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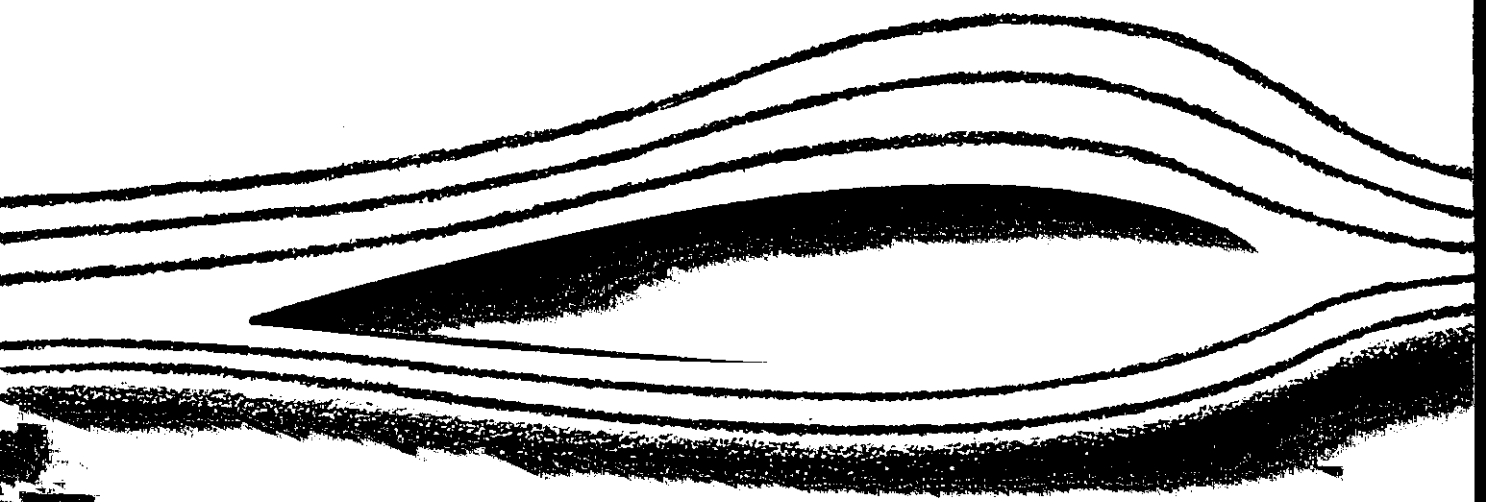
FLIGHT INSTRUCTOR'S HANDBOOK



DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

FLIGHT INSTRUCTOR'S HANDBOOK

Revised 1969

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Flight Standards Service

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FOREWORD

This handbook has been prepared by the Flight Standards Service of the Federal Aviation Agency for the information and guidance of pilots preparing to apply for flight instructor certificates, and for use as a reference by certificated flight instructors.

It has been prepared for use in conjunction with the (pending) Federal Aviation Agency *Flight Training Manual* and the *Private Pilot (Airplane) Flight Training Guide.* It supersedes Civil Aeronautics Administration Technical Manual 105, the *Flight Instructors' Handbook,* dated January 1956.

Some of the material in this handbook has been derived from the flight instructor refresher course developed by the Department of Aviation of the Ohio State University under a grant from the Link Foundation. Certain material on teaching procedures has been derived from the *Aviation Psychology Manual for Flight Instructors* prepared by Mr. Harold Holmes, of the National Safety Council, and Mr. Thomas Hogan for use in courses given by the Chicago Teachers College.

We acknowledge the valuable assistance of these institutions, and appreciate their kind permission for us to draw from their works.

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I. FUNDAMENTALS OF TEACHING AND LEARNING

A. How People Learn

The purpose of all instruction is to help students learn. Instructors work to see that learning occurs. The objective of all true learning is to effect behavioral changes.

When he enters the field of flight instruction, the professional flight instructor must consider his own goals in the conduct of flight instruction. He must ask himself "What must the flight instructor strive to accomplish?"

Education in general has three distinct purposes: The discovery of new knowledge, the dissemination of existing knowledge, and the translation of facts and knowledge into action on the part of the student. These three purposes are also directly applicable to flight instruction.

First, research in the areas of engineering, medicine, psychology, and aeronautics continuously brings to light new facts about piloting. The uncovering of these new facts and data which relate to flight instruction is generally, but not always, accomplished by universities or governmental and industrial research facilities.

Second, this information must be made available to those who can and must use it effectively. This educational function is usually accomplished by the use of publications such as textbooks, manuals, and technical releases; and by aviation symposiums, pilot-training clinics, and other special courses.

Third, once ideas have been discovered and the knowledge shared, it becomes the responsibility of those who teach to see that their students translate this information properly and effectively into action. The basic task of the flight instructor is to help students accept this knowledge into their being so completely that all of the flying they may ever do is affected by these facts. Facts and knowledge are important only as they influence what people do. They are unimportant unless prospective pilots learn to behave in accordance with such information. Pilots in their training must learn to do as well as to know.

This is the basic nature of the flight instructor's job. This is why he teaches. Armed with knowledge and skill, the professional flight instructor approaches the student pilot with the responsibility to teach him to perform in an airplane according to the facts which are involved. The facts of flight are known. The facts of learning are becoming more widely recognized. Flight instruction, therefore, is mainly a communication problem, so teaching and communications are almost synonymous.

Communications, however, can occur at several levels. Information may be simply transmitted and received, as when an instructor directs his student to "hold upwind aileron when you taxi." The student may receive this communication, and even be able to repeat it. Communication has taken place, but it has resulted in a very low level of learning.

Receiving information, even accurately, does not insure that the student understands it. Many pilots may have been told that thunderstorms are dangerous, or that high angles of attack result in stalls without at all understanding the factors and principles involved. In the case of the student instructed to "hold upwind aileron," he is incapable of performing properly unless he understands the meaning of "upwind" and knows the manipulation of the flight controls to put the ailerons in the desired position.

Communication at the understanding level goes far beyond the receipt of information; ideas must be comprehended. Understanding is a higher type of communication than

is the mere acquisition of facts. To be effective, however, the flight instructor must go beyond this level of communication.

Effective communication requires that information be provided in such a way that it affects the behavior of the student. The instructor who directs his student to "hold the stick toward the wind" when taxiing in a crosswind, and then explains the effects of the resulting positions of the ailerons, is directly controlling the student's behavior and at the same time building an understanding of the correct operation in a crosswind situation. This type of communication in instruction goes directly to the action required and the reason for it. If properly presented and explained on the basis of facts known to the student, it leads to effective learning.

