It was found, for example, that it was easy to learn that "dot-dash" stands for the sound "i" by remembering the common proper name Ito. Then for the code signal "dot-dash dot-dash" which stands for the sound "ro", one recalled the phrase "rojo hoko" (which means "to walk the streets"). For "dash-dot-dot-dot", which stands for "he", one remembers hamonika, (which means harmonica). The method consisted of associating the code signal to the similar rhythm of an appropriate key word. This method was found to lead to rapid learning at the beginning and was put into extensive application.

Another method, called the "dot-dash method", was employed to some extent. By this method the code was rather directly learned by orally repeating such phrases as "'dot-dash' is 'i'." However these phrases were often presented to the student by visual means and, most important, the proper temporal relationships of the code were distorted by the students' slow vocal recitation.

Another method for facilitating the learning of code was referred to in Koch's study; this method he called the "method of visual synthesis." By this method one, two, three, and four dots are lined up below their corresponding letters;

e i s h

these are remembered as "eish." Similarly four dashes are aligned with the corresponding letters of the alphabet. t m o ch which is associated with "tmoch," and again ...v.. is remembered as being the opposite of ..b.... .

A method somewhat similar to the "dot-dash method" is frequently used by high school students. Long series of vocabulary cards are made according to the first letter of the foreign word to be learned; then when the students attempt to recall a word they refer to the associations made with the cards beginning with the appropriate letter. Even though the students are often satisfied with such a roundabout approach, it is hardly a very direct method for learning the language.

Koch has referred to the "method of visual synthesis" as an example of analytical practice and he states the following defects of such an approach.

1. Training in communications operations that involve essentially auditory Gestalten (imagery) should not make use of visual symbolism. (For example, the similar sound method even though it is more devious in its approach is perhaps better in this respect.)

2. Analytical methods require a certain amount of useless tension in always having to anticipate another addition to that part of the code that has already been presented. For example, analytically when one hears --., he does not know whether the signal is --. itself, or whether it is the first part of --.. or of --... . The learner must be ready to bring up the corresponding letters for --.. and --... when he hears --. .

3. When code messages are presented at too slow a rate they do not have the coherence (closure) of codes. Then when a certain speed of transmission is reached closure is effected; the structure of the mental attitude adopted up to that time becomes inappropriate and the learner must change his approach.

4. When the Gestalt of the code is broken apart in this manner it cannot be directly assimilated within man's psychological organization. The fundamental core of these criticisms is basically that in such training the operations of the message reception in the beginning period of practice are of a psychologically different nature than those of later periods of practice.

Then we ask what methods are possible so that message reception training can be initiated at the proper high speed of message presentation, without making use of visual materials or intermediate codes for the mental translation of the message? The answer to this question is the chief contribution of Koch's work.

Koch first allowed his subjects to derive a general impression of what a sending rate of 50 or 60 words per minute entails. To do this he presented the subject a simple code with which they were entirely unfamiliar,

and instead of having them write a corresponding letter to the code, he merely instructed to make a dot on a piece of paper for each code sound he heard.

Then he determined when the students were able to write correctly twenty dots when twenty sounds had been given. If the code they had been receiving up to this time corresponded to the letter "i", at this time he required them to write the letter "i" whenever they heard the sound. In this way the students became able to receive the letter "i" at a sending rate of 50 words per minute without making use of the recall of any mental reference material.

When the students showed they were able to receive correctly at this rate, Koch inserted another code signal into the series of "i's" that were being transmitted with the instructions to record as dots those sounds that were unfamiliar to them. Then when examination of the student's performance disclosed that the dots were correctly placed among the record of "i's," he informed them of the meaning of that new sound, with the instructions to write this new letter when it was received. Thus the students acquired the ability to receive two code letters at a speed of 50 words a minute.

Furthermore this procedure of having the students record as dots code that they did not know led to other beneficial results in later practice periods. Even though a student has become fairly skilled in reception he is bound at first to run across sounds he has forgotten. Previously in this situation the student would lose track of the two or three codes that followed a signal he did not know. When the student has been instructed to record code he doesn't know as dots, that single code alone is lost without influencing the reception of the subsequent signals.

In this manner the individual elements of the code become added to the student's receiving vocabulary. Of course, since even though a code may be once well learned if it is not subsequently practiced it will be forgotten, the old code signals must be reintroduced from time to time while adding on new ones. In doing so the memory span of the student is progressively broadened. The term "memory span" may not be conventionally used here, but the point I am trying to make is that with the increase in the number of tone-images of code that the student acquires, progressive differentiations of the mental set of the response is effected. This is the backbone of Koch's method of message reception training, and since it gives the code only an auditory form it is called the "tone-image" method.

However Koch has also introduced a second training method which makes use of the formation of tone-images (Tonbild). This method he called the "two-tone" method. Ordinarily when we say "dot-dash, dot-dash" out loud, most of us give a different pitch to the dot and the dash and possibly vocalize the two with something of a rhythm. Usually we make the dashes higher (and louder) than the dots. It is quite possible that we do this because the auditory form of the code can be more effectively expressed in that manner. Moreover when the dot-dash code is presented mechanically

the dash seems to be heard as higher (and louder) than the dots even though they have the same frequency of vibration. In other words, since it appears when the code is orally vocalized and also when the code is heard, it can possibly be considered that a higher and stronger dash than a dot conforms to the innate nature of this auditory form, and that such a pattern has the structure of a complete Gestalt.

In view of this fact Koch presented the dots and dashes at different frequency and intensity levels by means of a special message transmission apparatus. Of course, the difference in efficacy between the tone-image and the two-tone methods was by no means as conspicuous as that between tone-image and analytical methods, yet the two-tone method afforded a smoother and more unbroken curve than the other. In Koch's work whereas an average of 27 hours was required to learn the code by the tone-image method, when the two-tone method was used this figure was able to be reduced by three hours. Of course after a certain period of time the two tones are gradually assimilated so that even though two tones are presented as such they are heard as one sound. At this time the code is being grasped by distinct auditory Gestalten.

As for the actual results of Koch's work, it was found that whereas it had previously taken highly motivated non-commissioned officers in German Communications Training Schools from seven to ten weeks of concentrated daily training to learn the code, only 28 half-hour periods over as many days (a total of 14 hours) were required by the new method to reach the same criterion of learning Even taking the lowest figure of seven weeks for the former training method, this means that the training can be shortened to 4/7ths by the tone-image method. This figure is made more striking when it is realized that Koch's subjects, unlike men in communications schools, were men who were not going into communications work and who had other jobs to perform.

The Problem of Communications Training in Japan

When Dr. Koch's work of which I have just spoken was first published in a German journal of applied psychology in 1936, it was immediately seized upon by other investigators because of its theoretical implications.

Koch's results and analysis can be most readily understood as support for many of the current views of contemporary Gestalt Psychology. Then since the theoretical prediction has been so successfully confirmed in practice, Koch's method had immediate appeal; indeed one group of psychologists who, by the way, were not too well informed as to the actual problems faced in communications work, went so far as to propose that a complete reformation of communications training should be undertaken based on this new method. (In this regard the work of Dr. Soichiro Furuki is well known. A New Method Of Communications Training. In "Journal of the Japanese Accustical Society," Vol. 4, No. 5, 1943).

As I have stated above, the two chief training methods employed in this country have been the "similar sound" method and the "dot-dash" method.

The oldest of these is the "dot-dash" method which involves learning code by reading visually dots and dashes reproduced on message receiving tape. This procedure is essentially telegraphic in nature and developed out of the training methods of old cable communications. The code was taken over without change into the auditory signals that became the dots and dashes of radio communication. The inadequacy of the method stems from its basis in visual communication needs.

Then the "similar sound" method is capable of successful application only with a language of the rhythmical structure such as that of Japanese, and it must be said that as far as memorizing code is concerned it leads to early proficiency. However the trouble is that it provides no more than just a memorized code and is hardly an appropriate method to employ in the perfection of the whole of the necessary communications learning. In other words, the fact that "I know a code" is not the same as the fact that "I am able to receive messages." This is entirely analogous to the fact that "I know words" is by no means the same as "I can speak."

However the "similar sound" and "dot-dash" methods did not provide only bad points for the communications training in Japan. With long experience and constant study a great deal of effort was directed towards overcoming the defects in these methods so that in the long run the methods employed many of the conceptions of Gestalt psychology.

Koch's study and its theoretical implications provided considerable grounds for argument when application to the problems of Japanese aviation communications training was considered.

The degree to which these problems had been scientifically investigated by Japanese communications experts can be understood by considering the extremely short time they took to master Koch's method. These men, actually occupied in communications work, more rapidly grasped the concept of "Gestalt" even than those in more purely psychological fields. This fact is clearly due to the actual acquaintance of these communications instructors with the concepts of the so-called "Gestalt" psychology in practice. Perhaps it was that the science of education in Japan had arrived at a level where it had only enough resilience to form a sensitive attitude towards the various psychological theories.

However, there were several difficulties that faced beforehand those who attempted to adopt Koch's "tone-image" method into Japanese communications training. (Army aviation officially adopted this name for Koch's method, however in certain areas it was known as the "auditory" method.)

The first of these difficulties lay in the number of code signals that had to be learned. Unlike the alphabets of other countries that contain in the neighborhood of 26 letters, the Japanese "alphabet", if one considers the syllabery, includes at least 48 figures. Discounting for the moment the possibility of a different type of code, if one thinks in terms of corresponding codes for alphabet and syllabery, the task involved in learning the codes in regard to time and effort could never be considered simply a matter of 26 versus 48. Even though one grant that the separate addition

of new code signals in the linear fashion of Koch's method can be easily done, when the number to be added is increased in this manner to 48 one cannot guarantee that the student will not become terribly confused. Since learning message reception is after all a task of memory, the scope of one's memory quite properly becomes a problem. If the range of human memory extends to 48 letters, then Koch's method is applicable here; however if 48 letters lie beyond man's normal limit, we should not expect to be able to use the method. If the latter situation is the case there is in fact a real difference in the message reception of Japan and that of foreign countries at this point, and it would have to be said that in this instance Japan is at a disadvantage.

The second problem might be termed simply a technical point. The Koch method calls for initiating the reception training at a transmission rate of around 60 code units a minute, however it would be extremely difficult to begin at that speed in Japan. As I have stated before there are many different types of Japanese code, among which there are quite a few of considerable length, so that 60 of these code units amount to an extremely high speed. The beginning student has to do a great deal of hard work at first as it is (although Koch maintains that there are less mistakes than when the training is begun at a lower speed.) The problem remains to determine the appropriate speed at which to initiate this training for learning Japanese code. However such data could be fairly easily recalculated.

With respect to yet a third problem, Koch's method is indeed a rational one but it seems restricted simply to the field of message reception training. In communications training the receiving and sending of messages must be taught concurrently. The physical limitations of the human hand do not permit one to operate his hands at such a speed from the beginning. By the tone-image method one may well be able to receive code at a rate of 50 letters a minute, but he is certainly not able to send the code at such speed as soon as the code is learned. Then if one has to begin sending training at a slow speed, it is certainly due to the fact that it must be learned at that speed; then it is feared that this slower learning will exert a retarding influence on the reception training.

On the whole these three points, especially the first and the third, were problems that had to be faced before the tone-image method could be introduced into Japanese communications training. The solution of these problems became extremely important for the progress of communications training in this country.

In order to determine possible solutions to these problems a group of psychologists and experts in the field of communications training was established to work together in actual training situations; after much study and research an overall solution to the needs of army aviation communications was reached and a new method of training was set up that was in effect a product of the tone-image method.

The methods and procedures followed by which this improvement was made are of course of great interest from a psychological standpoint,

but it is regretable that I am unable to discuss them in detail here. Here I must content myself with simply a single aspect of these results.

Let us review the advantages of a tone-image method of communications training.

The first point is that by means of this method code can be easily and rapidly learned right up to the limit of the individual memory scope. For instance, the complex and difficult numerical-abbreviations code so widely used in military communications is acquired far quicker than the general public would imagine. Since the main duty of many radio operators involves the use of the numerical abbreviations code, it is possible to give all operators a general knowledge of the code, and not to have to train specialists for that purpose. This point has led to increased motivation and self-confidence in learning code.

The second advantage of the tone-image method is that it facilitates the memory of the messages that are received. When the analytical methods that depend on visual images or on the verbal relationships of similar sounds are utilized to learn the code, by the time the code has been translated and written down as a message a relatively complicated mental procedure has become involved, so that considerable difficulty is met in attempting to remember the message. Take for example the old poem

Kara goro mo
Kitsutsu nare nishi
Tsumashiareba
Harubaru ki muru
Tabi o shizoomou.*

In this poem a traveler is unable to control his tears of longing for home. Yet in particular he is thinking of iris. How so? If one looks at the initial sound of each line of the poem he will see that they spell the word iris - kakitsuhata. If a fellow traveler did not receive such an explanation after hearing the poem, he would probably indeed not realize that the poem was written about iris. Now if this poem were learned by the previous message reception methods, it would involve some such complicated and devious means as trying to remember "kakitsuhata." Then the similar sound method would have this "kakitsuhata" learned by saying, "katoseki, kiite ho kaku, tsu go do ka, hamonika, taru."** In the tone-image method the dots and dashes take the place of words in communication.

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* It is not easy
For one who in duty wanders abroad
To think of the things
He has left in his homeland.

** The meanings of these words are respectively "Third class train ticket," "Report it when you hear it," "How convenient is it?" "harmonica," "tar".

When the students' names are spoken, it is by means of dots and dashes. Even the newspapers are read to them in dots and dashes, and by hearing these dots and dashes they become able to understand the contents of the newspaper. In other words, as I have said before word meaning and code are directly linked together. Spoken sounds become the sounds of radio code. Accordingly there are those who refer to this new method of training as the "direct method." By this kind of method men are trained to remember messages of over one hundred letters who previously could not have even imagined such an accomplishment.

A third advantage of the tone-image method is that it makes it possible for the radio operator to do two things at once. When receiving messages in accordance with the former analytical methods, it was necessary for the radio operator to focus all of his attention on the reception of messages so that he was unable to keep an eye on other tasks at the same time. We have found that by our new method men can be trained to carry out message reception so directly and automatically that if outside questions are asked the operator while he is receiving, he will be able to both answer the questions and to receive without error. Formerly, when using the similar sound method, for example, it was necessary to make a "mental vocalization" of the code as it was received. Then, since it was impossible to vocalize two words at once, the operator was unable to attend to anything else while receiving messages. However with the direct method of training it becomes possible to perform two tasks at once, just as students are able to think of other things while correctly taking down notes from the lectures of certain professors. The ability to perform this double duty makes the direct method of training extremely profitable for the needs of air communications where one can well imagine that a great deal of disturbing conditions come into play.

The fourth advantage of the tone-image method of training is that it greatly facilitates the qualifications testing for communications personnel. This fact has been consistently emphasized by Koch himself in his papers; he felt that if applicants are tested for progress after an hour's training in message reception, a valid measure of their potential qualifications as radio operators would be given. Formerly a collection of various mental operations that seemed to be related to communications work was assembled and issued to applicants as an aptitude test, however as I have already indicated, even though a great deal of effort was spent in this field, no real success could be claimed by the investigators. Moreover, since the psychological nature of the operations of message reception during the first part of training was different from that of the later part, even though they constructed the aptitude tests to resemble the operations of one part of communications training, they were unable to establish any reliable correlation for the test scores with actual performance in the other part of training so that they could not devise an aptitude test that measured the essential components of message reception training as a whole.

However, since the training in the early and advanced stages by the tone-image method is psychologically the same, it is possible to sample the whole of the training period by reproducing a small portion of the beginning period. One can readily understand how we can account for the

good results of our testing program. If a student wants to prepare himself beforehand for this aptitude test it would be necessary for him to prepare in accordance with this type of test. Just as the applicant performs on this aptitude test, so he should progress in actual training. But those who attempt to excell in early training with an eye to more advanced work and who practice by themselves the similar sound method or make use of dot-dash flash cards, should find that they are exerting a negative influence upon their future training. Even though one study on his own the phonetic symbols of a foreign language, he will not by this alone become able to acquire the proper accent of the language.

On the whole, the above considerations indicate the general nature of the advantages of the tone-image method of communications training.

Of course it should seem proper to everyone that a new method of training is put into practical application on the basis of the reasoning of psychological theory or of the results of scientific experimentation. However, until this method becomes proven a success in practice it is necessary for those who have the responsibility for the change to maintain great confidence and courage. I perticularly wish to point out that the process of introducing a new technical method into practical application and watching it develop into a successful tool for human progress, affords a great personal reward both to the theorists who devised the technique and to the expert practitioners in the field who guided its use.

It is impossible to deny the fact that the design of the tone-image method of communications training as a usable Japanese technique has been such a source of personal reward to the military psychology of our country.