Learning is sometimes defined as changes in behavior which result from experiences. This definition must be used with care, however, because changes in behavior also result from other causes, such as fatigue, physical or mental changes, or even natural maturing. A baby first learns to crawl, and then to walk as he matures. It would be completely unrealistic to try to teach him to walk at a point in his development when he has not yet started to crawl, in the belief that only learning is necessary.

Learning may be said to have occurred when a student's actions and behavior are governed by all relevant information made known to him. Flight instructors must be aware of some of the factors which are involved in and affect the development of this learning.

1. Perception and Insight.—Perception is the basis of all learning. Bits of information, called perceptions, may be directed to the brain by anyone, or a combination of the senses. The senses are the doors to the human brain. In learning to fly, the eyes, the ears, and the kinesthetic sense of feel are the most important. The student's use of all of his perceptive apparatus is extremely important to the flight instructor, because, from the point of view of learning, behavior is the end result and the goal of the perceptions to which he is introduced.

Perceiving involves more than the receipt of sights and sounds. Perceptions result when a person gives meaning to the sights and sounds which come his way. People base their actions on the way they believe things to be. The competent pilot receives quite a different perception from a slow decrease in cruising r.p.m. on a raw, moist day from that received by the inexperienced student who has previously flown only on warm, dry days.

Real meaning comes only from within a person, even though the sights and sounds which evoke these meanings come through the eyes and ears. Because the meaning which is derived from the information furnished by the senses may depend on many factors within each person concerned, and because perceptions are the basis of all learning, a knowledge of the factors which affect the perceptual process is very important to every instructor.

Among the most important factors which affect a student's perceptions are:

a. His physical organism.
b. His needs and requirements.
c. His goals and values.
d. His self-concept.
e. The time and opportunity for perception.
f. The element of threat.

The PHYSICAL ORGANISM is the vehicle by which the individual becomes aware of and operates in the world of which he is a part. A pilot must be able to see, to hear, to feel, and to respond adequately while he is in the air. A person whose perceptual apparatus distorts reality is denied the right to fly at the time of his first physical examination.

Man's BASIC NEED is to maintain and enhance his organized self. The self is complete. It is his past, present, and future combined; it is both physical and psychological. Man's most fundamental, pressing need is to preserve and perpetuate this self. All his perceptions are affected by this need.

Just as the foods one eats and the air one breathes become the physical self, so do the sights one sees and the sounds he hears become the psychological self. Psychologi-

cally, we are what we perceive. A man has physical barriers which keep out those things which would be damaging to his physical being, such as blinking at an arc weld or flinching from a hot iron. So likewise, he has perceptual barriers which block those sights, sounds, and feelings which threaten him in a psychological way.

Helping people learn, then, requires finding ways to aid them in developing better perceptions in spite of their defense mechanisms. Since man's basic need is to maintain and enhance his self, the instructor must recognize that anything he asks of the student which may be interpreted by the student as imperiling this self will be resisted or denied. To teach effectively, it is necessary to work with this life force, rather than to try to go against the grain.

Perceptions depend on one's GOALS AND VALUES. Every experience and sensation which is funneled into one's central nervous system is colored by the individual's own beliefs and value structures. Spectators at a ball game may "see" an infraction or foul differently depending on which team they support. The precise kinds of commitments and philosophical outlooks which the student holds are important for the flight instructor to know, since this knowledge will assist him in predicting how the student will interpret the experiences and instructions he receives.

Motivations are also a product of one's value structure. Those things which are more highly valued and cherished are pursued; those which are accorded less value and importance are not sought after. Motivations are one of the most important factors in learning. They are affected by many other factors also, and will be discussed in some detail later in this handbook.

SELF-CONCEPT, how a person pictures himself, is one of the most powerful determinants in learning. A student's image of himself, described in such terms as "confident" and "insecure," have a great influence on his total perceptual process. If the student pilot's experiences tend to support his own image of himself as a pilot, he tends to remain receptive to subsequent experiences. If the learner has negative experiences which tend to contradict or destroy his self-concept, he tends to reject additional training.

Negative self concepts inhibit the perceptual processes by introducing psychological barriers which tend to keep the student from receiving them and then perceiving what the instructor intends. They may even inhibit the ability to properly implement that which is perceived. That is, they affect unfavorably the "ability to do." Learners who view themselves positively, on the other hand, are less defensive and more ready to "digest" experiences by assimilating all of the instructions and demonstrations offered. Self-concept affects perception.

It takes TIME AND OPPORTUNITY to perceive. Learning some things depends on other perceptions which have preceded these learnings, and on the availability of time to sense and relate these new things to the earlier perceptions. Thus, sequence and time are necessary.

A student could probably stall an airplane the first time he tries to do so, regardless of previous experience. He cannot, however, "learn" stalling unless he has experience with normal flight. Even with such experience, he needs time and practice to relate the new sensations and experiences associated with stalling in order to develop a perception of the stall. In general, lengthening an experience is the most obvious way to foster learning, although this is not always effective.

Making the most effective use of the time available is a basic problem in instruction. This is particularly true in flight instruction, where the time available is often limited by financial considerations. The instructor must arrange his instruction so that the student pilot achieves the most perceptions in the least total time. Many factors in addition to the length and frequency of training periods affect the rate of learning. The effectiveness of the use of a properly planned training syllabus is proportional to the consideration it gives to the time and opportunity factor in perception.

THREAT RESTRICTS PERCEPTION. Fear adversely affects a student's perception by narrowing his perceptual field. Confronted with a threat, the student tends to

limit his attention to the threatening object or condition he has recognized. His field of vision, for example, is reduced when he is frightened; and all of his perceptual faculties are focused on the thing which has generated his fear.

Flight instruction provides many clear examples of this. During his first practice of steep turns, a student pilot may tend to focus on his altimeter with complete disregard for the airspeed or his coordination of the flight controls. On takeoff, he may be so possessed with the fear of stalling that he watches his airspeed indicator with complete disregard for the attitude of the airplane or obstacles in his path.

Threat limits an individual's ability to perceive. Anything an instructor does which is seen as threatening by the student makes him less able to accept the experience which the instructor is trying to provide. It adversely affects all of the student's physical, emotional, and mental faculties.

Learning is a psychological problem, not a logical one. Trying to frighten a student by threatening him with unsatisfactory reports or reprisals may make sense logically, but is not effective psychologically. The effective instructor is one who can organize the logic of his teaching to fit the psychology of the learner. If the situation ever seems to overwhelm him, the student feels unable to handle all of the factors involved, and a threat exists. So long as he feels capable of coping with the situation which he recognizes, each new experience is viewed as a challenge.

Realizing that behavior is a function of the way in which the individual perceives, and knowing that perceptions are affected by any and all of these factors enable a good instructor to facilitate the learning process by avoiding any actions which negate the attainment of teaching goals. Teaching is consistently effective only when these factors which influence perceptions are recognized and taken into account.

Insights involve the grouping of perceptions into meaningful wholes. Evoking these insights is the flight instructors' major responsibility. To insure that these occur, it is essential to keep each student constantly receptive to new experiences, and to work to help him realize the way that each piece relates to all other pieces of the total pattern of the task to be learned.

As a simple example, in straight and level flight the r.p.m. will increase when the throttle is opened and decrease when it is closed. On the other hand, r.p.m. changes can also result from pushing or pulling on the elevator control without changing the power setting. Obviously, engine speed, power setting, and airspeed are all related. Further, in a cruising situation the engine r.p.m.'s are a function of altitude as well as power setting.

Understanding the way in which each of these factors may affect all of the others, and knowing the way in which a change in any one of them may affect changes in all of the others is imperative to true learning. This mental relating and grouping of associated perceptions is called insight. Insight is basic to true learning.

Insights will almost always occur eventually, whether or not instruction is provided. For this reason it is possible for a person to become a pilot by trial and error if he supervises his exploratory actions, just as one may become a lawyer by "reading law." Instruction, however, speeds this learning process by teaching the relationship of perceptions as they occur, and so promoting the development of insights by the student.

As perceptions increase in number and are assembled by the student into larger "blocks" of learning to become insights, learning becomes more and more meaningful to him, and more and more permanent. Forgetting is less of a problem when there are more anchor points to which one can tie his insights. It is a major responsibility of the instructor to organize his demonstrations and explanations, and the directed student practice, so that the learner has better opportunities to understand the interrelationships of the many kinds of experiences he has perceived. Pointing out the relationships as they occur, providing a secure and nonthreatening environment in which to learn, and helping the student pilot acquire and maintain a favorable self-concept are most important in fostering the development of insights.

2. Motivation.—Motivation is probably the dominant force which governs the student's progress and ability to learn. Motivations may be tangible or intangible; they may be negative or positive; they may be very subtle and difficult to identify; or they may be obvious.

Negative motivations are those which may engender fears, and be accepted by the student as threats. While they have their uses in limited situations, such as the instruction of "captive" groups, they are not characteristically as effective in promoting efficient learning as are positive motivations.

Positive motivations are provided by the promise or achievement of rewards. These rewards may be personal or social; they may involve financial gain, satisfaction of the self-concept, or public recognition. Some motivations which can be used to advantage by the instructor include the desire for personal gain, the desire for personal comfort or security, the desire for group approval, and the achievement of a favorable self-image or sense of achievement.

The desire for personal gain, either the acquisition of things or position, is a basic motivation for all human endeavor. A man may be motivated to dig a ditch or to design a supersonic airplane by only the desire for financial gain.

Students are like all other workers in wanting a tangible return for their efforts. If such motivation is to be effective, they must believe that their "take-home pay" is worthwhile, and that their efforts will be suitably rewarded. These rewards must be constantly apparent to the student during his instruction, whether they are to be financial, self-interest, or public recognition.

Many lessons with objectives which are not obvious will pay off well during later instruction, but the student does not appreciate this fact. It is important for the instructor to make him aware of those applications which are not immediately apparent if the student's motivation is to be maintained. Likewise, the devotion of much time and effort to drill and practice on operations which do not directly contribute to competent performance as a pilot should be avoided.

The desire for personal comfort and security is a motivation which is often inadequately appreciated in flight instruction. All students want secure, pleasant conditions and states of being. If they recognize that what they are learning may promote this objective, their interest is easier to attract and hold. Insecure and unpleasant training situations retard learning.

All people want to avoid pain and suffering. The student pilot will apply himself to learning actions and operations which he realizes may prevent injury or even save his life. This is especially true when he knows that the ability to make quick decisions, or to instinctively act correctly in an emergency results from adequate learning.

The attractive features of the activity to be learned can provide a powerful motivation. Students are anxious to learn skills which may be used to advantage in a pleasant hobby or vocation. If they can be made to understand that each learning task to which they are directed will be useful in preparing for the activities for which they undertook flight training, they will be eager to pursue it.

Group approval is a strong motivating force. Every man wants the approval of his friends and superiors. His interest can be stimulated and maintained by building on this natural force. Most students enjoy the feeling of belonging to a group, and are interested in attaining an accomplishment which will give them prestige among their fellow students. If the student respects his flight instructor as a person and has confidence in his ability, he will also value his approval.

In flight instruction, the use of group approval as a motivating force extends to what we call "snob appeal." The ability to fly an airplane still conveys to a person a certain distinction among his circle of nonflying friends. The instructor must be careful not to destroy this effect by belittling his student's ability in front of his friends, and may even use a favorable exposition of the student's accomplishments to interest additional students in learning to fly.

In group instruction, praising and giving credit to students who have performed well

not only encourages those praised, but also motivates others in the group to greater efforts.

Every man seeks to establish for himself a favorable self-image. This self-image may be submerged in a feeling of insecurity or despondency which results in expressions of self negation. The prospective student who approaches flight training with an outlook of "I'd like to fly, but I don't think I could ever learn to do so" would probably never be able to learn to do so well if his expression described his true belief.

Fortunately, there is somewhere within each person who addresses himself to any task the belief that he can succeed under the proper combination of circumstances and good fortune. It is this belief in his own capability and desire to confirm it which can be the most powerful motivating force for any but the genuinely timid student.

This motivation can best be fostered by the instructor through the introduction of perceptions which are solidly based on facts previously learned, and which are easily recognized by the student as achievements in learning. Each additional block of learning toward the insight to be developed and toward the ultimate goal contributes to the confirmation within the student of his own favorable self-image. As this confirmation progresses and confidence is achieved, advances can be more rapid and the resulting motivation will be strengthened.

Positive motivation is essential to true learning. Negative motivations in the form of reproof and threats should be avoided with all but the most overconfident and impulsive students. Slumps in learning are often due to slumps in motivation. Motivation does not remain at a uniformly high level, and may be influenced by outside influences such as physical or mental disturbances, or inadequate instruction. The instructor must tailor his instruction to the maintenance of the highest possible level of motivation, and should be alert to detect and counter relapses in motivation which originate away from the flying school.

3. Obstacles to Learning.—Obstacles to learning are numerous and varied. They may range from disinterest and distractions to complete mental blocks, and may originate with such different sources as the student's family troubles and his misconceptions based on previous instruction. Among those obstacles which are common to flight instruction, and which have been recognized as major factors to be considered by flight instructors are:

a. A student's feeling of unfair treatment.
b. Impatience to proceed to more interesting operations.
c. Worry, or lack of interest.
d. Physical discomfort, illness, or fatigue.
e. Apathy fostered by poor instruction.
f. Fear, anxiety, or timidity.