In the first place let us try to consider the tone-image method from the standpoint of the actual communications instructors, whom we should properly call the technical experts in communications work. These instructors had already adopted a method of training which they had built up through long years of experience. Still even though the instructors employed these methods and sought continually to improve in their use, there was considerable need for even greater progress towards efficiency. However the tone-image method of training as I have outlined it here is no simple improvement of the former techniques, even though the previous effort of the instructors had been in that direction. The new method is more on the order of a different approach to training, and when it came suddenly to being forced into use, it became necessary to discard with seeming impudence the ways of thinking that had been held up till that time. Still even though there has been considerable confidence in this new method by those who based its design upon psychological theory, with just this confidence alone the new method cannot be put into successful practical application. That is to say, it is necessary for all concerned to develop sufficient understanding and insight into the operation of this new method; this fact probably involves a more rigorous "scientific approach" to the practical problems that are met by the instructors in the field. Without this understanding the training method could be only partially carried out and instead of the situation being improved by the technique, it would end simply in becoming unmanageable.

The success of the new method requires the adoption of a scientific outlook on the part of the practicners towards the field of psychology and the effort to demonstrate by scientific experimentation the principles that underlie the insight derived from experience; only in this way can the efforts of military psychology be properly directed.

In the second place let us consider the introduction of this new technique from the standpoint of the psychologist. The psychologist has an attitude of complete confidence in the belief that that which he advocates is theoretically sound; that is, he has confidence that if his theoretical analysis is applied to the practical situation it will lead to increased efficiency. When the theory is in someway related to army aviation and something were to go wrong in its practical application due to lack of internal confidence, the matter would not stop at being a question only of the honor of the psychologist; it would equally as much materially weaken the air fighting power of our country. As far as military psychology is concerned even though it is sound in theory, if it cannot be successfully applied in practice, the psychologist is not able merely to sit back and say "Well, at least it's a sensible theory." In that it is military psychology, the structure of its theory must satisfy the practical situation to be confronted. When theory and practice are separate so that they stand in abstraction opposed to one another there can be no military psychology.

However in most circumstances psychologists are not directly engaged in the activity they investigate. Of course it is not always necessary for them to have immediate first hand experience with the practical problem with which they deal or, in this case, to become the head training instructors themselves; but there are some who think that it is not possible to grasp the nucleus of the problem by handling an essentially practical problem theoretically alone without going into the work from the experience level. Yet if such were the case, it would not suffice for the psychologist even to have ten or twenty bodies. In short it is necessary for the psychologist to grasp the practical problem psychologically, and for the instructor to grasp the problem from a practical approach. Then if the assigned task is diligently performed by each group and a maximum effort is exerted by each to understand the problems of the other, the endeavor can result in a theoretically sound solution to the problem that is effective from the practical standpoint.

For this reason it was necessary for the psychologist to enter the actual training situation. Instructor and psychologist worked together; and it was indeed due to the fact that they handled problems together as they arose that the application of the new theory was successful. Only when this attitude was adopted could the new method be initiated with confidence of success; and the fact that the new method proved to be successful was indeed a great personal reward to the psychologists who are often not considered to be "practical" men.

The third source of personal reward from this new method of training, the rationalization of instruction, is something that cannot be achieved unless a real burden is accepted by the instructor. Yet "instruction"

and "rationalization" seem on first inspection to be incongrous. The activity of instruction is not something that can be carried out by separate individuals for themselves. Teaching and learning combine together to make up instruction, and proper instruction is the most appropriate adjustment between both teaching and learning. Formerly it often happened that if after a certain amount of training there were students who failed to acquire a certain standard of performance, it was assumed that the effort of the students had not been sufficient. Of course, the conscientious army instructors insist that such attitudes were not held among them, and it is a source of much personal pride that this was proved to be the case.

In the previous method of communications training, for example, the similar-sounds method, the student applied his own energy to learning the code even though it required passing his spare time in thumbing flash cards and studying, and attempting oral recitation of the material. The instructor was able to make much use of such student effort. However if the training is of the tone-image type, outside practice is likely only to damage the efficacy of the training, especially if the student makes use of such self styled methods of learning as I have mentioned above. Therefore the instructor must assume a greater responsibility for the progress of his class. Here strict scientific planning becomes essential, and especially when dealing with additional instruction for those who due to inherent defects do not achieve proficiency as rapidly as others, scientific guidance is necessary in order for the psychological efficiency of his instruction not to be destroyed. This burden must be taken upon themselves by the instructors.

Actually the increased efficiency of the instruction and the progressive rationalization of training are not measured in terms of the lightened physical and mental effort required of the instructors. Even though the effort of the instructors is possibly increased, the measurement of improvement lies in the increased ability of those instructed. An increase of instructor load, if it is scientifically and logically systematized, must be called a rationalization of instruction. The fact that this was demonstrated by the instructors is indeed a source of great personal reward. One can easily feel that such an attitude on the point of the instructor is automatically reflected in the learning approach of the students in training.

Those that feel that a "rational" or "scientific" approach to instruction will obliterate the emotional bond between the student and instructor are certainly lacking in aptitude for teaching. The scientific and rational approach to instruction has at its very basis a proper understanding of the mental attitude of the student by the instructor; this approach warms this affection between student and teacher, it never kills it. A genuine personal bond is possible only upon the basis of such an understanding.

Then one must say that even though the instructor performs his duty with the proper scientific spirit and approach, it is necessary for the student to follow the guidance of his instructor in good faith. Only with this faith can the training be carried out. I wonder if one cannot say indeed that this is progressive training. To take an illustration, if a

student who is more adept at visual than audial imagery attempts to make use of visual training aids without the knowledge of his instructor, it does not take a skilled instructor long to detect the influence of this practice upon the performance of the student. If there is a poor adjustment between the attitude of him who learns and him who teaches, the teaching or learning as such is not affected alone, but the whole of the mental cooperation that is involved in education becomes destroyed and meaningless, and nothing is accomplished. A proper realization of the scientific and psychological outlook as well as the personality attributes of the instructor, become thus the premise of successful training.

Several Problems Related to Communications

There are probably a great many problems in Japanese communications training that remain to be discussed, but I shall take up here only two or three that come to mind at the moment.

The large number of code signals employed in Japanese communication offers one source of difficulty. This has long been a heavy burden to communications training in our country and for this reason it demands consideration in some detail. Because of the number of code units the tone-image method of message reception training could not be imported just as it was to Japan. Then as I have pointed out before, it is not just the number of code units but the long and complex code signals that the code demands that present a difficulty to us. However, these problems are natural enough considering the structure of our language.

Yet one could never say that it would not be to our advantage to relieve ourselves of this burden if we can. The code we use has a structure that was not designed for rapid communication in this country. This is due to the fact that our code is a direct adaptation of the European morse code.

However, are there any particular reasons why Japan should not alleviate the problems that so beset its communications training? I should not care to believe that there is no possibility of doing so. I should like to present in the next few pages a few ideas concerning this subject which I have picked up from here and there.

It is true that the number of code units employed in Japanese communications is many, but this fact is clearly due to the fact that in our language we make use of fifty basic sounds. The arrangement of these fifty sounds differs from the alphabets of other countries in that it follows a logical and systematic order. The Japanese syllabery is constructed of five files of ten ranks each. The ranks go "a, i, u, e, o; ka, ki, ku, ke, ko; sa, si, su, se, so;" etc. and the first file goes, "a, ka, sa, ta, na, ha, ma, ya, ra, wa." Thus it would seem that if one could designate the rank and file in some manner, only around 15 code units would then be necessary. One can indicate ku by saying the third file in the ka rank, or the u file in the ka rank. This system becomes possible only when there is a systematic syllabery such as in Japanese; obviously the method could not be used with a foreign alphabet.

In the first place the task of learning a code of fifteen or twenty words can be accomplished in an extremely short while. That is, such code as the numerical abbreviations code so widely used in military communications but which cannot be disclosed in detail here can be acquired in an extremely short time. Therefore it would be an exceedingly easy task for the student to learn Japanese code if the fifty sounds were based on some simple code such as the numerical abbreviations system. Of course the strong point of this method becomes at once its weak point. The advantage of the method lies in the fact that if one can receive a memorized list of certain critical code numbers, then he is capable of receiving Japanese words. Then by merely writing down these critical numbers, one is able to translate the message into Japanese words at a later time. This method would probably serve the purpose of providing a rudimentary code that can be easily learned if necessary. However, as I have said, this advantage is at the same time, the disadvantage of the method. Now instead of having a "similar sound" method, we have a "similar number" method that is fairly easy to acquire. Since in this method the mental impression of the critical numbers must be rather clear, it should exert a considerable influence upon the message reception; due to the devious introspective translation of the code in terms of the corresponding sounds for the critical numbers, a direct union of the code as heard and its meaning would be impaired. This may prove to be a serious weak point in the method.

A second advantage of such a modification of Japanese code lies in the fact that since the structure of the code would be extremely simplified, a comparable step up of the possibilities for improved automatic transmitting devices would naturally follow. Such possibilities point the way for increased mechanization of the remaining human operations that are still necessary in the receiving and transmission of communications. Perhaps indeed such an alteration in code would lead even to the simplification of the automatic receiving apparatus that we have, and many of the other operations now carried out by human mental and physical work might become mechanized and automatized to a certain degree.

I may be retracing my steps a bit, but when we say that the Japanese communications code is long, we refer only to the code when viewing each code unit individually; by no means do we imply that a large number of words is necessarily contained in a given sentence. Indeed one could hardly think of the Japanese communications language as being further reduced by any considerable extent. Of course a phonetic translation of Japanese words often requires the use of the two nigori marks; when the twenty five sounds that are occluded by nigori marks are added to the syllabery, a total of seventy five sounds is obtained. If these sounds were added as such to the critical numbers of the code, a considerable complication would result. However if another rank of "ga, za, da, ba, and pa" were added, the forthcoming complication would probably be no more than that imposed upon the German communications code in the umlauted ä, ö, and ü.

It must indeed be said that the suggestion stated above is for the most part an academic proposition and that any actual application of the plan would necessitate a considerable amount of experimental study. Furthermore, to effect such a complete change at this time would undoubtedly lead

to a temporary impairment of the efficiency of the war effort of communications as a whole and to unnecessary confusion. Yet this seems to me a problem that might quite profitably be taken up in the future.

We have seen that with thorough training in the tone-image method of communications instruction, the sound of the code and the corresponding meaning of the word become directly joined together. In this case the differences in accent that in certain cases determine the meaning of the word would seem not to be mentally vocalized between the sound reception and the perception of its meaning. The practice of vocalizing the message implicitly while listening to code is not common in the actual message reception itself, but occurs only in attempting to memorize the message that was received. Yet it appears that certain types of persons and others who have been trained by some methods do not depend upon a mental subvocalization of the message but upon the visual image of the words, in memorizing a message they have received.

If such is the situation, one might well imagine that the dialect of the radio operator might become a considerable problem in message reception; an indiscriminate use of i's and e's, or of su's and shi's, for example, might well lead to impaired efficiency of the communication. To begin with the confusion of i's and e's, and su's and shi's is extremely common, and when these errors are made simply in crude speech, the offender often escapes with no more than a smile. But in military communication where the error of a single letter may be critical, and particularly in cryptographic work, those who are subject to such confusion simply are not qualified to be communications operators. However if the union between the sound of the code and the meaning of the message is direct, as in the tone-image method, this problem is so greatly modified that it probably would become unnecessary to carry out programs for the correction of a dialect during training. I wonder if this is actually so far beyond the realm of possible execution.

Another of the advantages of the direct union between code and meaning that is afforded by the tone-image method lies in the fact that it would probably facilitate the mastery of foreign language code. While it is certainly not absolutely necessary for a radio operator to know foreign languages, it is a decided advantage if he is able to recognize and set down messages in foreign code that he may pick up. It is for this reason that we take into consideration the ability of the operator to receive foreign code.

The superiority of the tone-image method of training in this respect can easily be demonstrated. When an operator trained by the tone-image method and one who received some other kind of training succeed in effecting a direct union between the code and its meaning, they can then quite easily study the code of foreign countries. Since a comparison of the learning ability of the two types of operators reveals the greater skill of the one trained by the tone-image method, another advantage of the tone-image method becomes apparent.

Then it has become necessary for Japan to have many communications operators who have mastered the communications of European languages as

well as their own. This is due to the fact that reciprocal communication in both tongues has become temporarily necessary between various nations within the Greater East Asia Coprosperity Sphere. Even if one regard only the number of code signals involved, once an operator has mastered Japanese code the communication systems of other countries is relatively easy. Of course one is unable to make a comparison with European and American operators with regard to learning our language and code. The decided advantage of the tone-image method is becoming progressively more apparent as the needs for its application arise.

Furthermore, even though I may wander from the immediate field of communications training, I wonder if the principles stated above in connection with the tone-image method may not shed some light upon the contemporary problems of using the romanized script in Japan and in employing raised dots for the blind. They probably bear some relation also to the matter of a conventional manner of writing proper names. That is, I feel that the problems of the perception of form faced in the tone-image method touch upon those problems related to the most comprehensible arrangement of signs in the visual and tactual as well as the auditory sense department.

The Selection of Communications Personnel

I have already stated that Koch's method of message reception training lends itself readily to adaptation as a suitable aptitude test for the selection of communications training personnel. However the form of the test as Koch advocates it is essentially a measure of the ability to learn to receive messages and to make the proper writing movements in recording these messages and as such covers only one aspect of the necessary qualifications for a radio operator. In order for a radio aptitude test to be adequate at all, it must take some account of the applicants aptitude for sending messages.

Practical experience in training radio operators has shown that of sending and receiving, it is usually more difficult to instruct the trainees in proper message transmission. Thus quite naturally sending ability becomes an important problem for the radio aptitude test constructor. If a large group of testees that have had no experience in message transmission are required to make the hand movements involved in sending code, it will be observed that some men will operate the key with primarily movements from the wrist whereas others will attempt to do so moving the arm as a unit from the shoulder. The difference between the two is immediately striking. However even the latter become skilled in proper wrist movement after a training period in which the appropriate wrist movements are instructed. The basis for this difference may lie in the anatomical structure of the wrist and fingers, and even though this difference is not precisely known there are those that maintain that persons with actual training experience can tell the aptitude of a trainee by simply looking at his hands. These problems are indeed very interesting, but we must venture to spare their consideration here.

Since audition occupies first of all such an important role in communications work it might be considered that a certain minimum auditory capacity

is a necessary qualification. However, I wonder if the problem of whether one is or is not able to perform radio work should be considered a matter of capacity. Of course it is a premise to grasping tone-images that one be able to grasp the underlying auditory stimulus, however receiving tone-images in not hearing itself. There are many persons who although they have excellent hearing are said to have amusia, and conversely it is possible to become a musician even though one's hearing be defective. Only to the degree that it determines whether the radio tone is audible or not can auditory capacity be considered a fundamental problem in the selection of radio personnel. One should recall the fact that even though his hearing capacity is relatively constant complex sounds are understood over the telephone when they are familiar and not if their form is strange to the listener. One must not confuse audition with the perception of auditory forms; herein lies the difference between the concepts of capacity and aptitude.

Certainly if one is deaf he will not be able to receive messages; this is a proven scientific fact. However, it is undoubtedly incorrect to believe that good hearing and deafness are opposite poles of a single continuum of auditory ability. That is to say, there are several different aspects in which hearing can be impaired. The first of these, psychologically speaking, is hearing strength. Differences in hearing strength are illustrated, for example, by the fact that whereas a normal person can hear a particular sound at a distance of 5 yards from the source, a person with defective strength of hearing may have to be 3 yards from the sound source in order to hear it. The second impairment of hearing ability is commonly known as partial deafness. Many partially deaf individuals are able to hear as well as persons with normal hearing for low frequency tones but find themselves unable to hear sounds of high frequency. The human hearing apparatus is so constructed that man has a normal audible frequency range of from 16 to 20,000 cycles per second; but partially deaf persons often have a reduction of the upper limit of this range. Partial deafness can be compared in many respects to color blindness. In the third instance, speaking from experiences common to all, there is what is known as functional deafness. Among the functionally deaf are those who when spoken to seem as if the sound had never entered their ears, or who even though they appear to have heard the sound, fail to understand its meaning. The three points made above must be considered when talking in terms of decreased hearing ability.

In communications work if the loss of hearing strength is slight, it should probably be of little consequence so far as one's ability to do radio work in concerned. Much more important as a problem is the seeming inability to grasp auditory forms. The situation is much the same with regard to the second type of impairment--partial deafness. I can point to the example of a man with partial deafness who is at present an important specialist in radio communications and who has never found his deficiency a handicap to good work. It has moreover been experimentally determined that many flyers become partially deaf at high altitudes. The third type of deafness is of course particularly undesirable in message reception work.

These concepts above limit consideration of capacity or lack of capacity far more than other personality characteristics, especially in contrast to the ability to comprehend auditory forms, and one should probably not disregard a man of talent because of a slight deficiency in hearing capacity. Such factors have often been recognized as exerting a strong influence on the accomplishment of those who later become outstanding in achievement, and in handling problems of this nature we come to see the difference between the concepts of capacity and aptitude. Capacity is determined by the discrete nature of possibility and impossibility, whereas aptitude falls along a continuum from suitability to unsuitability; it must be further pointed out that the devices used to measure these two concepts should be entirely different to start with.