A student who believes that his instruction is perfunctory, or that his efforts are not conscientiously considered and evaluated will not learn well. If a student develops the idea that his presence is welcome to the instructor only for the money he brings in, or that his instructor would rather spend his time with other students or at other duties, his motivation will suffer no matter how intent he is on learning to fly.

Motivation will also suffer when a student believes that his instructor is making unreasonable demands for performance and progress. The assignment of goals which the student considers difficult but possible usually provides a challenge which promotes learning. The assigning of impossible goals discourages the student, diminishes his efforts to perform adequately, and retards the learning process.

Impatience is a greater deterrent to learning than is generally recognized. With a flight student, this may take the form of the desire to make an early solo flight, or to set out on cross-country flights before the basic elements of flight have been learned.

The impatient student fails to understand the need for preliminary training, and seeks only the ultimate objective without considering the means necessary to reach it. In flying an airplane, as with every complicated human endeavor, it is necessary to master the basics if the whole task is to be per-

formed adequately and safely. Impatience to learn can be corrected by the instructor only by presenting the necessary preliminary training one step at a time, with clearly stated goals for each step. The procedures and elements mastered in each step should be clearly identified in demonstrating the performance of the subsequent step.

Impatience can result from instruction keyed to the pace of a slow learner when it is applied to an apt student or a characteristically fast learner. It is just as important that a student be advanced to the subsequent step as soon as one goal has been attained as it is for him to complete each step before the next one is undertaken. Disinterest grows rapidly when unnecessary repetition and drill are required on operations which have been learned adequately.

Worry or lack of interest has a very detrimental effect on learning. A student who is worried or emotionally upset does not learn well, and derives little benefit from any practice performed while he is in this condition. His worry or distraction may be due to his concern about progress in the training course in question, or may stem from circumstances completely unrelated to his instruction. Significant emotional upsets may be due to personal problems, psychiatric disturbances, or an antipathy for the training concerned or the instructor.

The student's experiences outside his training activities affect his behavior and performance in training; the two cannot be separated. When he reports for training, the student brings with him his interests, his enthusiasms, his fears, and his troubles. The instructor cannot be responsible for these outside diversions. He cannot ignore them because they vitally affect the results of his teaching. Instruction must be keyed to the utilization of the interests and enthusiasms the student brings with him, and to diverting the student's attention from his worries and troubles to the learning tasks at hand. This is admittedly difficult, but must be accomplished if learning is to proceed at a normal rate.

Worries and emotional upsets which result from the course at hand can be remedied. Such occurrences are usually evidence of inadequacies on the part of the course or of the instructor concerned. The most effective cure is prevention. The instructor must be alert to see that each student understands the objectives of each step of his training, and that he knows at the completion of each lesson exactly what his progress and deficiencies have been. Discouragement and emotional upsets are rare when the student feels that he is genuinely a party to his training, and that nothing is being withheld from him or is being neglected in his training.

Physical discomfort, illness, and fatigue will materially slow the rate of learning. This is important for both classroom instruction and in-flight training. A student who is not completely at ease, and whose attention is diverted by discomforts such as the extremes of temperature, poor ventilation, inadequate lighting, or noise and confusion, cannot learn at his normal rate. This is true no matter how diligently he tries to apply himself to the learning task.

Illness, such as a cold, or a major illness or injury, will interfere with the normal rate of learning. This is especially important to the conduct of flight instruction, because most illnesses adversely affect the acuteness of vision, of hearing, and of feeling which are essential to the correct performance as pilot. No effective flight instruction can be conducted when the student is incapacitated by illness.

Airsickness is an indisposition which is a great deterrent to flight instruction. A student who is airsick, or bothered with incipient airsickness is incapable of learning at a normal rate. There is no sure cure for airsickness, but resistance or immunity can be developed in a relatively short period of time.

Repeated flights during which the student is allowed to become airsick are not so helpful as are repeated flights which are terminated as soon as incipient sickness is experienced. For a normal purpose, such flights can be increased in length rapidly until normal flight periods are practical.

Keeping the student interested and occupied during all of his flight time assists in the prevention of airsickness. He is much

less apt to become sick while he is operating the controls himself than when he is riding as a passenger. Rough air and unexpected abrupt maneuvers tend to increase the chances of airsickness. Tension and apprehension apparently contribute to causing airsickness, and should be avoided.

Attempts at cures by deliberately making the student airsick during an early flight period are rarely successful. All attempts at further instruction should be discontinued as soon as the student reports that he is experiencing airsickness.

The detection of fatigue in a student is important to competent flight instruction. This is important both in assessing the student's performance early in a lesson when he may be suffering from inadequate rest the night before, and in recognizing the deterioration of his performance which results from continuing intensive concentration on a complicated task. Once fatigue occurs as the result of application to a learning task, respite should be offered by a break in instruction and practice, or by a change of pace. Fatigue can be delayed by introducing a number of maneuvers which involve different elements and objectives.

Fatigue is the primary consideration in determining the length and frequency of flight instruction periods. The amount of training which can be absorbed by one student without incurring fatigue does not necessarily indicate the capacity of another student. Fatigue which results from training operations may be either physical or mental, or both. It is not necessarily a function of physical robustness or mental acuity. Generally speaking, complex operations tend to induce fatigue more rapidly than do simpler procedures, regardless of the physical effort involved.

Instruction should be continued only so long as the student is alert, receptive to instruction, and his level of performance continues to be consistent with his experience.

Apathy in a student develops rapidly when he recognizes that the instructor has made inadequate preparations for the instruction he is giving, or when this instruction is deficient, contradictory, or appears insincere. To hold the student's interest and to maintain the motivation necessary for efficient learning, well planned, appropriate, and accurate instruction must be provided. Nothing destroys a student's interest so quickly as the "let's see now, what did we do last time?" approach to a period of instruction.

Even an inexperienced student realizes immediately when the instructor has failed to prepare properly a lesson he is trying to conduct. Poor preparation leads to spotty coverage, misplaced emphasis, repetition, and a complete lack of confidence on the part of the student.

Instructions may be overly explicit and so elementary as to fail to hold a student's interest, or they may be so general or complicated that they fail to evoke the interest necessary for effective learning. The instructor must teach for the level of the student if he is to be effective.

This does not mean that the instructor must lower his own standards and viewpoint to that of the student. He must adjust his presentation to be meaningful to the person for whom it is intended.

For example, instruction in the preflight inspection of an airplane should be presented quite differently for a student who is a crew chief on a military airplane from the instruction on the same operation for a student with no previous aeronautical experience. The inspection desired in each case is the same, but a presentation meaningful to one of these students would be inappropriate for the other.

Poor presentations of instruction may result not only from poor preparation, but also from distracting mannerisms, personal untidiness, or the appearance of irritation with the student. Permitting the impression that he is "talking down" to the student is one of the surest ways for an instructor to lose the student's confidence and attention. Once this confidence is lost by the instructor, learning rate is unnecessarily retarded.

Fear, anxiety, and timidity place additional burdens on the flight instructor if he is to teach effectively. These are obstructions which limit the student's perceptive ability, and retard the development of insights from

those perceptions which do find their way into his consciousness.

The student must be comfortable, confident in his instructor and the airplane, and at ease if he is to learn effectively. Providing this atmosphere for learning is one of the first and most important tasks of the instructor. Although doing so may be difficult at first, successive accomplishments of recognizable goals, and the avoidance of alarming occurrences or situations will rapidly improve the student's ease of mind. This is true of all flight students, but may require special handling by the instructor only for obvious cases.

4. Habits and Transfer.—Learning by developing perceptions and combining them into insights is a process of forming performance habits, and transferring the habits formed in one task to the performance of more complicated subsequent tasks. The performance habits considered here are such small elements of performance as using the rudder to prevent a slip or skid when the ailerons are moved, or merely restraining the downward pitch anticipated when the throttle is closed. The influence of these small habits in the student's learning of the subsequent task is called "transfer."

Transfer is usually considered to be either positive or negative. Positive transfer describes an element of performance carried over which is useful to the correct performance of the subsequent learning task. Negative transfer describes an element of performance which hinders, or at least does not aid, the correct performance of the new task.

An example of positive transfer is a student's application, during his first attempts at landings, of the recognition and use of control responses learned during his practice of slow flight. Negative transfer is involved when a student attempts to reduce the airspeed in a diving spiral by pulling back on the elevator control, a procedure which has worked in other flight situations he has experienced.

The flight syllabus should be arranged to take maximum advantage of positive transfer by introducing new maneuvers in an order and manner which permit the elements learned in each maneuver to be used in the performance of subsequent maneuvers, so far as possible.

The formation of correct habit patterns from the beginning of any learning process is essential to further learning and for correct performance after the completion of training. For example, the scanning of instruments during flight can be developed during an early stage, especially by "integrated" flight instruction, to such an extent that it is carried on, even when everything is satisfactory, without conscious attention by the pilot. Because of this habit pattern the pilot's attention can be aroused immediately when a serious or critical situation is indicated.

Habit patterns soon become the most important factor in the pilot's basic actions in controlling an airplane. Coordination of the rudder and aileron controls, maintenance of altitude and airspeed, and the control of heading are almost completely controlled without conscious attention by the experienced pilot. Because this is so, the formation of correct habit patterns early in the student's training has a vital effect on his later performance as a pilot. He performs either well or poorly because his habit patterns are correct or incorrect. Inaccurate and improper control manipulation is more often due to faulty habit patterns than to ignorance of the correct procedures.

It is therefore the responsibility of the instructor to insist on correct procedures from the outset of training to provide proper habit patterns. He will find it much more difficult to correct faulty habits later in training than it is to foster correct habits from the beginning.

This is the basic reason for the "building block" technique of instruction, in which each simple task is performed acceptably and correctly before the next learning task is introduced. The introduction of instruction in more advanced and complex operations before the initial instruction is mastered leads to the development of poor habit patterns in the elements of performance. Faulty performance of the elements are inevitably carried through to all future learning and piloting operations.

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B. Levels of Learning

Learning may be accomplished at any of many levels. The lowest level of learning is the ability to repeat back something which one has been taught, without understanding or being able to apply what he has learned. Progressively higher levels of learning are *understanding* what one has been taught; achieving the *skill to apply* what one has learned, and to perform correctly; and associating and *correlating* what one has learned with other things previously learned or subsequently encountered.

One may instruct a beginning student that he should enter a turn by banking the airplane with the aileron control and applying sufficient rudder in the same direction to prevent slipping and skidding. A student who can repeat this instruction has learned by rote. This will never be very useful to him if he never has the opportunity to make a turn in flight, or if he has no knowledge of the function of the airplane controls.

With proper instruction in the effects and use of the flight controls, and experience in their use in straight flight, the student can develop these old and new perceptions into an insight by which he knows how to make a turn. At this point, he has developed an *understanding* of the procedure for turning the airplane in flight. This understanding is basic to effective learning, but may not necessarily enable the student to make a correct turn on his first attempt.

When the student understands the procedure for entering a turn, has had turns actually demonstrated to him, and has practiced turn entries until he can consistently achieve an acceptable performance of turn entries, he has developed the *skill to apply* what he has been taught. This is a major level of learning, and one at which the instructor is too often willing to stop. Discontinuing instruction on turn entries at this point, and directing subsequent instruction exclusively to other elements of piloting performance is characteristic of piecemeal instruction, which is always inefficient. It violates the "building block" concept of instruction by failing to apply what has been learned to future learning tasks.

The highest level of learning, which should be the objective of all instruction, is that level at which the student becomes able to associate an element which he has learned with other segments, or "blocks," of knowledge or accomplishment. The other segments may be items or skills previously learned, or new learning tasks he undertakes in the future.

The student who has achieved this level of learning in turn entries, for example, has developed the *ability to correlate* the elements of turn entries with the performance of such combined and complex piloting operations as those required for the performance of chandelles and lazy eights.

The flight instructor must require his students to achieve at least the skill to apply the correct procedures for the performance of each flight training maneuver. Learning will be accelerated and the student will become a more competent, resourceful, and safer pilot if he further learns to associate the elements of each segment of his learning with all other related skills and bits of knowledge, and to correlate the application of their elements with other learning and operational tasks.

C. Rates of Learning

Although it would be convenient if the rate of learning should be uniform and predictable, it is not always so. Students may progress rapidly for a while, and then suddenly progress more slowly, or even retrogress for a period of time. Such variations are to be expected, but it is the responsibility of the instructor to detect them as soon as possible, and to try to eliminate their causes by redirecting his instruction to level them out as much as possible.

1. Advances and Plateaus in Learning.— Characteristically, learning proceeds rapidly at first when a new task is introduced, and then slows as a reasonable degree of proficiency is achieved. When plotted on a graph, this decrease in the rate of learning is shown as a leveling off of the ascending line which represents progress in learning. As the student achieves the ability to cor-

relate what he has learned with other bits of learning, progress tends to be resumed, and the line on the graph resumes its upward climb at a slower, but fairly uniform rate.

The level, or relatively level portion of the learning curve on the graph is termed a "plateau." It may represent a period of training during which the student is perfecting his *ability to apply* the new skill he is learning, and has not yet awakened to its application to and *correlation with* other learning tasks. Figure 1 illustrates a typical learning curve, showing a plateau in the learning of a mechanical operation.