We must yet consider another matter in relation to the qualifications selection of communications operators. This point concerns the fact that just as is the case in pilot training those persons whose performance falls below a certain level of proficiency must not be maintained in training even though they have already received a considerable amount of the training program. A single man of inferior ability in a training program does not only show poor performance in his work but he also exerts a detrimental influence upon the functioning of the training group as a whole. To illustrate, even though ninety-nine men out of a group of one hundred student radio operators are able to send and receive code at a rate of 100 letters a minute, if one of the group is unable to send above a rate of 60 letters a minute, the other ninety-nine students are unable to manifest a performance of more than 60 words even though they have the ability to do 100 words. A few inferior students force the performance of the group as a whole down to their level; for this reason the bottom limit of the radio qualifications test becomes a matter of extreme importance. Of course the same thing can be said of other specialized training units, but since in communications work a net of communications is formed by the direct association of one operator with another, the influence of poor men is directly expressed. Therefore in the selection of radio operators the bottom acceptible limit of the aptitude scale must be made as high as possible; indeed more than that this minimum performance can never be so high that it does not lead to an increase in communications efficiency.

For this reason the problem of a qualifications test takes the form of a qualifications examination since it is not necessary that the distribution of test scores fall along a Gaussian normal distribution curve. Those whose scores are higher than a predetermined standard can be impartially selected and they can be designated suitable as a group. This means that the qualifications test is methodologically similar to a capacity test. Similarly in testing the progress of the students in training, the number of errors and omissions per thousand words can be determined and a certain minimum standard for excellence set up; then small deviations in performance above this minimum level are of no particular importance. In this way an adequate gauge of performance is afforded.

We have considered above the qualifications related to radio operation in so far as the communications techniques as techniques were concerned

However technicians are not merely mechanical beings that perform functions automatically; we must remember that in communications work, as in piloting, the technique is successfully acquired only by adapting the whole personality to the nature of the work involved.

Communications work differs from other types of work in its continuity. Even when the code messages are coming in from morning to night as fast as one can flick with his thumb the teeth of a comb, the radio operator cannot afford to miss a single one; and when the messages come in as slowly as one a day, the operator must be ready to take note of it. The operator thus has little control himself over the work he has to do. For this reason those employed in such work must continuously discipline their spirit. The strong sense of responsibility that is necessary for this kind of work is not derived from the pressure of external surroundings but from an inwardly directed power of persistence. Here there is no room for weak vacillations of the will.

Because of this communications work is often solitary work. The radio operator is not apt to have an immediate supervisor and but few companions. A single unit is formed out of a small number of men. These widely separated units are mutually coordinated only by the chain of radio waves. Then just as they are widely separated in space, the units are separated psychologically. Yet these operators are not weakened by feelings of loneliness; instead they have established a firm spiritual union that far surpasses the imagination of the ordinary person. Here it is necessary for them to hold a stong sense of responsibility.

Furthermore as I have stated before, the influence of a single inferior operator is such that his negligence has a broad effect upon the scope of the relationship between the units as a whole. Accordingly with respect to his ability each man naturally feels a great responsibility towards himself, and by this sense of responsibility the awareness of their common brotherhood is strengthened and the obstacle presented by the long distances of seperation is surmounted.

Wherever there is aviation, there must inevitably be radio activity. It is by no means an exaggeration to state that all aerial judgments and expressions of will must be transmitted through the mediation of the hand and ear of the radio communications operator. Even the last Banzai of those who depart is commuted to their hands.

Although it is possible to analyze in terms of separate individual "abilities" the various techniques that underlie the operation of the instruments of communication and the skillful transmission and reception of messages, if one considers the great responsibility that rests upon the shoulders of the radio operators it becomes impossible to regard the qualifications upon which communications training depend as abstract abilities separate from the overall structure of their personality.

CHAPTER V

THE PSYCHOLOGY OF PREPARATION

There are indeed many types of jobs that are fundamentally preparatory in nature. It is generally considered by the public that those workers engaged in preparatory work are for the most part limited to the ground crew that directly handles the plane such as the engine mechanic, or the metal worker, or the electrician; however, the work of preparation extends in actuality all the way from the ground crew attached to a particular plane in the front lines to the men at work in the arsenals to the rear. Therefore we should expect it to be of considerable difficulty to attempt to grasp within a single framework of principles the unique characteristics of preparatory work from the standpoint of occupational psychology. The topics that have now come to be contained within the field of occupational psychology were at one time chiefly the problems of training or of personnel selection which accordingly determined by the type of techniques involved the nature of the preparatory work upon which they depended. However, occupational psychology has revealed that all the persons associated with such work have a common mind as preparers and that they have adopted a mutual spirit of preparation. These persons take great pride in the nature of their work as being essentially preparatory and are mutually joined by a common spirit. Thus one should expect this work to have a powerful internal psychological force that permeates all that are engaged in its activities.

The General Characteristics of Preparatory Work

In what ways, then, does the work of preparation differ from that of piloting a plane or of sending and receiving radio communications messages?

Perhaps the fundamental factor that differentiates the psychological nature of preparatory work from that of the other aforementioned types of work is the fact that preparatory work is primarily regulated by the quantity of work to be done, and that it is only secondarily controlled by temporal considerations. Contemporary psychology has found much use for the concepts work-limited and time-limited; just as piloting and radio work are time-limited in that they fall within an area of work that is essentially regulated by temporal factors, so is the work of preparation work-limited in that it is primarily controlled by the quantity of the task to be performed and is time-limited only after the desired quantity and quality of the work has been achieved. In other words, as I have said before the acts and operations involved in piloting must be perfected to a certain degree. If the acts are dull and slow so that the operations are not performed within a certain predetermined period of time it is simply impossible to fly. When one is playing music even though the rise and fall of successive notes is correctly executed, the performance is not music unless the proper time relationships between the notes is maintained. However, the nature of preparatory work does not permit that it depend upon variations in the accent and rhythm of the work. Of course, the very nature of aviation would indicate that speed in its preparatory work is desired, but this hardly more than saying that in almost any type of work the sooner it is done the better.

This characteristic of being work-limited is fundamental to the work of preparation, and it leads to several important factors that differentiate this type of work from the jobs involved in piloting and radio communication. Because preparatory work is work-limited, it is progressively being divided into a larger number of separate jobs. These in turn are divided into a group of other separate tasks. When one of these particular divisions is mechanized only the function of that unit becomes automatic, and that unit only will show the marked increase in efficiency. Therefore we see that the unit occupations are formed according to the particular characteristics of the work differentiation and they must each be carried out in the manner that happens to be most appropriate to them. The way in which these different unit occupations are composed then depends upon the fundamental nature of the work to be done. Due to this fact many circumstances arise where the work-goal to be accomplished can be achieved by the cooperative efforts of many men acting together. Furthermore, due to this fact the qualifications of the necessary workers can be subdivided into appropriate groups, so that those individuals who seem to excell in a particular ability can be directed into that type of unit occupation where this ability can be most effectively utilized. If the division and allotment of unit occupations within such preparatory work is not adequately made so that instead the workers must be suited to performance of the work as a whole, the general output efficiency of the work is correspondingly lowered. It has appeared that as the organization and mechanization of the preparatory needs of aviation has increased the clear differentiation of the required work has increased proportionately.

We see, then, that preparatory work is of such a nature that it can be easily subdivided into various unit occupations; these unit occupations are commonly known as the "basic craft skills." The basic craft skills include, for example, such tasks as chipping metal work, fastening bolts, plaiting rope, washing, and making lacquer ware; these skills must be learned and mastered just as other arts. However if the divisions of this work are precise and distinct, they can be independently performed and automatically executed so that some of the functions that once had to be mastered by man can be carried out in substitution by machines. Many of the machines with which we are now all familiar were designed to serve such a function. When certain parts of the work are mechanically allocated in this way the portion of the work that requires mastery is diminished, and the intellectual capacity to handle machines becomes correspondingly more important. We shall probably refer to this point again later. Among those who are employed in work directly related to aviation there are many who are engaged for the most part in such unit occupations, especially if one include here those persons associated with the airplane industry.

However, not all of the work that is preparatory in nature consists merely of simple basic craft skills that can be neatly subdivided into functional units either to be mastered or mechanized. There are also compound occupations that are composed of fixed patterns of these unit occupations or basic craft skills. The established order of the basic craft skills involved is dependent upon the structure of the particular object that is being dealt with, and in this way an understanding of the

machines involved becomes necessary These jobs are concerned chiefly with method or formula, and understanding rather than mastery becomes necessary. For example, the job of engine disassembly and assembly consists primarily in understanding the functional construction of a mechanical compound and in performing the necessary basic craft skills in an appropriate order. Such occupations we shall term basic preparatory techniques (methods), and the basic preparatory techniques become a problem of appropriate or inappropriate basic craft skills and a correct or incorrect working order, as opposed to the problem of workmanship and mastery in the case of the basic craft skills themselves.

Basic preparatory techniques have a certain fixed structure in the order of their basic craft skills and as such represent preparatory work as a pure formula, however much of the work of preparation does not have this kind of purity of organization. Preparatory work also includes a type of occupation that might be termed conditional preparatory techniques. Such occupations require an understanding of the present condition of the machine with which one is working and the subsequent directed effort that is adapted to this condition. For example, the inspection and maintenance of the planes in a flying outfit are conditional preparatory techniques that require the organization of many basic preparatory techniques and basic craft skills that have been selected and apportioned according to the immediate needs. Even though an airplane may be used every day over a long period of time it is never the same airplane twice; each day it presents a completely different set of conditions to the maintenance crew. In production many airplanes are constructed by a scientific process to conform to rigid standards of identical maximum capacity, however, in use they each manifest characteristic differences. Thus we see that such conditional preparatory techniques as plane inspection and maintenance can be efficiently carried out mechanically only with extreme difficulty.

From the above discussion we see that with basic craft skills mastery or mechanization is necessary for adequate performance of the work involved. Then, in the basic preparatory techniques intelligent reasoning becomes necessary in order to carry out both the correct order of basic craft skills and the skillful performance of these operations; in other words intelligence is necessary in order not to do the wrong work -- even though degrees of functional dexterity are involved, in the basic craft skills it is somewhat difficult to perform the wrong work. But we see that in the conditional preparatory techniques reasoning ability and intelligence (together with perspicacity and patience) become even more necessary.

In aviation the jobs of supply and preparation of planes has been largely divided into the separate aspects of production and maintenance, and on the whole it can be said that in these occupations the emphasis is more upon steadfast, accurate, and reliable work than upon skilled or adroit performance.

In order then that the work of preparation can be most accurately and reliably executed, it becomes necessary to establish a pattern or formula for the work, just as was the case with piloting; those operations of the work that are without form must be pressed into a formula, and a

precise working order for the basic crafts skills determined. In the most efficient preparatory work an appropriate ordering of the basic craft skills will be accompanied by skillful performance of the unit occupations involved. However as our technology progresses the unit occupations become more clearly specialized, and when the unit occupations become mechanized the mastery that had been necessary up till that time becomes superfluous. Since the techniques then involved are concerned with handling mechanical and automatic equipment, the "expert" who has perfected a simple art is reduced in value. We have seen that even in the technique of piloting a differentiation of the techniques involved has resulted in increased mechanization and automatization of function, however this differentiation is probably of a different nature than that of preparatory work, so that even greater mechanization is anticipated in the future. Indeed there is a great need for such progress. Much of what is now "intuition" must become scientific procedure.

We have come to see, then, that the work of preparation can be divided into basic craft skills, basic preparatory techniques and conditional preparatory techniques according to the particular characteristics of the work involved and its differentiation into specialized parts. We shall next attempt to consider the various working attitudes that underlie these types of occupations.

The Attitude Towards Preparations Work

The first attitude we shall consider is that of those who must repetitively perform the unit occupations of the basic craft skills. Since the work of these men has become automatic to a considerable extent manual dexterity does not often pose a serious problem. The men who stand before an automatic machine in an airplane manufacturing plant do not directly manifest their ability in the final form of the completed product; rather as machine operators they carry out time after time their simple and monotonous activity. The results of a job analysis might reveal that this type of work is the easiest and simplest of the many associated with the production of an airplane, yet in actuality this is by no means the case.

If an unexperienced person were to undertake an inspection of an industrial plant and would work on one or two of the products by operating for a few times the appropriate automatic machines, he would probably be quite startled at how easy and simple the operation of the machines appears; indeed he would most likely assume that no particular qualifications were necessary to be able to perform such work. However such is not the case. Even though this inspector repeat the operation of the machine a hundred or a thousand times that day, he would be unable to grasp the true nature of the work unless he continued at the job for a week, and a month, and a year, and then several years. The constant repetition of a simple task should by no means be considered easy to do, especially if the effort of the worker is not directly reproduced as that effort in the quantity and quality of the final product of that work.

Here we meet the problem of the will to work and the volitional disposition of the worker. From one period of rest to another the worker experiences waves of changing volitional strains. Such waves as excitement, fatigue, laxity, initial effort, and end spurt markedly effect both the quantity and quality of the output of the worker. At times the worker merely awaits the end of his shift; at other times, when working towards a goal (or required standard) the worker will produce the effort to work vigorously until that mark is reached. Furthermore these waves of heightened volitional tension last at times over periods of weeks, months, and years; similarly working strain and "slumps" vary in duration from a few moments to a week or even a month. Those who are engaged in this kind of work should not be persons who often feel that their will is blocked and who are easily made lax or excitable. Indeed the volitional disposition of the prospective worker is an important matter to consider among the qualifications for such occupations. The volitional disposition of the worker has been shown to have a marked relationship to the efficiency of his work.

If one decides that certain qualifications are necessary to perform such work on the basis of a superficial analysis of the work alone without having considered the problem of the volitional disposition of the worker, the workers that merely meet these requirements are qualified only in so far as their general interest in a new type of occupation will carry them. Since such qualifications can usually be acquired by practice anyway, the matter of a suitable volitional disposition for the work becomes of even more significance.

Normally when a person undertakes a new job -- when he selects a job that falls within his own type of work -- he probably does not do so with a view to taking a couple of licks at his job when he feels like it or performing the work on the basis of temporary interest. Instead when a man takes a position in a field which he expects to make his life's work, he certainly does so with an attitude towards a long range volitional tension. In other words he expects to learn the work and to become skilled in its performance, so that he comes to look on the work as his "job." It is extremely necessary to consider the long range aspects of the job in attempting to understand the psychological nature of a particular type of work.

The keen interest that usually accompanies the early periods of learning a new type of work is by no means maintained as one becomes progressively more familiar with the job. This is especially the case with regard to jobs that have been highly mechanized. If the type of work is one that has not become mechanized so that the harder one applies himself to the work the effort is directly manifest in the final product, that is, if the work is of a primitive form, the initial interest may be of a different nature than that to which we have just been referring, and such an interest in the work may continue to be apparent. In such occupations one may feel himself to be at the center of the work, however it is indeed difficult for the majority of those employed in the production lines of today to regard themselves as such.

In other words in the basic craft skills type of work once a certain definite limit has been reached, the work comes to be performed almost automatically and unconsciously. The manner in which the worker executes the unit occupations incites little interest in the unit occupation itself. Yet the concept of the joy of working need not become meaningless for this reason. Many workers at this point take up a keen interest in the quantity of their work that they produce. Thus those working organizations in which it is possible for the workers to extend at will their amount of output provide a factor that will enable their employees to maintain an active interest in their work. On the other hand, those organizations that prohibit such an expression of ability perhaps for economic reasons even though the workers themselves may possess this ability, lead in the long run only to decreased efficiency.

Even those occupations that must seem to outsiders intolerably monotonous, stereotyped and devoid of interest are in the minds of the workers activities that derive a proper meaning from many other ways of life. When coupled with an awareness of one's mission such a philosophical approach towards working becomes unalterable in its strength. For this reason even those occupations that seem of such a psychological nature that prohibits interest can be transformed so as to afford sufficient opportunities for interest on the part of the workers. For example, when one has become skilled in this work to such a degree that the expression of his capacity is again limited, it is possible to gain new interest in working by a change in the working environment. Familiar illustrations of this point are easily afforded. If one finds he has to walk a considerable distance even though he is extremely tired, one can forget his tiredness and feelings of discomfort by making visual judgments of distance and then checking this by counting the steps required to get there instead of merely walking aimlessly. However, frequent changes in the working environment are hardly feasible in many cases. Indeed a much stronger stimulus for interest is afforded by pointing out to the worker the way in which his work is closely related to his everyday life. Then too interest can be heightened by making the worker conscious of the role his work plays in the lives of his country men. For this reason the progress of other countries in many fields is carefully watched and made known to the workers. In Russia, for example, elaborate charts of the quantity of the production in rival countries are prominently displayed in conspicuous places so that the plant employees will be stimulated to do more work from a comparison of their own production with that of their competitors. Such methods of encouragement are being widely employed in our country today. By taking advantage of the psychological characteristics of the work in this way, we are able to raise our standard of production and bring about a satisfactory tension of interest in our work.

The second general type of preparations work -- that of the basic preparatory techniques -- differs from the type we have just described in that the work involves the continuous repetition of a body of work that is made up of several different parts. Moreover as a rule the work is of such a nature that once it has been initiated it is not easily discontinued halfway but is impelled to completion by strong psychological forces. Since the body of work is composed of a series of unit occupations

it becomes possible for the worker himself to enter a little deeper into certain aspects of his job. The quality of the work can often be altered by varying the degree of excellence to which the various parts have been performed: in other words, it becomes possible to establish work standards for basic preparatory techniques. It would seem to many then that this kind of work would be harder than that of the basic craft skills, but this judgment generally stems from the fact that a certain amount of intelligence and performance ability are required in order to learn the work. Since considerable mastery of the work must still be achieved once the general outline of the job has been learned, the biggest factors that lead to difficulty are not those that are directly associated with a lack of interest as in the basic craft skills.

As a rule the difficulty in being able to perform such occupations well lies in one or two specific areas. For example since the structure of a machine is such that in its assembly and disassembly, the various parts of the machine are added or taken away in a serial order, there is little likelihood that a valve will be inserted backwards or a screw upside down. Machines are assembled and broken down in a reasonable and sensible way. However there are two or three operations in this work that can lead to rather serious errors if careful attention is not paid them. These areas are often called critical points. Thus if one learns the job of machine assembly merely by going through the steps involved one after the other, only seven or eight out of a possible ten points to be learned will be grasped. If, however, the drill is repeated several times with attention called to the critical points the method of machine assembly and disassembly can be well learned so that few mistakes will be made.

When one must acquire a general working method he attempts to understand the appropriate order of the unit occupations involved. Then he must become proficient in the performance of each of these unit occupations. However even though no great change in the ordering of these unit occupations is possible, if they are individually more skillfully performed the efficiency of the job as a whole can be raised. Furthermore the psychological nature of such work can be altered by changing the conditions under which the job must be done, as for example, having the workers work together rather than alone.

Thus we see that in the basic preparatory techniques the worker is able to measure for himself his own effort and to see the effects of that effort upon the resulting product. In this way one is able progressively to increase his working proficiency so that it is relatively easy to have enthusiasm for the work. In other words, those types of work that are easy to master make difficult jobs, and those that are difficult as work are easy as jobs. This feeling is particularly strong in the case of persons of more than average intelligence. However, even in such kinds of work as the latter the interest in the work cannot be continuously maintained simply on the basis of the will to work. Here too a strong awareness of the ultimate purpose of the work forms a powerful source of encouragement to the worker.

We shall consider next those types of work to which we have referred as conditional preparatory techniques. Among those engaged in such work

are the front line maintenance men who are the machine attendants in the hangars of our air bases. It is, of course, necessary for these workers to have sufficient ability with many of the basic preparatory techniques of which we have just spoken. They make practical application of these techniques upon the airplanes committed to their charge. The specific details of the work they perform differs widely according to the situation; by no means is there a fixed predefined job to be carried out. The ground crew, for example, must closely inspect all the critical parts of the plane before flight and check all the instruments. They must give the plane a trial run and check the timing of the engine, making the repairs and adjustments that are revealed to be necessary. They supply the plane with fuel and turn it over to the pilot in perfect running condition. Upon the return of the plane from its flight it is again inspected with regard to pertinent comments from the pilot, and the cycle is repeated as stated above.

It is true, needless to say, that other types of preparatory work, such as that of war industry, depend to a certain extent upon the conditions existing at the time of the working, however the work of the air forces ground crew is necessarily determined by temporary operating conditions since it must always function in strict accord with the activity of the plane. One can readily understand that these workers must not only be skilled in the mechanics of their work, but must be able to make quick use of their heads: they are often called upon to do their work without sufficient light in a far corner of an airfield that is thickly covered with grass -- they have little enough equipment with which to work as it is, so that when they drop a small mechanical part with which they were working, they are unable to get another if they cannot find it.

Still even though the working environment is constantly subject to variation, it is absolutely essential that the work be accurately done. In other types of preparatory work such as that of the production line, the perfection of the work product can be checked by tests. However the suitability or unsuitability of the work of the first line maintenance crew can only be ascertained directly by a trial run or a test flight; indeed the imperfection of their work is at times only revealed by the sacrifice of valuable lives and military equipment. The quality of the work product of these workers is directly expressed in the ultimate activity of aviation itself. This fact is not only most easily converted into a strong awareness of the mission of these workers but also becomes a heavy burden to them which functions even more as a basic encouraging stimulus of the will to work.

The essential difficulty of this type of work however lies, from the psychological standpoint, within the difficulty of establishing a fixed method for the performance of the work. In order to make this kind of work easier it is necessary to put the work into some sort of definite form. This problem is of extreme significance to ground crew training.

Work that varies often in accordance with frequent changes in the conditions upon which it depends is quite likely to lead to the omission

of part of the work that is necessary. This fact is the most vital hazard in all types of inspection work, and in order to limit the number of resulting omissions a method known as the "fool-proof plan" was devised in America. The "fool-proof" method can be interpreted as meaning a method of inspection that can be performed even by fools. According to this method a predefined order for the inspection is followed: some task becomes number one, another number two, and so on. Then when number one is completed the direction to number two should become readily apparent. The entire inspection is carried out in this order. This method of inspection is indeed fairly efficacious in seeing that none of the points of inspection are left out. Although they were not derived from this American method, the current mode of reporting and checking on the operation of public transportation facilities resembles the fool-proof method in some respects. By this method an established order is followed and the individual items checked separately.

However certain problems arise in connection with a method such as the "fool-proof plan." For example, even though there be a great many points to check, it does not go so far as to be always necessary to investigate each point with the same degree of thoroughness. Whereas there are points that should be inspected everytime before a flight and also those to be checked everyday, there are some points that need be inspected only once a week or once a month. Therefore, if the inspection is carried out merely by one system it is almost unavoidable that some points will be considered unnecessary to be checked each time, which probably means that they will end simply in being comperatively neglected. That is, with only one inspection system some points will finally receive only a superficial checking so that sometimes a defective part may be erroneously approved through superficial inspection. Moreover if two or more systems are set up unless their coordinated operation is carefully supervised one takes the risk of completely forgetting one of the systems.

Furthermore, even though men of a certain disposition think that they are carefully following a fixed order, the fact remains that actually a satisfactory investigation has not been made. A similar situation is met when we attempt to recall details of a course on a final examination. If we try to hit on this or that particular fact that we memorized in preparation for the exam we often feel quite satisfied with our performance even though we later find that we have done poorly. Actually of course we simply did not learn all the points and we were capable of judging our recall only on the basis of what we were able to remember of what we had learned. Insofar as this kind of thinking can occur in the "fool-proof plan" it becomes somewhat more vulnerable.

Moreover, the actual work of maintenance as it is met in the field can by no means always be performed just as one might like best. If some unexpected obstruction arises during the first part of the methodical investigation so that a certain phase of the inspection cannot then be completed, the maintenance crew is prone to postpone that point to return to it later, at which time the method becomes no longer fool-proof.

The defects of the fool-proof plan that we have mentioned above,

however, do not fundamentally deny the value of this method. By looking at the operation of the "fool-proof plan" we are able to observe one aspect of the nature of the conditional preparatory techniques.

The men who excell at maintenance work are those who never abandon a task they have undertaken half-way. Once these men have taken up a job, they never decide to come back to it even though an easy performance of the task is blocked by some present circumstance. The amount of work to be done does not decrease by coming back to it and in the long run the job must be done anyway. Only when the men who carry out the inspection hold such a mental attitude can a systematic plan for routine checkups become a "fool-proof method."

When one is placed in command of a group of maintenance personnel he becomes quickly aware of the ways in which this attitude towards work comes out in their barracks life. In military terminology the way in which a man goes about his daily living is known as "personal management." Out of a large group of men there are a few who do their work as it strikes them best at the moment and who often forget some of their assigned duties; they appear in formation in inappropriate uniform or forget to sign their name to the roster so that it doesn't check with the number of men. Such men seem to have a poor quality of "personal management" and are particularly unsuited to the work of maintenance and preparation. For such men to become successful members of a ground crew outfit it would be necessary for them to reform their personal habits. This is no more than what I have said before concerning the acquisition of any technique: learning a new technique is not a matter of adding on another skill to those a person already has; rather one's whole pattern of living must reflect the technique. Man does not acquire a technique but becomes a technician. If a man seems to exemplify in his daily living the psychological structure of a technique it can be safely said that he shall have little difficulty in becoming a master of that technique.

It seems then that we must say that whether or not a person can become a successful worker in a given type of occupation depends chiefly upon the character of the individual concerned. Then also the method and training in a technique must be adapted to the characteristics of the group for whose use it is intended.

The Awareness of Mission

The union of an awareness of mission with one's interest in his work -- the psychological sense of satisfaction one feels when engrossed in his work -- affords the greatest stimulus to increased working performance and leads to the manifestation of the maximum working efficiency. Yet when one considers the awareness of mission from the point of view of the psychology of preparation, it is indeed easy to understand how the mission of the preparatory work associated with aviation could be misapprehended. Since the ultimate purpose of war aviation is the control and leadership of the sky this mission can be directly manifest only by those who actually serve in the sky; the job of preparation is quite likely to be considered only a premise to the realization of such a goal.

However, the battle for the sky is not merely a matter of bearing arms and going up to enter into combat with the enemy. The preparers who stand below in the production of those arms are fighters equally as much. The general activity in fighting has come at the present time to be greatly differentiated; in order that the widespread effort of war could have some measure of uniform control it has become largely mechanized, and this increased mechanization has necessitated in turn a large working organization. It is for this reason that aviation, which has become particularly mechanized, has one of the largest fighting organizations within our war effort. This organization extends to all of the social strata of our nation. The core of this organization is composed of many different groups: the pilots who struggle on the front lines of the sky, the maintenance personnel, the designers of the planes in use, the men engaged in their production -- even the housewives who sow the seeds of the most essential flax; all of these people are the warriors of aviation. They are bound together by a clear concept of their fighting; indeed all represent the real power of aviation and as such must have pride in their own direct participation in the glory of our aviation victories.

All of these people engaged in aviation work contribute towards our victory in aviation and victory could not be achieved without any of these fighters. For this reason they all work together as one member in strict cooperation. However there are those that feel that preparations work derives its meaning only from activity in the sky and that even though it is a necessary job, it exists more as a "thankless" job. If there were no superior aviators there could be no superior preparers; and even though the preparers do their work perfectly, if there were no actual flyers to use their products their whole effort would be without meaning.

Thinking that preparation exists for service in the sky, just as thinking that service in the sky exists for preparation, is a narrow and self-centered approach that loses sight of the many goals and ends to be realized in the victories of aviation. Actually preparations work plays an extremely important role in aviation activity, and it is essential that the preparers have pride in the fact that their perfection is the necessary condition for the perfect functioning of the aviation organization. In this way indeed is the position of preparatory work properly realized.

The joy and pride at the victories of aviation should not be possessed by the actual flyers alone. The love the mechanic feels towards the plane to which he has been assigned, the strong surge of joy that comes as he sees his plane return without accident, and the intense pride on hearing the first report of the day's engagement as the pilot jumps out of his still moving plane -- all of these things are the intimate joys that are held within the heart of the ground crew members. Yet on the other hand these joys are no more than those of the fighter of the production line when he hears the day's news from the front lines; there are the countless silent messages that are given in prayer as one portion of work is completed, and the quiet salutations that accompany each airplane as it moves still unfinished down the assembly line. Each of these joys closely binds the work of the preparer to the final victories in the air. All who are a

part of the great aviation organization must recognize that all are pressing on towards a common goal and that steps in this direction are sources of pride that in turn belong to all. Indeed on the faces smeared with sweat and grease of all who participate in the united activity of the aviation organization shine courage and joy in their common purpose.

Of course even though we say these things we are not people who have to be trained in the awareness of mission in order to be stimulated at all to activity along these lines; on the contrary we usually try to think of the ways in which our own contribution is utilized. We ask ourselves the general function our part plays in attaining the objectives of aviation, and we attempt to consider the ways in which our own contribution may be lacking in some respect. In doing so we receive an even greater awareness of mission and bury ourselves even further within our duty. Moreover in doing so many workers rely heavily on such considerations as how did their individual work function at the time of the application: how did the plane I serviced stand up in the battle today? Into which enemy planes did the bullets I made strike home? What part of the plane does this rivet I have just made support? That is to say, as we work we consider the most efficient application of our efforts and attempt to bind our work to the ultimate objective to be served. We like to feel that the effort of our own contribution is reflected proportionally in the practical application as measures of our own ability: we feel that rather than making rivets we are driving them, and rather than manufacturing parts that we are employing them, rather than producing, preparing, and rather than preparing, piloting. In other words we tend to project ourselves farther along the temporal chain of events that lead to the final goal. Certainly in this way it is easy to have a good psychological awareness of one's own duty.

However there are many situations today where it is not possible to see an obvious relationship between one's immediate occupation and the ultimate objective of the work. The first and last stages in the construction of a single weapon do not have a clear cut temporal contiguity as in former times; indeed it is often not possible to discern even the barest outline of the final product in the object upon which one is working. Individual jobs do not each add on special abilities to the construction of a complex weapon.

At the present time we have already made such scientific and technological progress in the field related to aviation that the work involved has come to be widely specialized into many independent occupations. Only when the individuality of the separate workers who participate in the manufacture of a machine is completely destroyed can a modern complex machine be perfectly constructed. The perfect airplane does not show the individuality of each of the workers that has participated in the manufacture and production of the plane. The manifestation of the effort of the workers who have created it must be expressed symbolically in a way that transcends individuality. Each worker must find his joy in sacrificing his individuality by identifying himself with the purpose of the organization as a whole.

Qualifications Testing and Personnel Administration

We shall now consider again the general problem of psychological qualifications. One of the foremost fields of activity for the aviation psychologist is that of qualifications testing, and since we have already briefly discussed the problems of qualifications for piloting and communications work I shall now proceed to take up two or three of the more important matters related to qualifications testing for preparatory techniques.

Qualifications testing for occupations that are essentially preparatory in nature seems to be in relatively wide vogue today, certainly at least insofar as industrial occupations are concerned. However one might find considerable disagreement as to whether or not the testing program is actually effective or successful. Some persons advocate the essential efficiency of the testing work on the grounds that some industries that have initiated testing programs and apportioned them job openings, report an overall increase in work output among their employees following selection on the basis of test results. However if one look more closely at this "efficiency" he will see that the resulting increase in work output does not necessarily validate the tests as scientific measures of qualifications; there are some who maintain that the increased efficiency in performance is due to the fact that the mere giving of a test to a prospective employee influences his future job-outlook so that his learning attitude is stabilized and his adjustment to the work facilitated. Stated in another way, this point of view maintains that if a prospective employee is given pretty much any kind of test, by the testing circumstances alone he comes to feel that he is suited for the job. Of course, from a utilitarian point of view such "efficiency" of qualifications may be of some practical value, however it is rather dangerous to conclude that it provides scientific validation of the test or that the test is accurately functioning as a measuring instrument.

If one attempts to apportion the separate jobs within an industrial area that are influenced to some extent by the working attitude of the worker by selecting and testing a certain aspect of the work, even though the function tested is by no means fundamental to that particular job, a possible increase in efficiency actually due to the volitional elasticity of the worker may be taken as a sign that the qualifications test was appropriated as such. There are many instances of where tests have rather boldly and imprudently been devised of entirely inappropriate measures in order to demonstrate this point.

However even though we may not want to employ the volitional elasticity of the worker towards invalidating qualifications tests, I wonder if we should not make use of the concept in attempting to consider the implications of the fact that different types of work are associated with different spiritual inclinations. It seems to me that a certain resilience of will is required in order to effect a harmonious union of one's pleasure at working and the awareness of mission. The qualifications test should never be designed from the point of view that the testee is a human machine having simply a certain aggregate of abilities; the qualifications test should seemingly take some account of the worker's awareness of his role

within the national purpose. Certainly taking some account of the life attitudes which provide a great source of driving power to the worker has not been attempted in the qualifications tests current application today.

If one considers the qualifications tests that are in widespread use at the present time it is quite apparent that these tests attempt only to get at the superficial aspects of the work. For example, the test for a lathe operator is largely a test of the motor coordination of the two hands, that for a fitter on an assembly line consists of a test of form discrimination or for accurate visual measurement. Of course these various abilities may be quite necessary in order to learn to perform the unit occupations, yet it is hard to deny that these skills can become acquired anyway after a period of training. As I have stated before, these abilities may indeed be necessary before a unit occupation can be performed, yet the mere ability to do the work by no means indicates that a particular man will become a good worker. The work must become the worker's "job" or "occupation." In order for a man to be a good worker he must mold these unit occupations within the underlying tone of his whole approach towards life. There needs to be something with which to sustain these unit acts, that makes them a true part of the worker and draws them close to the core of his individuality (Ich nähe). Certainly adequate qualifications tests must take into account how closely the particular occupation fits within the individual personality structure of the testee.