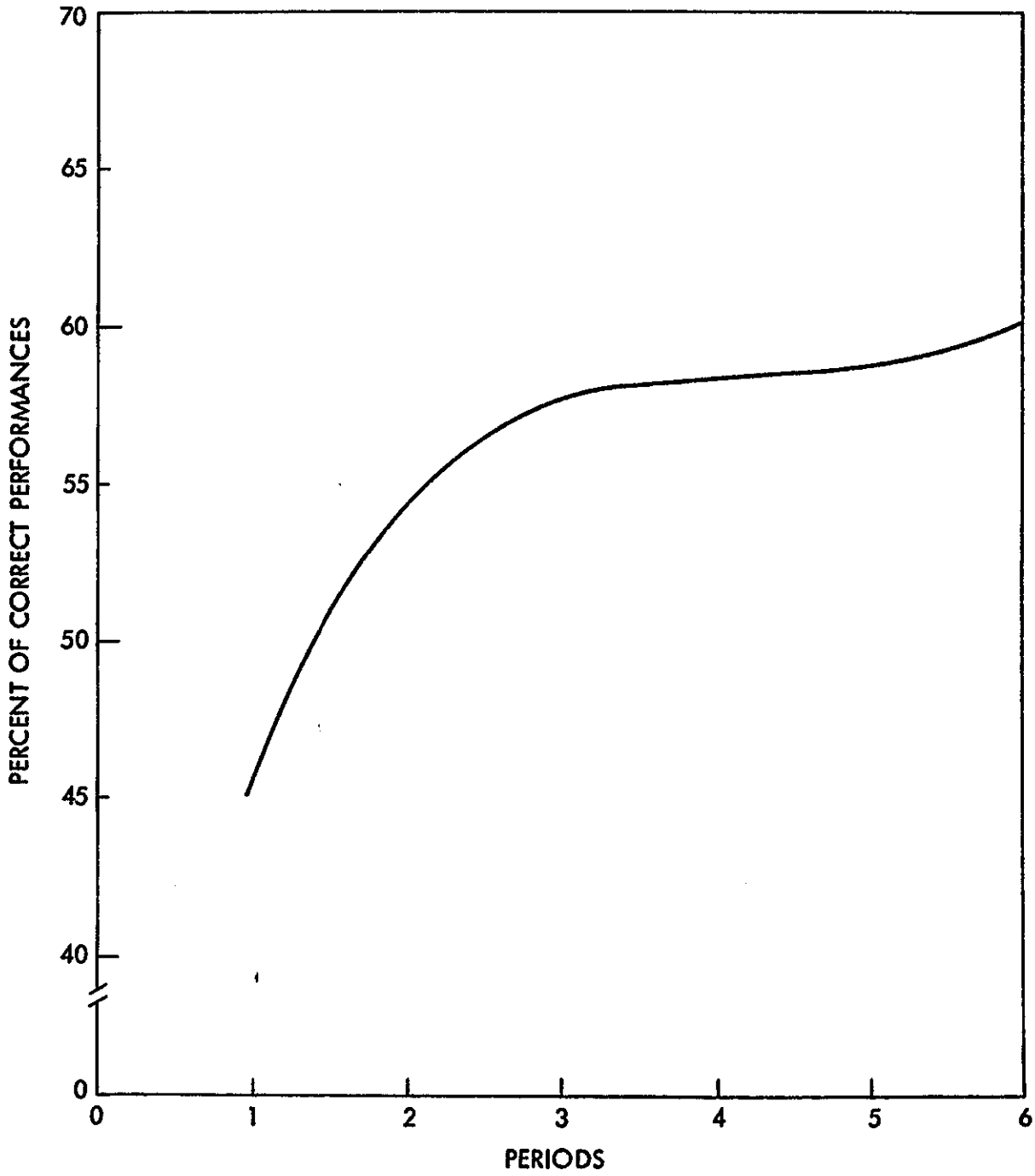

FIGURE 1.—Typical learning curve.

It should be noted that the typical learning curve rises rapidly as a new learning task is introduced, levels off as skill and knowledge are achieved, and then continues its rise at a slower, steady rate as the student learns the associations and correlation of his newly acquired accomplishment. Actual learning curves rarely follow exactly the classical, or ideal, curve.

The rate of progress in learning is affected by so many outside influences that it is not often predictable. The rate of learning is adversely affected by diversions, lagging motivation, and emotional disturbances; and training schedules are upset by such factors as the weather, equipment breakdowns, and unavoidable absences. It is these influences on learning which the good instructor can counter by careful planning and by redirection of emphasis in his instruction.

Temporary random plateaus in the learning rate are not necessarily serious, and can be expected with any student. Each one should be examined carefully, however, to identify any contributing influences which can be countered. The instructor must be aware of the plateaus characteristic in the learning process, and be prepared to evaluate their significance when slumps occur and to take corrective measures when appropriate.

Slumps or plateaus in the rate of learning are more likely to occur as a student advances to more complicated operations, such as crosswind takeoffs and landings. Often the reason for this is that the student has failed to master one element of the operation, which leads to the appearance of deficiency in the performance of all of the elements involved. Improvement usually becomes normal again when this one element is mastered. The instructor can accelerate this improvement by identifying the element which is disturbing the student, and by concentrating his instruction on that one phase of the operation concerned.

Without competent instruction, the student probably will not understand why he is showing no improvement, and will become discouraged. This discouragement, itself, tends to prolong the plateau. During such periods of discouragement, the instructor should step in to isolate and correct the difficulty, and to provide special incentives which will maintain the student's interest until normal progress is resumed.

Reversals sometimes occur, during which a student's performance becomes worse with continued practice. Generally such reversals are due to a faulty habit pattern involving one of the basic elements of the maneuver or operation involved. This habit causes the student to repeatedly practice an erroneous performance until correction is very difficult. The instructor must not accept such errors and misunderstandings as normal plateaus in the learning process. They must be corrected before any further progress can take place.

Reversals in the rate of progress can also occur when a flight instructor places too much emphasis on a single phase or element of a maneuver, to the exclusion or subordination of the consideration of its overall performance and objective, except for the correction of specific performance deficiencies. An example is concentration on the maintenance of altitude during ground reference maneuvers with a resulting poor performance in planning and coordination.

2. Memory and Forgetting.—One key to the achievement of satisfactory progress in learning is attention to the principles which relate to remembering and forgetting. While the learning of a mechanical skill, such as operating the controls of an airplane, is often considered to consist mainly of demonstration and practice, memory plays an important role. Things which must be remembered range all of the way from essential items of information which must be remembered by rote, such as radio frequencies, to such complicated performances as the planning and precise speed and attitude control necessary for the performance of a chandelle.

In considering the role of memory in learning, one soon encounters the great area of overlap between conscious memory, as we think of it, and habit patterns. What, exactly, is the relationship between knowing that the carburetor heat control is just to the right of the throttle, and being able to oper-

ate it without looking even when one cannot confidently state where on the panel it is located? Actually, our memories as they are reinforced by constant usage become established as habit patterns, and so become a part of us.

Viewed in this light, each bit of information or element of performance remembered is a potential habit pattern. The ability to remember disassociated bits of information which are not regularly used, such as names or telephone numbers, is a faculty with which we are not all favored. The most reliable means for the instructor to use to assist his student in remembering vital bits of information and performance is to require him to use and associate them as frequently and with as many different applications as possible.

Drill, recitation, and quizzing assist the student in establishing information in his memory. None of these alone is so effective, however, as is continuing usage, practice, and application to different situations.

Forgetting is subject to the same considerations as remembering, but with the reverse effect. Bits of information which are not used or associated with other information tend to be quickly forgotten. Habit patterns, however, become deeply ingrained in a person's being, and although recall may be difficult they are always present to some degree. Thus, habit patterns which have been firmly established and cultivated by repeated usage are retained, and will often come to the fore in emergencies, even after years of neglect.

Those phases of learning which are purely memory work should be recognized and presented to the student as such. Presentation in the most simple form possible will assist him in remembering them. Requiring the student to dig such information out for himself, or assuming that he will eventually run into this information without direction is poor instruction. Making it easier for him to acquire the necessary memory learning will free the student to concentrate on the more involved skills and mental features of his training.

Most important, attention directed to providing the student with the necessary "memory" information as it is needed, and providing continuing usage and associations for this information is essential to fostering a desirable learning rate. Permitting gaps in this information as flight training progresses, or inadequate fixing of information in the student's memory will eventually result in slumps and reversals of the learning process.

Memory is the major factor in learning. It constitutes essentially all of the learning classified as "knowledge," and has a basic effect on the retention of motor skills. The following are five significant principles which are generally accepted as having a direct application to remembering, and consequently to learning.

a. *Praise stimulates remembering.*—Responses which give a pleasurable return tend to be repeated. Absence of praise or recognition tends to discourage one, and any form of negativism in the acceptance of a response tends to make its recall less likely.

b. *Recall is promoted by association.*—Each bit of information or action which is associated with something to be learned tends to facilitate its later recall by the student. Unique or disassociated facts tend to be forgotten unless they are of special interest or application.

c. *Favorable attitudes aid retention.*—Man learns and remembers only what he wishes to know. Without motivation there is little chance for recall. The most effective motivations are those based on positive or rewarding objectives.

d. *Learning with all our senses is most effective.*—Although we generally receive what we learn through the eyes and ears, other senses also contribute to most perceptions. When several senses respond together, fuller understanding and greater chance of recall is achieved.

e. *Meaningful repetition aids recall.*—Each repetition gives the student an opportunity to gain a clearer and more accurate perception of the subject to be learned, but mere repetition

does not guarantee retention. Practice gives an opportunity for learning, but does not cause it. Further, it is believed that three or four repetitions provide the maximum effect, after which the rate of learning and probability of retention fall off rapidly. This is consistent with the learning curve illustrated in figure 1 on page 13.

D. Common Misconceptions About Learning

Many misconceptions about learning have developed throughout the years. Some of these are based on partial truths, some on traditional methods, and some even on sadism and domination. None of the misconceptions described in this section should be accepted by any professional instructor.

Some instructors believe that students can be motivated to learn by fear. They apply punishment or threat of punishment as a routine training technique in the belief that scaring students by threats, or even by violent flight maneuvers guarantees surer learning.

Many students and some uninformed instructors believe that learning is hard work, and that people learn only by exerting physical effort. According to this school of thought, the mind must be exercised by unpleasant tasks, and making it easier for a student to learn is contrary to the fundamentals of sound teaching.

It is a popular belief that "one picture is worth a thousand words." According to this theory, the presentation of an unexplained picture is more productive of learning than is a written or verbal presentation.

Many teachers believe that a longer learning experience is more beneficial than a shorter training period, and that the quality of learning depends on the length of time devoted to it. Such people believe that a pilot with 400 hours is necessarily a better pilot than one with 200 hours.

Some instructors believe that teachers must "keep students in their place" by refusing to be friendly with them. They believe that a good instructor must keep his distance and remain impersonal in order to be effective. It is asserted that students will always take advantage of friendly treatment to get by with lower performance standards.

Some schools believe that competition is the key to successful learning. It is alleged that since competition is the basis of the "American way of life," students look up to the fast learners. Those who are less successful must fail and fall by the wayside.

One philosophy of education preaches that all students must experience setbacks and disappointments, because failure is a part of life. According to this school of thought, the best preparation for life and action includes frustration and failure as a part of learning. Tests should be developed so that no one can get a perfect score.

These are all misconceptions which the professional flight instructor must constantly watch to be sure that he has not accepted without realizing it. Many of them are prevalent even in recognized institutions of learning, but all have been discredited as effective techniques of instruction.

E. Role of the Flight Instructor

Learning to fly should be an enjoyable experience. By making each lesson a pleasurable experience for the student, the flight instructor can maintain a high level of motivation in the student. This does not mean that he must make things easy for the student, or sacrifice his standards of performance to please the student. The student will experience pleasure from a learning task well done, or from successfully meeting the challenge of a difficult operation just as surely as he will from a joy ride.

The idea that people must be led to learning by making it easy has no basis in fact. People are not always attracted to something which is pleasant and easy. Actually, they devote more effort to things which bring rewards such as self enhancement and personal satisfaction. People want to feel capable; they are proud of difficult achievements. A great instructor can motivate his students to tears and sweat without any thought of rancor or unpleasantness.

Learning to fly should be interesting. Sustaining his student's interest can be achieved only by building up his own in-

terest in the goal of each lesson. Knowing the objective of each period of instruction gives meaning and interest to the instructor's service and to his student's efforts. Not knowing the objectives involved leads to confusion, disinterest, and uneasiness on the part of the student.

Learning to fly should provide an opportunity for exploration and experimentation for the student. The student should be allowed time to explore for himself and evaluate the various elements of each maneuver or operation presented. He must discover his own capabilities and acquire self-confidence. This can also be fostered by using alternative presentations for different students so that the student does not feel that he is merely following the footsteps of others.

Learning to fly should be a habit-building period, during which the student devotes his attention, memory, and judgment to the development of correct habit patterns. Any goal other than a desire to learn the right way makes the student impatient of the instruction and practice he needs, and should be trying to obtain. The instructor must keep this goal before him, by example and by logical presentation of learning tasks.