For these reasons the vocational and industrial psychologists of today are greatly interested in the matter of the volitional disposition of the worker. Tests of volitional disposition do not make use of the restricted motor tests that are often the basis of the qualifications tests we have described above. They do no more than make a rather rough division of the work into various types of jobs and then classify each of these types according to the various concepts of volitional psychology. Through the proper use of such tests the working efficiency of the workers can be conspicuously increased. Many persons who would make unsuitable workers can be excluded by this kind of test as for example the men that constantly try to avoid working and who are slovenly in their attitude towards this work, or those men who do not make adequate adjustment outside the plant due to the psychological pressure of the work. Such inferior qualifications in the prospective worker are only rarely discovered by means of the narrow abilities tests that were described earlier. If a testee indicates that he has a wide elasticity of will and is not particularly subject to changes in mood, the probability is high that he will make an efficient worker even though he may manifest poor facility on the tests of superficial abilities since these for the most part can be overcome with training.

Men who have shown the appropriate volitional disposition on the basis of such tests will probably find that they are able to make a satisfactory adjustment to that particular type of work. This means that they will not only be able to adjust to the waves of laxity and interest tension that accompany the performance of the unit occupations -- that is, they will be able to get the knack or hang of the work, to which we have already referred -- but they will also be able to adjust to the performance of

these occupations time after time and day after day -- that is, they will be able to make the work their own "job" or "trade." The natural consequence of this adjustment is even greater adjustment. Furthermore we should probably not fail to consider the fact that going beyond the matter of personal satisfaction in finding a suitable vocation, the proper volitional disposition should lead the worker towards greater awareness of his own ultimate objectives and goals in living. It seems hardly necessary to consider which is more suitable: giving a man the type of work in which the volitional and psychological characteristics of the work must closely conform to his own volitional disposition, or blindly assigning him to any type of work and requiring him to exert his greatest effort to comply his will to the characteristics of the work. Is it the best administrative procedure to measure with tests the partial coincidence of a restricted ability and to assign the man to a job fundamentally on the basis of his test performance, and then to force him to try to fit his own personal attitudes within the framework of that occupation?

I strongly feel that the approach towards job analysis and qualifications selection should assume a higher plane. Quite recently qualifications tests have appeared which are primarily based upon the will to work, and the tendency for such tests to spread to the industrial psychologists and personnel managers of our country is becoming progressively more apparent. This tendency seems to point towards attitude of regarding work not as any sort of abstract "work" in itself, but as a personal "job" that is closely tied in with the individual's attitudes towards life. The same general tendency is to be seen in the German Prahtische Charackterologie (Practical Characterology).

However, the fact that a suitable will to work is necessary for maximum efficiency was found to be true also with regard to piloting and communications work. The same can be said with regard to intelligence. Although intelligence can be understood simply as the matter of being able to use one's head, it is perhaps better to say that we measure intelligence in terms of the relative facility one demonstrates in performing simple reasoning, judging and memory tasks within a given short period of time. Even though a certain amount of intelligence is prerequisite for adequate performance of the preparatory tasks associated with aviation, it is at the same time extremely necessary in piloting and communications work. One of the first intelligence tests that was applicable to the needs of large scale testing programs was the Army Alpha Examination designed in the United States at the time of the First World War. The test has been revised and appended in content, but has survived in much the same form, the ravages of severe criticism. The fact that essentially the same test is widely used today both in our country and abroad is direct evidence that intelligence as measured by such scales plays a significant role in the training of various new techniques.

Then the question might well be raised, but are not intelligence, volitional disposition and the absence of physical deficiency necessary factors for the training of techniques in general? Indeed it is so. One could hardly doubt that the most superior pilots could just as easily have become superior maintenance men. This merely asserts the fact that

with respect to general capacity a selective narrowing must be made, for pilots rather than communications men and for communications operators rather than maintenance men. If one should ask in what way the necessary classification is made, it would be necessary to reply upon the basis of the so-called isolated abilities which we have just questioned or other special abilities which the individual may possess. But proper intelligence and volitional disposition form the foundation that must sustain these special abilities, and since one can say that there are within the highly specialized and mechanized techniques of contemporary aviation no special abilities that are separated from these factors, it follows that in order for there to be uniform development of aviation as a whole there must be equal apportionment of these abilities among each of these types of aviation activity.

To attempt a classification of personnel without appropriate testing for their special abilities is absurd. However to assign to be pilots the men of the best qualifications and select for the other training schools men from those that remain who are inferior in ability to the pilots, is equally absurd. In other words, a "narrowed selection" of personnel with regard to general intellectual, volitional, and physical ability does not imply a succession of progressive inferiority. To illustrate, whereas it was necessary that only those men of intelligence scores falling within 70th to the 100th percentiles be selected for pilot training, it by no means signified that communications personnel should be taken from among those of intelligence below the 70th percentile. Some men of intelligence scores up the 100th percentile should also be assigned to communications and maintenance training schools. The effort of "narrowed selection" should be to make the lower limit of the classification as high as possible. When determining the qualifications requirements for specialist schools the first necessary task is to establish the general range of the required qualifications; only after this standard range has been established should the investigation for special abilities be initiated. If at the time of personnel assignment the psychological structure of some of the occupations has become somewhat more clearly apparent than that of others and a general investigation for suitable qualifications is undertaken, only those jobs that could define the conditions for their performance would have men of superior intelligence and volitional disposition, unless a general level had been established for all jobs. If this were the case, only those jobs in which the special characteristics were psychologically defined would develop as techniques, which fact is merely an invitation to an inefficient balance in operations.

More specifically with regard to aviation, the former method of selection and classification involves considerable danger of assigning the best men only to communications work which has a relatively simple structure as a technique, or to piloting which is dependent upon certain precise minimum requirements. The task of controlling the overall selection by means of a unified policy to prevent this warped balance is the duty of those men in charge of selection and qualifications testing. Only once a general apportionment of the personnel with regard to intellectual, volitional, and physical capacity has been made, is it safe to proceed with

the narrowed apportionment on the basis of special ability. In those areas of preparatory work, especially those associated with production and manufacture, where there is considerable fluctuation in efficiency due to the inability to make accurate tests of special abilities, increased attention must be given to planning more adequate modes of personnel management.

Furthermore, if qualifications selection in piloting and communications work is not properly carried out so that a person who has already commenced training is subsequently judged to be unsuited to continued training within the program, he cannot be transferred to another type of job within the same general kind of training. Since the structure of the techniques of piloting and communications work is rigidly defined there is only the possibility of removing somewhat deficient students from the entire training program. In radio work for example, men who are unable to receive above a certain minimum rate are not judged to be merely "low in ability", but are designated as lacking the qualifications to be a radio message receiver. In the preparatory areas of production and maintenance, however, there is a considerable range of the type of jobs available for men of differing abilities, and since several degrees of ability are possible within a single type of work it becomes necessary to exercise personnel management in determining the appropriate change in occupation for those workers of unsuitable qualifications for the tasks to which they have been assigned. If the direction of the change is unskillfully handled no particular increase in these non-workers' performance is likely to occur. Here again we meet a problem that must be faced by the psychologist.

The Mental Attitude of Handling Machines

Just as it is necessary to have a certain elasticity of will in order to be able to adjust quickly and adequately to the assigned work and as it is necessary to have a certain amount of intelligence in order to grasp the proper sequence of acts in the method of work, so it is equally as necessary for the men who handle machines -- production workers and maintenance crew members -- to have a certain amount of skill. Yet this skill should not be considered in exactly the same light as volitional elasticity and intelligence; as I have stated before, skill is intimately bound up with personality. The techniques involved in handling machines in production and maintenance work are essentially limited by the amount of work to be done ("work-limited"), and are accordingly easily differentiated into parts of which some of the manual aspects can become comparatively independent. For that reason what we have called skill -- a certain manual dexterity or Handgeschichlichkeit -- is quite apt to serve an independent role as such.

However the fact that in certain aspects of the work skill as such can serve an independent role only indicates the direction in which these techniques can become more mechanical and independent in the future. In other words the fact that we can point to certain areas as skills merely demonstrates that there remain other aspects of the work that have still not been mechanized. Perhaps to repeat, between the various parts of the work that have become automatic human elements are filled in. Therefore

if this human element is still necessary even in the ultimate state where more mechanization is not possible, it must be said that the human element is an important factor in the performance of a technique; but on the other hand, although it is probably not possible to reach that ideal state, if we rely too heavily on the human element we hinder differentiation of the technique, which in turn offers a block to progress.

It is often said that the Japanese people far out-distance other people in manual dexterity. However when this statement is transformed to the boast that the Japanese are able to accomplish by means of their innate "intuition and dexterity" delicate jobs that those of foreign countries are unable to perform without the use of machines, it must be said that this attitude forms an obstacle to progress in that technique.

The limited nature of the extent to which man can do precise work by "intuition and dexterity" is readily apparent. The detailed accuracy that is necessary in many modern techniques is far outside the range of human visual and tactual determination. The skill by means of which a carpenter is able to construct a house without blue prints, or a tailor is able to fit a piece of cloth with only a crease and a needle, or we are all able to grasp small peas with long chop sticks, in no way reaches the precision that is demanded of the man who makes use of a machine. These skills are valuable in mechanical work only in so far as they apply to operating the machine or moving parts skillfully or adjusting the body parts of the machine. These skills are useful here only in that they roughly and grossly regulate the precise work of the machine and as such do not have a fundamental relationship with the technique.

It is indeed quite possible to attempt to deal with the problems of human perception that are necessary to discover the minute differences in the work of a skilled and unskilled operator, or the differences in quality rather than quantity of his work. We might attempt to discuss the ability of the pilot to discern individual differences in brakes and rudders or the fact that some planes are good and others not so good even though the same plans and manufacturing procedure were used in their construction. (The Japanese, by the way, claim to be particularly adept in such delicate discrimination. For example, many of us maintain we can tell a Japanese sword merely by the smell of the blade). But for this it is necessary to consider the function of the human element that exists between the mechanized aspects of the technique of handling machines. The matter depends upon a closer consideration of the role of human dexterity in these techniques.

If this dexterity depends upon a delicate adjustment to volitional tensions as I have said before, and if it can be manifest rationally only with a certain intelligence, then it is probably most efficaciously employed in such techniques as piloting and other arts where a certain amount of "inspiration" comes into play. However, the effort of science is the complete mechanization of the differentiated aspects even of these arts and piloting

If such is the case one might consider somewhat pessimistically the efficacy of the unique dexterity of the Japanese, however it can be most completely utilized as manual skill in performing the superficial aspects

of the work and should by no means compare with the quantitative efficiency of mechanical precision and accuracy. It may be that by diverting this dexterity back to its fundamental source in volitional and intellectual superiority, it can come to possess in time tremendous practical applicability.

It is indeed rather unfortunate that the free spirit and superior intelligence of the Japanese people have been directed chiefly towards manual arts; they are most clearly manifest in the skillful management of their everyday business and home activities. Even under stress such an attitude does not develop into a scientific and mechanical mental attitude but leads rather into more refined arts. The mental set to perfect manual skills is entirely different from the set to handle machines. However it would by no means be necessary for us to change our fundamental volitional and intellectual structure in order to adopt a scientific attitude; this can be achieved simply by diverting the direction of their application. This direction can be relatively simply carried out within the homes and schools of our country by a national education program. The task is entirely different from attempting to instruct a slothful people of low spiritual development in scientific techniques; it is simply a matter of directing a mental attitude. Let us try to consider the problem in a familiar situation.

Already countless machines crowd us in our homes; we have electric lights, gas fixtures, running water systems, radios, bicycles, telephones, phonographs, and so on. We have adopted a mental attitude towards these already completed machines that is one essentially of practical use as utensils. When something goes wrong with one of them, we give it a bang or two and hope that it will start up again. And fairly often it does. Here we manifest our intuition, or knack, or traditional secret, or finesse. This attitude is one such as we should utilize when we break a piece of wooden furniture. It is not that we do not have the factual knowledge of mechanical things for we are taught such matters in the national schools. The trouble is simply that this knowledge is not firmly grappled to our daily lives; it looks like our intuition has merely got the reach on what we have been taught, since we have been able to manage successfully by means of it in our daily lives. It almost appears as if the contents of our education were entirely separated from our actual behavior.

However the situation has shown marked improvement in recent times. Model airplane construction has been instituted in the public elementary schools and the mechanisms which operate in a bicycle are taken up in the texts of our science courses. To what extent the memory of the physical laws is effected by employing such familiar objects in science classes, I do not know. However, if one watches the young people at play with the airplanes they have built, he will see that when some piece gets out of line so that the plane is disabled, the children will skillfully make some adjustment that results in a beautiful flight of the plane. Thus practice in the construction of model airplanes leads to the acquisition of a certain kind of manual skill. Of course, just because one is handling a machine does not mean he would not be able to make good use of some such manual skill and "intuition," and the plan of having the children draw

up a careful draft of the plane and specify the materials that will be needed does not necessarily mean that in doing so they will not be able to acquire some notion of appropriate manual skills that could be used in flying the plane. I feel the rather terse maxim, if the plane doesn't fly it's no good, might be of considerable value to the Japanese people.

We have all heard the old people speak of the early Germans who came to this country: how a certain housewife became able to cook rice as well as the most experienced native cook simply by marking down the quantity of water and rice to use and the time of boiling; how they would use a thermometer in preparing their hot baths; how their children when asked by a Japanese how long it would take to get to a certain place would first make him demonstrate the size of his pace and then inform him it would take him so many minutes to get there at that speed. There is much within this attitude that we must practice and acquire within our daily lives, however it might be possible for us to go too far in that direction. We must be able to integrate the scientific approach within our daily living but we must not attempt to understand everything in terms of scientific technology.

In order to become a worker in the aviation organization, whether it be to become a pilot, a communications operator, a maintenance crew member, or an assembly line operator, it will be necessary to be able to handle some kind of machine skillfully; and since a mental attitude of handling a machine as a machine is prerequisite to that ability, if the prospective worker does not already have such a mental attitude it becomes necessary for aviation training to instruct him in such an attitude from the ground up. However, the foundations of this mental attitude should already be cultivated within the worker by his public education and family training. When the aviation trainee first begins his training he should be able to pass on directly from the texts of his public schooling; it is to be hoped that more and more of the basic material that underlies aviation training will continue to be weaved into the national education program so that training in aviation as a technique would be only a matter of completing a process already begun.

CHAPTER VI

THE PROBLEMS OF SAFETY AND ACCIDENTS IN AVIATION

A Prevalent Attitude Towards Airplanes

There can be little doubt but that a strong subjective fear and apprehension with regard to the safety of aviation has for a long time been a severe block to a more widespread dissemination and development of the culture of aviation. Of course, regardless of whether such an obstruction existed or not the need for aviation has been imperative, and the sincere and persistent effort of the men who have devoted their lives to the development of aviation has been sufficient to overcome that barrier within themselves.

Yet it seems to be widely held for some reason or other that aviation is essentially unsafe. We shall attempt to consider this attitude from a psychological point of view.

It seems significant that when man is faced with the decision of whether or not to adopt an entirely new element into his pattern of life, he is most likely at first to take a strong attitude either for or against the change. The more original in nature this element happens to be or the more radically it differs from his past modes of behavior, the more marked this dichotomous reaction is apt to be. When coal was first introduced as fuel in London a fine was soon imposed upon its use since it was considered that its smoke was dangerous to health. Even today when a new medical drug is discovered there are on one hand the men who promote the reputed efficacy of the cure it offers, while on the other hand there are those who react against the drug and oppose its use. The situation was much the same with the train and bicycle that are in such wide use today with regard to initial criticism; inventors are often considered to be an odd type of men and those who immediately utilize the new invention are regarded as radical, and in extreme cases, even criminal. No matter how superior a new invention happens to be, it seems always to experience a period of relative weakness just after its introduction where it must withstand rather widespread adverse public opinion. Then when the invention gradually achieves general acceptance the early opposers quite naturally completely forget their previous opinion. A similar reception has accompanied the development of aviation.

However, it cannot be denied that the situation is somewhat unique with regard to aviation. A first point lies in the fact that unlike the bicycle, train, and automobile, the airplane does not play an obvious everyday role in the lives of most people. For this reason when we consider airplanes we are apt to have to resort to some sort of rather vague abstract notion that we have picked up concerning airplanes. Since our comprehension of airplanes is influenced in this way, if we are constantly subject to conversation about airplane accidents we are quite likely to add to our abstraction concerning airplanes the impression that they are unusually prone to having accidents, even though we may have

never seen an airplane, much less an airplane accident before. Those people who feel that airplanes are particularly subject to accidents probably consider that the airplanes so pleasantly flying above their heads and the planes so successfully engaged in combat with the enemy are exceptions to the rule.

However those who actually have to fly airplanes day after day are firmly convinced that airplanes are perfectly capable of flying safely. They could hardly believe otherwise and continue to fly them. They would not make it their business to do nothing but fly planes if they felt that planes were suddenly apt to lose the capacity to fly or to have accidents. Similarly, when a person who has never flown in a plane before and who perchance has some apprehension with regard to the safety of flying first hears the roar of the airplane engine and observes that the wheels are actually off the ground, he is at once overwhelmed with the awareness of his flight and neglects to consider the dangers of which he had previously been so conscious. He no longer is concerned with forces outside the plane. The various feelings of fear that he had had before the flight seem to disappear somewhere or other and he becomes confident of the ability of the plane to fly.

One must not lose sight of the fact that even though the two types of people that receive the initial introduction of a new technique are extremely different in approach -- one of these selects only the unfavorable elements of the abstract conception of the technique and regards them as fundamental, whereas the other group picks out only the advantages of the technique from their abstract conception and magnifies them --, the fact remains that the matter with which they are dealing is in reality just the same. Those who expound on the safety of airplanes and thosewho exhort their dangers in the long run afford each other mutual counter-evidence; for the most part they are all likely to be men who have never attempted to evaluate their own assertions with any degree of comprehensiveness, and it is for this reason that fruitful discussion between the two groups is rarely to be had. The answer to the problem lies in a thorough and objective investigation of the facts that are related to the safety of aviation -- or the danger, as the case may be. This is in effect a scientific study of accidents, which means here that the study should be of an impartial nature.

Then let us consider the freqency with which airplane accidents occur. the data that are available at hand must of necessity be somewhat old since the most recent figures for any country have not been made public, and due to the fact that the published estimates are likely to be heavily weighted for purposes of propaganda we shall have to content ourselves with figures that are not entirely applicable to the immediate situation. Ten years ago the figures ran in this manner.

Type of Transp.	No. of Miles Traveled	No. of Accidents	No. of Deaths	No. of miles per accident	No. of miles per death
Airplane	10,305,595	128	17	802,512	606,211
Automobile	18,440,664	47,049	1,100	382	16,764
Railway	193,504,320	18	8	10,766,906	24,235,540

The figures above for railway accidents exclude such other modes of transportation as streetcar and subway and apply only to direct collision or derailment. If one considers the circumference of the earth to be 40,000 miles, these figures indicate that airplane accidents occurred at a rate of one every other flight around the earth, whereas an automobile accident occurred everytime one traveled as far as the distance from Tokyo to Gifu. With regard to the number of deaths, these figures become for the airplane one for each 15 circumferences of the earth, and for the automobile one for each two-fifths revolution of the earth.

However, there are probably some who would object to such statistical manipulation. It might be maintained that the frequency of accidents should not be considered only in terms of distance, that is, the number of accidents per number of miles traveled. Indeed the real efficiency of aviation is seen not in the matter of distance but in speed. The figures would become considerably changed if one would plot the data for example at an average speed for the airplane of 200 and for the automobile of 30 miles per hour. If one considers then the number of accidents as a function of travel time, these figures become for the airplane one accident per 4000 flying hours, and for the automobile more than one accident every 12 hours travel time. Furthermore, if the figures for the number of deaths as a function of travel time are calculated, for the airplane one death occurred every 3000 hours of flight, and for the automobile one death occurred each 60 hours of travel. (These figures are somewhat inapplicable to conditions in our country since they are derived from American data.) However, these figures would seem to indicate that aviation accidents are comparatively rare.

"But airplanes still fall!" persistently claim those whose mental attitude is as rigid as basket worms clinging tenaciously to their hosts. Of course one cannot say that airplanes simply will not fall. The fact that we claim that the danger of aviation accidents is small compared with that of other modes of transportation merely demonstrates the possibility of at least a small number of accidents. Aviation does not take exception to the rule that things that are numerically small can have great significance. Herein lies a second problem.

When one considers the matter, the mechanical dependability of the plane is an extremely necessary premise for aviation. If something happens to a machine on the ground it results simply in a failure to run not an accident. Accidents on the ground are largely a matter of human errors in the method of handling the machine. Indeed one feels that the possibility for an automobile accident is least when the engine has stopped running. On the other hand with regard to airplanes people feel that if the machine does not function properly the problem is still faced of getting back to the earth and that the job of having to make a landing under unsuitable conditions -- the forced landing -- is extremely dangerous and is resorted to only in desperation. And the truth of the matter is that a forced landing is not made entirely without danger. Now if it were the case that people were afraid of airplanes because of insufficient faith in the mechanical reliability of the machines of their country, one could hardly criticise their fear as groundless: the fact would be no more than

evidence of the low technical standards of that nation. Indeed the advent of an entirely reliable machine is one of the basic goals toward which the development of aviation technology is directed.

Yet it is hardly the purpose of this book to discuss the relative mechanical superiority of the planes of various countries. We shall make a machine of adequate reliability the premise upon which to base the following discussion.

Now if something happens to the engine or fuselage of a plane while in the air so that the pilot is unable to maintain his altitude or pursue his course, he will eventually have to make a forced landing. At that time the passengers will probably be required to stand in a safety zone in order to prevent bodily injury. They will probably feel that "This is it!" as they say, particularly if the pilot has been unable to find a suitable landing place or if they were flying over enemy territory. Quite the contrary to this, if a mechanical defect appears when travelling on the ground, a simple delay of an hour or so will usually result in successful resumption of the journey. One must say that on the ground one has the opportunity to discover and repair the defect and the chance to find his way through the danger. It is this point that seems to make people feel that methods of transportation on the ground are essentially safe and those in the air dangerous. For this reason when we hear of an airplane accident that occurred on the runway of an air field we do not feel as great a shock as when we hear of accidents from crashes or forced landings, even though the disastrous damage that most runway accidents incur is well established. In other words, the difference between whether there is or is not a means available to alleviate the defect has so strong an influence that it completely eradicates in most minds the difference in the frequency of accidents of 4,000 and 60 hours of travel time.

The psychological discord between the necessity of a free will that is able to express itself within the limits of voluntary behavior and a fate (to use so gloomy a word) that prescribes all activity is the mechanism upon which such conceptions of safety and danger are based. It has been well said that "the fact that there is no set balance between the misfortune and happiness one will receive on this earth is one of the clearest indications of the great mercy and compassion that inlay the human design", yet the remarkable thing is that the men who actually possess the strongest power of will and the greatest ability to execute their intentions are most aware of the presence of a fate which they are in many ways unable to control or influence.

Generally we find that when we undertake a new responsibility we do not run up against experiences that follow logically from our immediate surroundings, but rather we see that previous insignificant experiences often play a determining role upon the situation that we encounter.

Providence also exerts strong influence upon the ability that man manifests.

The power of man is greatly increased when he achieves the state

where he does not regard Providence as an enemy but has faith in it as a friend.

These words were expressed in The Psychology of National Defense, to which I have earlier referred, yet they seem to be particularly applicable here.

Fridtjof Nansen, the courageous arctic explorer, has written:

"If it were true that all events are reducible to natural laws so that all our actions are determined by an infinite series of previous cause and effect relationships, then there could be no real meaning to the concept of free will. Furthermore, there would be no actual basis for the moral sense of responsibility by which we are motivated. The work of the great thinkers of the past would have to be reduced to a somewhat foolish attempt to avoid this fact. An absolute natural law is merciless and without compassion and can allow the concept of free will no more than it can tolerate the notion of an absolute first cause, whether it be called 'mind' or 'God.'" (From Our Human Outlook, translated to the Japanese by Yoshinohara Saburo.) In these words Nansen states the implications of an entirely scientific attitude. Yet he does not accept such an approach and goes on to say concerning a national emergency that faced his country, "Regardless of the course that is taken the result will follow a path of action, and reaction, and further reaction to the reaction. Still the reactions are unified in that they constantly maintain the direction of progress, and even though this progress is beset with hardship and great difficulty, it is still progress." (From The Life of Nansen, translated to the Japanese by Nagashi Kaname.) It was only by a voluntary expression of fate and progress that the personal hardship of the trek by sleigh of the 8th of April, 1894 was possible.

Then we must conclude that there are some men who having attained an accomplishment believe that it was partly through the influence of fate that they were able to do so. On the other hand there seem also to be those who as they continue to fall back point to the hand of fate and passively set their hearts to suffer their lot. We must certainly say that there is a great difference in the effect this final barrier has upon their capacity. It has been written "In the code of the warrior one finds death. There is continuous death: death at each moment of day and night." Yet the warriors did not react to the death they pledged of themselves by folding their arms and calmly waiting for it.

In the last analysis, those who maintain feelings of fear towards airplanes even though there is objective evidence of their mechanical safety must have this attitude towards aviation accidents deeply ingrained within their personality. It can probably be said that those who have such an attitude are likely to be weak not only with regard to aviation but also to other areas of human activity, and one should not expect to find many things of value entrusted to such irresolute persons.

Accidents and Psychology

Aviation is essentially safe. However, as I have state above, the problem of aviation safety is relatively important simply because accidents do occur from time to time. The accidents associated with aviation are of a different nature than those of other modes of communication, and this difference has given rise to a mental attitude that in turn has had a significant material influence upon the development of aviation. For this reason the problem of aviation accidents has been the subject of much investigation from the very beginnings of aviation up to the present. In all countries special committees have been established to initiate appropriate counter measures against aviation accidents. It is the function of these committees to investigate each accident as it occurs, to describe its course, determine its basic cause, lay clear its responsibility and to suggest suitable counter measures that might be taken. The proper functioning of these committees in order to prevent the occasional useless death of valuable men. The work of these committees is convenient for the psychological study of accidents since detailed investigations of all accidents are made and the resulting data are available almost without exception.

Yet the scientific study of accidents and of appropriate counter measures does not have value alone in the negative sense of simply explaining the nature of accidents and pointing out how their number can be diminished. When the problem is approached with such an attitude psychology does no more than tag along behind accidents. Indeed accidents are by no means to be prevented by merely seeking the superficial imperfections in the various aviation techniques; we should doubtless be afforded positive material if we were able to discover more clearly the fundamental nature of aviation techniques themselves. With such information we should be able to improve basically the techniques employed in aviation. From a positive standpoint, then, accidents can serve the purpose of an "observation window" to enable us to understand more adequately the core of the techniques of aviation.

It seems hardly necessary to elaborate on the fact that a psychological study of accidents could be of great significance to aviation if only due to the fact that psychological forces play a large role in moulding one's fundamental outlook towards aviation. It is the duty of psychology to probe into the human factors enmeshed within the complex muddle of scientific causal law and chance that underlie accidents. A psychological study seems particularly necessary in view of the fact that over half the accidents associated with aviation can be related to human error. Furthermore, a psychological investigation of the processes of accidents should clarify the mental and volitional forces that motivate the pilots that fly planes. A knowledge of the fundamental cause of accidents should reveal more clearly the structure of volitional behavior. Accidents indeed afford "observation windows" and accordingly are of great interest to aviation psychology. By understanding more adequately the structure of human volition psychology is better able to attack the core of the problem of qualifications testing and to consider more effective methods of training and instruction. The psychological study of accidents should enable us to devise better techniques in the prevention of accidents and the selection and training of aviation personnel.

During the early period of the development of aviation, the problem of accidents was rather generally neglected by an organized aviation psychology, although this fact should probably not be taken as a sign of lack of interest. Yet the birth of aviation medicine and aviation psychology as definite fields of study probably developed out of the need for the establishment of effective control against accidents -- indeed psychology itself may in some ways be considered to have orginated in the need for a study of accidents. Actually such studies were in great demand before the First World War since it become quite clear that most of the men sacrificed in aviation accidents were victims of accidents due to human errors that they had brought upon themselves. The chief reason for the fact that the psychologists associated with aviation at that time chose instead to take up the problem of qualifications testing can be traced to their great eagerness for conspicuous success. This attitude gained inertia with time and the impact of the period upon public opinion has persisted today in the common prejudice to regard psychology as primarily concerned with testing activities. If the psychologists of that period had not been so foolishly eager for success and chosen the problems of qualifications testing on which to work but instead had pushed ahead to the investigation of accidents and possible methods of reducing the number of accidents, perhaps a more fundamental understanding of the basic psychological issues associated with aviation would be available today. At least it is my opinion that aviation psychology should have proceeded along this line of approach first. An investigation of the problem of accidents would unquestionably have made the analysis of personnel selection and training far simpler.

At that time only those accidents that indicated a larger need for personnel in certain fields received study, and there was no attempt to interrelate the basic nature of the laws governing qualifications and accidents in general. Thus from our point of view today we can find value in this early work only where the qualifications tests that were devised have shown some degree of efficiency. Even giving any kind of test at all provided an initial increase in performance over not giving a test at all. However there can be no progress without first establishing some sort of foundation upon which to build. For this reason the testing work in all countries remained at a stand-still and psychology was forced to suffer a perhaps unjust evaluation. Yet this lack of progress finally forced psychology back to the original duty it had chosen to avoid and to the consideration of appropriate counter measures against accidents. I feel that for this reason the study of accidents plays an important part in the development of aviation psychology. However, one of the reasons also why little progress was made during this period is the fact that the psychological principles with which an investigation of accidents could be efficiently undertaken had not at that time become sufficiently understood.

However what kinds of counter measures can be established by a scientific study of aviation accidents? To what extent can actual success be attained? Even though it were clearly understood by what psychological forces accidents occurred, just understanding them alone does not mean that the rate of accidents will actually decline. The principles that underlie accidents must in some way be applied to practical situations in concrete personnel

selection and qualifications testing methods and indeed they are not truly sufficient until they are practically applied also in the training method in use. A corresponding improvement in the techniques of instruction must follow. Psychology is a basic science only when it is utilized. The relationship between psychology and areas of practical application is exactly as the relationship between physics and mechanical engineering. Thus it might be possible to consider aviation psychology as purely a branch of applied psychology, however since it takes as its subject matter the various human phenomena associated with aviation, aviation psychology is intimately related both to theoretical and applied science, and thus the relationship between the pure and applied branches of aviation psychology is not as independent as that between physics and engineering. Aviation psychology then neglected its early heavy interest in testing and undertook directly the study of accidents. However, since psychology had not entirely cut itself free from its pre-scientific influences it was relatively easy for it to produce work that did not have firm basis in practical areas. Not alone in Japan but also in other countries the study of accidents resulted for the most part in the noncommittal collection of statistical data. A new and more adequate study of the phenomena of accidents is needed in which the undertone of these previous influences is sufficiently discarded.

Then there are some persons who erroneously feel that accidents can be prevented merely by giving the operators of the plane various psychological suggestions which if followed will miraculously bring about a cessation of accidents. It seems hardly necessary to discuss this approach again; such ways of thinking merely characterize those persons who are actually unacquainted with the psychological nature of accidents. Regardless of the extent to which the psychological investigation of accidents is carried, it will still not be possible to predict the precise day and hour in which an accident will occur. The situation is similar to the fact that even with our best seismological techniques we are unable to predict the exact moment an earthquake will occur but have only previous indications that it looks as if an earthquake will soon occur. Just as it is possible to broadcast earthquake warnings on the basis of certain changes in the rise and fall of the tide, it is possible to have previous indication of an accident on the basis of a forced landing necessitated by engine trouble. Thus for example no matter how skillful the qualifications tests are that we devise, we can understand by such tests only the relative degree of accident frequency a particular individual will manifest. Then the man who is unsuitable with regard to probable frequency of accident occurance will similarly be difficult to train and will prove himself unskilled with the various techniques of piloting. Whether an accident will occur or not must be determined by whether or not an individual shows an inferior performance with regard to certain tested skills. These two factors are often closely united. There are also those persons who even though their piloting may be extremely skillful under normal circumstances have serious doubts concerning their ability to perform satisfactorily in a danger situation. However, the revelation of this trait also belongs to the ultimate goal of qualifications testing. The great difficulty lies in the fact that whether or not an accident is apt to occur frequently

depends fundamentally upon the many complex conditions that give rise to the accident itself.

It might be wise to add that it is necessary for the psychologists and others who undertake the investigation of accidents to be extremely careful in certain other respects. First the investigator must not be deceived by the size of the particular accident. Often with extremely severe accidents where the plane is smashed beyond recognition and the passengers are entirely destroyed, the basic cause was an extremely small matter. It is frequently the case that whether or not an accident is drastic in appearance depends upon the chance factors of the situation. Thus in studying accidents it is necessary to bring the operating chance factors into clear focus. The way in which these chance factors came into play must also be considered. Since severe errors and mistakes can also directly influence the type of accident even though the chance factors of the situation are operating, if the investigator concentrates too exclusively upon the phenomena of accidents he will be unable to grasp the important psychological factors that influence aviation accidents.

Those men who set out to discover the mechanical cause of accidents often become so accustomed to dealing only in terms of the cause they are out to find that they see only the superficial aspects of the accident. In a situation where an accident has occured due to engine failure as a result of the wearing out of a certain metal part, such investigators will search only for the worn metal part without concerning themselves with the fact that only a small amount of damage was done to the plane or that a large number of passengers happened to be injured by the crash. In those cases where the accident is due merely to the operation of a single physical law of cause and effect this kind of approach is quite adequate. However, if the basic cause was due to an error in human judgment, such an approach is liable to prevent the investigator from obtaining a reliable picture of the essential factors involved in the accident. When it is determined to make a forced landing due to engine failure resulting from a worn engine part, the way in which the decisions are made in effecting the landing becomes extremely significant. Certainly a great range of possible events is afforded if the pilot is free to select at will the time to attempt the landing and the place it is to be made. The accident is large or small according to whether he selects one particular alternative or another. If there is a tree stump in the path of the forced landing, the reasons why the pilot did not select another place or why he was unable to avoid the stump can all be investigated. Accidents vary greatly from one to the other with respect to their relative size, however the mental attitude of the pilot that is largely responsible for these variations is often unknown. Thus when we investigate the psychological facts which accompany the phenomena of an accident, we must make every attempt to discover the mental attitude of the pilot that is consistant with the form of the accident. A consideration of the points made above should indicate the general method by which the psychological study of accidents should be organized. That is, the first point of concern in the plan of investigation should be the accurate description (Beschreibung) of the accident rather than a statistical compilation of data. A statistical study offers only the first hint as to where the significant problems for investigation lie; by averaging the complex

chance factors involved in the accident one is apt to obliterate the psychological individuality of each accident. Consequently it can be said that the psychological study of accidents seeks out the psychological pattern (Gesetz) of the accident, rather than the operating laws (Regel). Indeed it is only by carefully and accurately inspecting of the facts of the accidents with a view of discovering an underlying pattern that principles will be induced that can be practically applied to accident control, qualifications testing, and personnel training methods.

A Survey of the Causes of Accidents

If an aviation accident occurs, by what method are we to determine its primary cause? A practical answer to this question becomes necessary here.

When a report is received at an air base that one of its planes has had an accident at once the necessary persons are dispatched to bring back the passengers involved and the damaged plane. In those cases where some injury has happened to the passengers or where their injury is suspected a medical doctor must also be sent. At the same time another group of men at the post are delegated to act as an accident investigation committee which then accompanies the pick-up squad to the scene of the accident. This committee is composed of pilots and other technicians such as maintenance operators and at times contains also aviation medicine and psychology experts if they are available. At the scene of the accident the situation at hand is photographed in detail and descriptions of the course of the accident are obtained from those persons directly involved in it. In those cases where this is not possible, accounts of the accidents are obtained from those who observed the accident from the outside. Then when it is said, for example, that something went wrong with the engine, a member of the investigation committee will attempt to start the engine on the spot -- if it is possible. When all pertinent information relevant to the accident has been gathered at the scene of the accident, the fuselage and engine of the plane are dismounted by the pick-up squad and brought back to the home base. On the basis of the material it has obtained at the scene of the accident, the investigation committee decides upon the cause of the accident, makes a report of its conclusions, and prepares a description of the course of the accident and suggestions for the prevention of similar accidents in the future. The commander of the post then attaches a statement of the measures taken with respect to those responsible for the accident and transmits the report to the Central Office of Accident Prevention. The Central Office of Accident Prevention examines the report and directs such subsequent investigation as seems advisable; if necessary, representatives of this office are sent directly to the base in question and conduct whatever special investigation may be needed to bring the data to completion. A final decision regarding the accident is made and a record of the protocol printed and distributed to the areas concerned. Appropriate data are transmitted to statistics centers and those offices concerned directly with the design of accident prevention methods. In order that the counter measures may be inclusive in nature and that efficient liason be maintained among the areas concerned the Office of Accident Prevention has at its service men familiar with piloting,

maintenance operation, communications work, weather determination, plane design, flight control, legal aspects of aviation, aviation medicine and psychology, and so forth.

Ideally accident investigation is carried out in this manner today, yet I feel I should add that in our country this method is not always followed in practice. It is true that the essential problem for the psychological study of accidents lies in the matter of how the judgment of the investigators becomes transformed into counter measures for the prevention of accidents, but the vital point of the investigation is specifically the clarification of the responsibility for the accident. Here a great difficulty that faces all countries is the standardization of the terms and concepts which underlie the judgments involved.

As one can well imagine the true cause of accidents is a very complex thing. For example even with regard to accidents that have occurred due to inferior piloting skills, if the mechanical safety of the plane had been high enough to compensate for these inferior techniques the accident would not have happened. Then in much the same way the responsibility for the accident can be placed upon the training that the pilot had received. If one were to investigate the matter closely enough he would probably be able to trace the fundamental cause of the accident to a number of fundamental techniques. Thus one should hardly be able to say that the task of determining a fixed principle upon which to base the responsibility for such a complex matter is an easy one. It often happens that the decision must be entrusted to a qualified judge with only faith in his competence. At that point the investigation is no longer a science. The matter can be compared to traffic accidents where at times the responsibility is delegated to the operator of the vehicle since he was driving on the right hand side of the road instead of the left, and at times it is delegated to some breakdown of the machine as in the case of a tire blowout. Usually we find that the responsibility for accidents is placed upon the machine when the conventional design of the machine has been revised, upon the instructor when he attempts to improve his method of teaching, and upon the pilot when one wants to point out the working strain upon the pilot. It is natural that judgments of the cause of accidents and the numerical data that appear in statistical tables based upon these judgments not be made in themselves the object of a scientific study. The attempt to do so results only in further complication of the situation. Thus we see that the judgments that underlie the determination of the cause of accidents have a marked tendency to reflect sensitively influences from any aspects of aviation that are operating at the time of the judgment. The study of the techniques involved cannot simply be delegated to the scientist.

However, if we fully realize what has been stated above, a common sense approach to the statistical analysis of the causes of accidents is not entirely without value. I shall utilize an outline of aviation accident statistis as a focal point about which to continue my discussion. Even so, I am not permitted here to publish the latest figures concerning air accidents. I shall have to be satisfied for the present with civilian

aviation accident data. Of course as I have just said, the actual numerical data themselves are of no great significance. The first statistics I shall present are American and appear in H. G. Armstrong's Principles and Practice of Aviation Medicine, 1939, which was translated by the Aviation Psychological Branch of the Department of Aviation at the Imperial University. (The translation appeared under the title Aviation and Man.)

This book presents the following classification of the cause of aviation accidents:

I. Human Errors
- A. Errors of the pilot
  1. Errors of judgment
  2. Inferiority of technique
  3. Disobedience of orders
  4. Miscellaneous
- B. Errors of other personnel
  1. Errors of supervisory personnel
  2. Errors of maintenance personnel
  3. Errors of other personnel

II. Material Defects
- A. The engine system
  1. The fuel system
  2. The cooling system
  3. The ignition system
  4. The lubrication system
  5. The structure of the engine
  6. The propeller and propeller accessories
  7. The engine control system
  8. Miscellaneous
- B. Body defects
  1. The flight control system
  2. Movable surfaces
  3. Stabilizing surfaces; strut and metal fittings
  4. Wings; struts and metal fittings
  5. Landing apparatus
  6. Wheels, tires, and brakes
  7. Fuselage, engine mount, and metal fittings
  8. Cowling
  9. Tail wheel and skid
  10. Miscellaneous
- C. Handling qualities
- D. Instruments
- E. Miscellaneous equipment

III. Miscellaneous
- A. Weather
- B. Darkness (Visibility)
- C. Airfield and landing surface
- D. Other

The point that is of particular interest to us is I. Human Errors and especially I. A. Errors of the Pilot. This classification divides the fundamental cause of accidents into three categories. However this classification is applicable chiefly to civilian aviation since several aspects of military aviation have been overlooked. These divisions can be divided into even greater detail. The numerical values that correspond to this classification can be found on page 293 of Aviation and Man. They are as follows:

CAUSES OF ACCIDENTS IN CIVIL FLYING

CAUSE	Commercial	Pleasure	Scheduled
Personnel:			
Pilot:			
Error in judgment	12.14	8.13	12.50
Inferiority of technique	14.88	30.31	1.79
Disobedience of orders	0.00	0.34	3.57
Carelessness, negligence	11.56	12.05	14.29
Miscellaneous	0.00	0.43	0.00
Total	38.58	51.26	32.15
Others:			
Supervisory	2.02	0.00	4.46
Other	0.87	0.92	3.04
Grand Total	41.47	52.18	39.65
Engine Failures	13.43	17.40	10.71
Structural Failures	16.77	9.09	10.71
Total	30.20	26.59	21.42
Miscellaneous:			
Weather	10.75	6.02	21.07
Darkness	0.29	1.63	0.00
Airfield (water or land)	13.41	8.17	14.29
Other	3.76	3.81	0.00
Total	28.21	19.63	35.56
Undetermined	0.00	0.57	3.57

According to these figures general mechanical causes made up 26% of the aviation accidents, those causes due to sky and land environment comprised 28%, and the remaining 46% were due to human causes; of the human causes only an extremely small percentage were due to errors of persons other than the pilot. These results differ only slightly from the figure of 55% accidents due to human errors that was published somewhat later, yet this figure must be questioned because of the possible influence of propaganda. In regard to military aviation the responsibility for the accidents is greatly complicated; since forced flights are necessary the figures for accidents due to human causes should probably be generally increased as the flying time per accident is correspondingly reduced.

The following figures that are indeed quite old were published by

an English naval physician after the First World War. The figures refer to a study of 58 accidents. (Why he took this small number of cases, I do not understand.) Anderson: Public Safety and Accidents Investigation Committee of the Royal Aero-club. "Aeroplane Accidents" in J. of Naval Medical Service, 1918.

Body and Engine Accidents	1
Errors of Judgment	42
Carelessness	7
Fatigue	4
Unavoidable Opposition	4

When the figures are grouped with respect to the time of flight when these accidents occurred, they become:

Taking off	10
In the air	2
Landing	46

According to these figures we see that by far the largest number of accidents were due to errors in judgment of the pilots and that landing is the great trouble spot in flying. The situation has not changed today.

An interesting study with respect to the cause of accidents was published shortly after Anderson's work by the German psychologist O. Selz. Selz's figures incite more interest than the preceding data in that they are organized around an analysis of the objective causes of accidents that are due to constitutional factors and factors based upon experience. His data are as follows:

OBJECTIVE CONDITIONS OF ACCIDENT	% CONSTITUTIONAL CAUSES	% EXPERIENTIAL CAUSES
Landing difficulties	31	7
Interference by other planes	81	4
Wind	43	12
Too great or little speed	88	8
Incorrect turns	70	0
Other poor control by pilot	82	10
Negligence of pilot	86	14

Selz attempts to allocate the cause of most aviation accidents to constitutional factors and takes into consideration such psychological concepts as the distribution of attention, the power of concentration, judgment ability, and self control. On the basis of this work he devised qualifications tests composed of tests of distractibility, dexterity, and emotionality. This work seems to be regarded rather highly at the present time.

We shall return later to the causes of accidents; next we shall consider the phenomena of accidents.

The Phenomena of Accidents

American figures are available concerning the various types of aviation accidents with respect to the manner in which the accidents occur.

Even before the work of Armstrong it was well recognized that more than half the airplane accidents occurred during the time of the landing or take off. In other words the airplane is weakest when it is on the ground. Just as butterflies and moths are able to flutter with agility and grace in the air but are reduced to a shaky creeping on the ground, so airplanes are able to make no more than struggling movements on the ground. Airplanes by no means necessarily return to the airfield from which they took off. Since flying is not possible without landing and taking off, it is somewhat natural that accidents should occur more often in these stages. The following data by Armstrong support this point:

NATURE OF ACCIDENTS	% COMMERCIAL	PLEASURE	OTHER
Part I			
Collision with objects other than airplanes	6.31	1.42	3.52
Spins or stalls (engine failure)	0.52	0.56	0.77
Spins or stalls (not engine failure)	5.78	6.25	8.52
Forced landings	11.00	17.30	13.52
Landing accidents	44.00	44.00	44.00
Take Off accidents	22.00	22.50	19.70
Taxying accidents	9.25	5.96	6.93
Fires	0.00	0.28	0.44
Structural failure	0.57	1.14	1.54
Part II			
Fires after crash	1.73	1.42	2.42
Propeller accidents to persons	0.51	0.85	0.99
Taxying-airport accidents	0.00	0.00	0.11
Glider accidents to persons	0.57	0 00	0.55
Parachute jump (involuntary)	0.00	0.28	0.77
Acrobatics	5.78	3.70	5.39

(The figures in Part II are included in Part I)

I shall attempt to describe these types in brief detail.

Collision with objects other than airplanes: running into the side of a mountain in a fog, striking the ground when flying too low, etc.

Spins and stalls (due to engine failure): the engine suddenly stops, the pilot makes improper control of the steerage. The early airplanes were apt to go into a spin simply if the engine stopped.

Spins and stalls (other than above): poor control in acrobatics or defects in the body of the plane.

Forced landings: the engine fails to function properly or the plane meets impassable atmospheric conditions so that it is necessary to land in a nearby open field. Sometimes it is possible to land in a place of the pilot's choosing, at other times not. In the old days they would tell of running up against engine trouble over the middle of a pine forest and being able to land, make repairs, and take off again without incident; but today one should imagine the feat would be quite difficult considering the nature of our airplanes. However, it is often possible to land, make repairs, and take off in forced landings depending upon the type of ground surface available. Even when a plane finds it necessary to land at a nearby airfield because of engine trouble it is technically termed a "base forced landing."

Landing accidents: failure to contact the ground surface properly due to poor control of the direction, angle, and speed of the approach or due to a sudden change in direction to avoid an obstacle or a tire puncture.

Take Off accidents: turning suddenly because of some obstacle in the runway, or attempting to headup without sufficient engine power, or banking too quickly.

Fires: a spark from the wiring system ignites the fuel system. Unusually poor engine adjustment, especially in the carburetor.

Fires after crash: Fire often breaks out because of the failure to cut the ignition switch in making a forced landing.

Airport taxying accidents: these occur chiefly on narrow runways and usually involve collision with other airplanes. Sometimes when taxying on too rough ground the wings will snap because of inertia.

Involuntary parachute jumps: the meaning of this classification, together with that of propeller accidents and glider accidents, is not clear to me. Perhaps it refers to the accidents that occur when a person falls out of the plane because the safety belt comes loose.

If I continue to write on the description of accidents some readers may actually begin to be afraid of airplane accidents; they must not overlook the fact that these occur only after long intervals of flying time. Yet one should certainly not fail to discuss accidents because of the cowardice of such few individuals.

Then how many lives are lost by aviation accidents? We have recourse to the following statistical data from Armstrong's work. They refer to percent of accidents in each group.

	Uninjured %	Light Injury %	Heavy Injury %	Death %
Scheduled Flights	70.0	13.2	6.2	10.6
Commercial Flights	79.2	7.1	2.5	11.2
Pleasure Flights	80.1	8.1	4.1	7.7
Other	75.2	9.4	4.6	10.7

If we rely then upon these figures, in the neighborhood of 80% of the persons involved in accidents do not receive injury. The death rate for forced landings is around one out of ten persons. However since the death rate due to explosion or collision in the air is considerably higher one can see that the comparative safety of forced landings is due to the relative possibility of directed effort to minimize bodily harm.

The Human Factor in Accidents

If one were to attempt to determine the absolute cause for any accident he would probably be brought back sooner or later to a realization of the fact that its comprehension is beyond the power of human understanding. This is because the airplane is in its every aspect fundamentally a creation of the heads and hands of men. Yet in considering the human element in accidents we can say that in a certain sense the plane is separated from the working hands of man as it leaves the production line, and we shall concern ourselves with the human factors that operate once it is passed into the hands of pilots and maintenance men.

Of course in doing so we must not feel that we are dealing with an absolute machine at this point and that the separation between man and this machine is unalterable. Our distance between pure man and machine is in continuous oscillation so that we are pushed now to the side of man and now to the side of machines. Our selection of the starting point of the human element is entirely arbitrary.

Consideration of the various phenomena of accidents that have been described above reveals that a division into two types of accidents is possible, the first type containing those accidents that occur when a mechanical obstruction arises that prevents the pilot from flying as he wishes, the second comprising those that occur when no particular obstruction comes up but which are due to some type of inferior handling of the plane. Yet if it is possible to correct the mechanical obstruction the matter never gets within the realm of accidents -- it remains merely an "incident." On the other hand in those cases where an insignificant mechanical defect is progressively enlarged and aggravated by improper handling of the machine, the resulting accident must be attributed to certain human elements. Even though there are no clearly defined limits to human factors I shall attempt to consider their functioning as a whole.

It is quite easy for the average man to think upon hearing the phrase "aviation accident" that the whole incident happened in a brief moment and that it was not possible for the pilot to organize appropriate counter measures to deal with the situation. Yet all accidents are by no means instantaneous in nature. It is possible to check accidents to a considerable extent by well directed judgment, determination, and control. The situation is the same as with disease where the suitability or unsuitability of medical diagnosis often determines whether recovery is possible.

Then what steps should a pilot take if at a certain altitude he develops serious trouble so that it is clearly impossible to continue flight?

(1) First he should determine as accurately as possible the cause of the engine trouble.

(2) He next must consider whether or not he can repair the defect and achieve engine recovery; if he decides that it is possible to do so he must organize the measures he is to follow.

(3) If he decides that he is unable to repair the damage he must choose a place for a forced landing and guide his course in that direction. Of course, if engine failure had been at all expected, suitable landing places should have been determined beforehand while flying.

(4) If it becomes clear that recovery is not possible the pilot must pay particular attention to maintaining his altitude. Only when he is confident of his control of the plane in making the forced landing should he directly lower his altitude.

(5) Once the landing place has been selected the pilot then proceeds to judge the condition of the landing surface and to ascertain the wind direction. Finally he raises his goggles so that he won't be injured on the shock and cuts the ignition so that fire will not break out.

This procedure applies to those situations where a mechanical obstruction to engine performance occurs. If these operations are carried out in a manner appropriate to the situation the damage to the plane is held constant, and the matter remains an incident. If the failure was due to some simple malfunction, as for example a clogged fuel line or a disaligned stop-cock, the necessary repairs can be made on the spot. In other words, such situations arise when the pilot finds that he is prevented from controlling the place as he might choose best.

However if one of the five general procedures mentioned above is poorly executed, the mechanical factors within the situation are severely aggravated by the human factors. For example:

(1) If the cause of the mechanical obstruction is not correctly ascertained, that is, if the pilot fails to identify the trouble as being in the fuel line or lubrication system, foolish and inappropriate corrective measures are organized. When the pilot sees that his efforts are fruitless he may become greatly rattled depending upon his particular personality. Errors here can lead to serious consequences.

(2) If the pilot decides that the damage cannot be repaired in the air and he knows that his home base and destination are too distant to be reached, he must calmly undertake his forced landing without delay. If he unwisely puts off his landing his initial advantage in altitude may be entirely lost.

(3) Thus the pilot should always be careful in selecting the altitude at which to make his flight. For example even though in a test flight the pilot has every degree of confidence in the instrument he is using, because it is in fact a test flight he should be particularly careful with respect

to maintaining sufficient safety altitude and flying space.

(4) To what extent the pilot should continue to attempt to start his plane or make repairs while in the air is entirely a matter of his own best judgment. Proper decisions are made only by his keen "machine eyes" with respect to his particular position and situation.

(5) If it is necessary to attempt a forced landing, the decisions involved should be judged with care but executed unfalteringly. Unlike everyday breakdowns in almost all conditions of forced landings, re-flight or making repairs when once on the ground is impossible. The pilot is given time to make only one decision, and that decision must be accurate. If he is unable to make the proper decisions such an accident can arise that it is not possible to tell whether it was a forced landing or a crash.

We see then that there are many instances in the course of events that follows the development of engine trouble in the air at which it is possible to aggravate the nature of accident that may ensue, and if proper adjustment is not made to these instances avoidable accidents can come about. Thus the subject matter of volitional psychology becomes extremely important in the study of accidents.

The type of accident described above is one in which the pilot's control of the situation goes hand in hand with the mechanical obstruction as fundamental cause; thus the ability to make the various judgments and determine the necessary counter measures to prevent a serious accident in the case of engine trouble should be added to the various skills that mark the qualified pilot.

There are other accidents that are somewhat similar to this type yet that are almost entirely due to human factors. These are the accidents that occur when due to insufficient familiarity with the machine, insignificant occurrances take on the "illusion" of serious defects and the pilot follows the procedure outlined above to an accident. If a pilot does not have complete confidence in his engine (particularly if he is a certain type of individual) it sometimes happens that he will look at the usual exhaust flame or hear the ordinary sound of the engine yet imagine that something has gone wrong. The situation is analogous to the occasional fear of the inexperienced passenger that arises out of a misinterpretation of insignificant phenomena of flying. These accidents depend upon a sufficiently thorough preparation of the plane to allow the pilot freedom from worry and accurate knowledge of and objective familiarity with the plane on the part of the pilot. If these two conditions were satisfied the accidents due to such illusions could be reduced to a minimum and there need be no fear of these unfortunate accidents. Such accidents are of course included in the statistical tables we have presented under mis-judgments and illusions of the pilot.

Yet by no means all of the mechanical defects that lead to aviation accidents are due to faulty design or manufacture of the plane. First, when a pilot makes an error in handling the body or engine the engine itself will sometimes be unable to function properly. In the second place the mechanical obstruction may be clearly due to human error in the

preparation and maintenance of the plane.

With regard to the first of these, the pilot's handling of the machine, the problem rests again in the relationship between man and machine. The aviator asks, why do they make these planes so difficult to operate? The designer on the other hand asks the question, now why do the pilots have to make such errors? Here we meet the crux of the matter of producing airplanes that are machines that must be used and handled by men. Complex engines are entirely comparable with scissors in that if even the simple machines of household use are not handled properly, they do not work. If a rapidly operating engine is suddenly cut off, the engine is upset and makes an unusual exploding sound, and if altitude is lost very quickly the engine will become too cool. Not only inferior skills of this kind are involved, but if the pilot forgets to shut off the cooling system in a hard cold wind the engine will also become too cool, and if he forgets to adjust the feed cock the engine will stop due to lack of fuel. It is quite easy to reduce these matters simply to the stupidity and inattention of the pilot, but that is only the more reason why psychology should be concerned with them.

The structure of an airplane has gradually come to be an exceedingly complex and elaborate thing. Due to the fact that even though a possibility of error is provided each time a new technique is introduced, the technique itself prevents the performance of a larger number of inferior and faulty operations, air men are able to operate an airplane of considerable complexity with only a comparatively small amount of training. Consider a more familiar example. By equipping street cars with automatic door opening devices the activities of the car men are somewhat increased, but if the door is not closed the car will not go forward and the car man knows that the car will not go forward when the red light indicates that a door is still open. Thus when increased operations become necessary it is possible to construct automatic devices to perform them reliably, and even though it may result in mechanical complication it provides a simplification of the necessary human acts.

However, even though we can recognize the fact that the mechanization of human activities in flying has been carried out to a remarkable extent, it has by no means reached the stage where all human oversight and errors are prevented. In other words the acts of operating necessary to control the functioning of the engine and the acts of piloting necessary to guide the plane to the desired destination are still two discrete systems. Adjusting the fuel cock is not directed in terms of piloting the plane. Likewise opening and closing the ventilator doors has no direct relationship to piloting. Therefore if the volitional activity associated with piloting should happen to demand an excess of mental energy to overcome an obstacle that has arisen, one might expect that at this point the mental energy associated with operating would be reduced, possibly resulting in omissions and oversights. However, the process of mental activity is no such simple thing. Even a simple act of forgetting such as that to which I have just referred cannot be satisfactorily explained by such reasoning. For example many people who firmly resolve to post a letter they have just written on their way to the office actually end up forgetting

to do so. The implication here is that the forgetting occurs because the task of going to work over a long period of time has resulted in the establishment of a smooth pattern of activity that is entirely different from that formed by saying for the first time, "Now I must stop and mail this letter if I run across a mailbox on the way." If a different road from the usual is chosen in order to mail the letter, forgetting is not likely to occur since the customary pattern of going to work is not satisfied and a connection can be formed between the two different patterns of activity. A similar explanation for the human omissions and oversights in piloting can be found within the fact that the mental task of piloting is composed of a group of activities that are organized into various different mental systems.

Thus we should expect to find that when a pilot is suddenly transferred to another type of plane from that with which he has long been familiar, the new operations that are required in the control of the plane would be fairly frequently forgotten. It might even be said it is not advisable to let the pilot become too accustomed to flying a particular type of plane if he will have to be transferred to a more complex type later. If a drastically new method of piloting is involved there is no great danger of forgetting when the pilot is consciously attending to the new techniques, but if the change is slight the pilot is apt to slip into his former habit with a resulting omission of the new operation. Thus one should expect the omissions and oversights in piloting to be divided into a number of types of operations, each with a characteristic underlying tone, and only those which conform easily with the individual type of pilot are apt to be well performed by him. Those operations that can be most reliably executed by an individual conform most closely with his own particular mental organization and correspond most precisely with his present psychological make up. The structure of our piloting and training methods must be directed in this light.

Next we have accidents that involve human errors in preparation.

With regard to accidents that are fundamentally due to inadequate service of the plane since the nature of preparatory work has come to be largely specialized, the particular responsibility for the accident can be rather precisely allocated. If for example an accident should occur because of inadequate fuel supply, a defect can be found within the fuel lines upon inspection, and investigation of the work of the man whose duty it was to check the line can be initiated. Because there are many different types of preparations work -- we say that "there are many types" but we mean that the work has become independently specialized to a certain degree -- there are also many kinds of preparations errors possible. A statistical analysis of the aspects of preparation work that are most often found to be faulty and of the relative success of different preparations methods is accordingly of considerable value. If the frequency of accidents due to particular maintenance deficiencies is known, appropriate working and inspection methods can be devised to limit these errors. One is able to evaluate such methods as the "fool-proof plan" in this way. However, simply because a certain aspect of preparation is often found to be deficient does not necessarily mean that essentially psychological

problems are involved. The difficulty may conceivably lie in the mechanical part itself.

As I pointed out in connection with the fool-proof method, the difficulty of preparations work lies chiefly in the fact that the various parts of the plan differ in the temporal period at the end of which they should be inspected. It is generally the case that in those points that need inspection daily there are actually few defects, and conversely those points it is not necessary to check except over an interval of time (that is, the points in which there are few defects) are actually the places where we find the defects arising.

However, if the determination of the responsibility is relatively easy, the psychological investigation of the reasons behind faulty preparation is correspondingly more difficult. This is due to the fact that unlike that of piloting the mental set towards preparations work must constantly change with the changes in the work to be done and a fixed pattern for the performance of the work cannot be established. Then the quality of the manual skills involved in the work, such as whether a valve is closed too tight or not closed enough, does not readily appear on the surface of the work. Since such manual skill is not particularly important in preparations work on airplanes, the most significant errors lie in omissions and forgettings within the body of work to be covered. Then among these there are many where the term "forgetting" does not accurately apply; some errors lie in the failure to manifest sufficient power of observation to discern whether certain parts are defective or seem "to be about to become defective." Even in the "fool-proof plan" the inspector has to judge whether specific parts are defective or not.

In short, the first essential requirement in order to prevent accidents due to faulty preparations is to perform the work slowly, steadily, and faithfully. These three qualities are far more important in the long run than that the work be done rapidly. Herein lies the fundamental difference of preparatory work and the job of piloting which is largely fixed with respect to these attributes. Even though preparations work is executed rapidly, the increased speed alone does not raise its efficiency. A job of 50 minutes that is done in 40 minutes has raised its efficiency only 20%. Moreover with respect to accuracy a job of 100 units of work even though it took the time of 120 units of work still manifests the efficiency of 100; yet work of an efficiency of 99 may at times result in a practical efficiency of zero.

Let us take a concrete example of a typical preparations situation. An operator is inspecting the flight control system and finds that a metal connecting pin is defective. When he attempts to replace it he finds that at the moment he has none on hand in his work kit. He will then probably do one of the following:

(1) He will go out in search of the material and without considering other work, will continue his search until he finds it, whereupon he returns to the plane and replaces the damaged pin.

(2) He walks around and tries to find the material, but since he has too much other work left to do he does not stop on the way; yet gives notice of the defect and marks it clearly.

(3) He allows the slightly defective material to pass, but does not forget to find the material later and replace it the next time.

(4) He lets the defect remain, intending to replace it, yet subsequently forgets to do so.

(5) He leaves his work to look for the material, but on the way meets another with whom he stops and talks for a while so that he finally forgets what he was looking for and returns to other work.

It is probably obvious from which of the situations above accidents are likely to result. Thus it appears that whether or not the work will be done accurately and faithfully depends chiefly upon the personality, mental attitude and working habits of the individual maintenance operator. If intelligence and common sense are necessary to perform the tasks of preparation work, it is just as essential that the worker be able to force himself to continue to work until he has overcome the obstacles that arise in his path. In order to be able to perform the techniques of maintenance work skill as such is not particularly necessary; instead, a certain amount of intelligence, mechanical familiarity, and common sense of the hangar is required to learn the techniques involved. But in order for a worker to continue to do good work a conscientious attitude is primarily essential. In other words it appears that the necessary qualifications necessary to be able to perform a stereotyped and practical type of work and those necessary for the best continued performance of the work need not always be the same.

There are still other human elements that influence the course of accidents that we have not considered. For example aviation medicine has already done much work on the efforts of the clouding of consciousness due to acceleration and centrifugal force, and oxygen deficiency. Other factors might be the unskilled manipulation of the controls of the plane due to any of the various normal flying illusions or the voluntary disobedience of orders and regulations. However, I shall not attempt to take up these factors individually here; the material presented in the first and second chapters of this book will give an indication as to where the chief human weaknesses lie. These factors must all receive consideration in the construction of adequate aviation qualifications tests.

When one thoroughly investigates the course of an accident he is usually impressed with the fact that it was largely by chance that the accident actually happened. Although the same defect is present in the plane, the accident that occurred in the flight is entirely different from the performance of the plane on the warm-up test run or at the take off. Why did the accident not occur as soon as the take off was made? And why did it take place when it actually did? One can do no more than say that it was chance. And it is chance. It is chance that two systems of cause

and effect should cross at a given instant and give rise to an accident. However one of these systems, the one by which an obstruction arose in the engine, can be anticipated and should be prevented. In this way we are able to forestall accidents. If this first cause and effect system is prevented it is natural that the two systems should not coincide. Thus many of these cause and effect systems must be rigorously sought out and precluded. If aviation machines are refined to the extent that obstructions will not occur, if landing strips are entirely free from obstacles, and if flight regulations are faithfull adhered to, it is safe to assert and that marked reduction in aviation accidents will result. The factors that remain are the individual differences in the volitional structure of the pilots, the crude nature of our human sense receptors, and the lack of precision in our thinking.

The exclusion of the human element as a causal factor leading to accidents must be sought in three stages: the thoroughness of personnel selection by adequate qualifications testing; the successful penetration of aviation training; and sufficient interest in the work.

Yet even by the strictest application of these three counter measures -- for example, American selection standards are so high that 70-30% of their personnel do not qualify -- it is not possible to say that accidents can be entirely checked. Even though one may be completely confident of his ability to finish a meal without dropping a single grain of rice and then actually succeeds in doing so, it is difficult to extent the matter to saying that he can do it for a year and then several years straight. Most persons are quite sure they can perform simple addition problems correctly once, but the matter becomes changed when a thousand and two thousand problems are presented. Unfortunately, man's will is not as free as he might like to have it, and various changes in behavior can arise because of these limitations. Even though one manifest a maximum interst in what he is doing, it cannot be said that he will not lapse into brief distraction. It is indeed true that "man errs when he is exerting effort."

It is probably true that so long as the airplane is an instrument that is used by man, a state where there are no accidents due to human cause will not be achieved. This does not mean that there is absolutely no possibility of reaching such a state, however great difficulties lie in the path of attaining this goal by human means. Qualifications testing cannot select men who positively "will not" cause accidents; it can only indicate the men who have such volitional power that they will make a sincere effort not to cause an accident themselves. These men can at any time become potential sources of accidents simply by relaxing this effort, and about this factor qualifications testing can do nothing. Here we find the limit of personnel selection and the boundary of training.

POSTSCRIPT

As I reread this manuscript which is now after a year and a half ready for publication, I am struck with a number of deep emotions.

When I first took up my pen it was my intention to name the completed book Aviation and the Japanese, but since it is the hope of the book shop that the title of the book most clearly capture the spirit of the work, as the volume grew in size its title was revised to Aviation Psychology. In organizing the contents of the book it was my effort to select material that dealt primarily with the psychological characteristics of the various branches of aviation. For more thorough consideration of aviation qualifications testing and personnel training I revised a portion of this book and added more detailed material within another book, Aviation Qualifications, which is already in publication. In these two works my original plan has been carried out.

Truly I find it difficult to justify the fact that a person should undertake to write a book while engaged in public duty. Of course, my public service is directly related to aviation psychology, and since this book deals with that subject, my literary effort is in many aspects a furthering of my daily work; yet trying to perform both tasks separately, with the steady change of time and place, I found extremely difficult even from a psychological point of view.

This manuscript was written in the study of my home in Zuchi, it was written in my bedroom at the flight school where I worked and it was written on the straw mats of strange hotels. No matter where I was my work was constantly interrupted to my great consternation, and no matter how many times the manuscript was revised I found myself straying too far from the point and taking great detours so that the final product is in truth very difficult to read. The sections that most sorely need attention are those parts of the first chapter dealing with perception and those of the second that pertain to the analysis of acts. However since I have already come this far, I shall boldly let the work stand as it is. Consequently if any meaning is gotten from reading this book, I shall be very pleased.

Thus many psychological difficulties were experienced in writing this book, however the main reason why I continued the work in spite of these difficulties has been, as wrote in the preface, because of a sincere promise to my bother.

My eyelids burned at the luster of the decoration of the Superior Fourth Order of the Golden Dove, and I was fired with determination to conquer these difficulties. A young eagle wants to fly from one height to another. In so far as I am associated with aviation psychology, it is in my position to help many young eagles to become strong eagles. At this moment planes are flying the sky above the coast of Sagami. I lost a brother in that sky, but I make his spirit my spirit, and I shall strive to give strength to a thousand and to ten thousand eagles.

If this insignificant writing is able to serve in the least this purpose, it will be the noblest gift of farewell to my brother I am able to offer and it will realize my hope that is even beyond hope.

Even though it comes at the end of the writing, I should like to give most cordial thanks for the good will shown by those who have assisted in the preparation of this book. The commanding officers of the Air Force Headquarters who bestowed their ready consent; to Mr. Hisashi Hoshunichi who gave advice concerning perception; to Mr. Furukawa Tesshi who offered criticism related to ethics; to those associated with Mr. Yamasaki Tadao of the Head Flight Office for their many valuable suggestions concerning censorship; and to Mr. Nishiyama Kenji at the publishers Koyama Bookstores, I express my most sincere appreciation.

The Author