The flight instructor must be concerned with the basic drives and desires of man if he is to become an effective teacher. A perceptive teacher of aviation can make learning to fly interesting, pleasurable, and a rewarding experience.

Once the flight instructor is clear in his own mind on the general objectives he seeks, and has an understanding of how people learn, he is ready to teach so that these objectives are achieved and so that learning is fostered most effectively and efficiently. The procedures described in the chapter which follows have been outlined to assist him in doing so.

II. EFFECTIVE TEACHING METHODS

A. *Teaching to Help Students Learn*
   1. Professionalism in Flight Instruction
   2. The Instructor-Student Relationship
   3. Safety Practices

B. *The Teaching Process*
   1. Preparation
   2. Explanation and Demonstration
   3. Trial and Practice
   4. Review and Evaluation

C. *Planning Instructional Activity*
   1. Determination of Overall Objectives
   2. Identification of Blocks of Learning
   3. The Syllabus
   4. The Lesson Plan
   5. The Flight Instruction Breakdown

D. *Maintaining Student Interest*
   1. Using the Student's Motivations
   2. Using All of the Student's Senses
   3. Contriving Experiences
   4. Teaching From the Known to the Unknown
   5. "Watch Your Language"
   6. Emphasize the Positive

E. *Use of Training Aids*
   1. Models
   2. Charts, Diagrams, and Performance Tables
   3. Audiovisual Courses
   4. Programed Instruction
   5. "Handees"

F. *Evaluation*
   1. Oral Quizzing
   2. Demonstrations of Ability
   3. Examinations and Tests
   4. Applying Appropriate Standards

II. EFFECTIVE TEACHING METHODS

A. Teaching to Help Students Learn

1. Professionalism in Flight Instruction.— The flight instructor must really believe in his work if he is to do his best. So long as he is instructing, he should constantly strive to be the best flight instructor in the business, no matter what his final goal in aviation is to be.

In the past, qualification as a flight instructor was sometimes based only on the applicant's proficiency in the performance of practiced flight maneuvers. This has not always been productive of effective flight instructors. It is now generally recognized that instructor qualification must be based equally on teaching ability.

The flight instructor must be fully qualified as a pilot, without deficiencies or faults in his piloting performance. His qualifications must go far beyond those required for certification as a pilot, however, if he is to achieve recognition as a professional flight instructor. Professionalism in flight instruction is necessary if instructors are to teach effectively, command greater prominence, merit increased responsibilities, and receive higher salaries.

Although the word "professionalism" is widely used, it is rarely defined. In fact, no single definition can be provided which will encompass all of the qualifications and considerations which must be present before true professionalism can exist. One noted educator has made a list of the major considerations and qualifications which must be included among these:

a. Professionalism exists only when a service is performed for someone, or for the common good.
b. Professionalism is achieved only after extended training and preparation.
c. True performance as a professional is based on study and research.
d. Professionalism presupposes an intellectual requirement. The professional must be able to reason logically and accurately.
e. Professionalism requires the ability to make good judgmental decisions. The professional cannot limit his actions and decisions to standard patterns and practice.
f. Professionalism demands a code of ethics. The professional must be true to himself, and to those he serves. Anything less than a sincere performance is quickly detected, and immediately destroys his effectiveness.

The flight instructor and prospective flight instructor certificate applicant should carefully consider this list. Attempts to operate as a flight instructor without any one of the qualities listed can only result in poor performance and deficient students. Preparation and performance as a flight instructor with these qualities constantly in mind will soon command recognition as a professional in the field of flight instruction.

2. The Instructor-Student Relationship.— The flight instructor's first step in teaching is to gain the student's confidence. If he fails to gain and hold the confidence and respect of the student, all of the instruction he gives him will be ineffective. Gaining the student's confidence and respect is very much a personal matter. Consideration for the student's point of view and personal interests, and careful planning of each period of instruction are essentials without which the student's confidence is quickly lost.

From their first meeting, the instructor must attempt to analyze carefully and cor-

rectly the personality, thinking, and ability of each student. The ability to analyze a student correctly, and to apply instruction in the manner to which he is most receptive is essential to good instruction.

No two students are alike, and the same methods of instruction cannot be equally effective for all students. To analyze the student and develop the appropriate methods of instruction for him, the instructor must talk with him at some length to learn his background and interests, to study his way of thinking, and to understand his temperament. His methods of instruction may change as the student advances through successive stages of his training; a gentle introduction must sometimes be followed by strict instruction if progress is to continue in advanced stages.

An instructor who has not correctly analyzed his student may soon find that his instruction is not producing the desired results. This could mean that, for example, he has analyzed as a slow thinker a student who is actually a quick thinker but hesitant to act. Such a student may fail to act at the proper time, even though he has correctly understood the situation and knows the correct procedures, because he lacks confidence in his own judgment or capability. The correction would obviously be instruction directed toward developing his self-confidence, rather than drill on flight fundamentals.

The slow student requires instructional methods which combine tact, keen perception, and delicate handling. If he receives too much help and encouragement, he may develop a feeling of incompetence. Too much criticism of his performance may completely subdue a timid person, whereas brisk instruction may force him to apply himself more diligently.

A student whose slow progress is due to discouragement and a lack of confidence should be assigned "subgoals" which can be attained more easily than the normal learning goals. For this purpose, complex flight maneuvers can be separated into their elements, and each element practiced until an acceptable performance is achieved before the whole maneuver or operation is attempted. As an example, instruction in turns across a road may begin with consideration at first for headings only, and the problems of altitude control, drift correction, and coordination can be introduced separately, one at a time. As the student gains confidence and ability, his goals should be increased in difficulty until his progress is normal.

The apt student can also become a problem. Because he makes few mistakes, he may soon assume that the correction of errors is unimportant. Such overconfidence soon results in faulty performance. For such a student, a good instructor will constantly raise the standard of performance for each lesson, demanding greater effort from the student. Man learns when his errors become known to him. A student who is permitted to complete every flight lesson without corrections and guidance will fail to retain what he has practiced as well as he would if he has his attention constantly called to the analysis of his own performance. This does not mean that deficiencies must be invented for his benefit, because unfair criticism immediately destroys the student's confidence in his instructor.

The fact that a student needs patient guidance must not lead the instructor to provide constant support and assistance on all of his training flights. If after full consideration and consultation with other available instructors, it is apparent that the student does not have the temperamental and physical aptitude necessary to become a safe pilot, he should be discouraged immediately from taking any further flight training.

The student should be constantly aware of his progress. The failure of an instructor to communicate to the student his evaluation of the student's progress establishes a barrier which blocks further effective instruction. This does not mean that the student must be presented with a grade slip or performance analysis at the end of each lesson. Many students have a natural awareness of their progress, and can derive from the instructor's directions, corrections, and comments a very accurate idea of their own progress. Others may be less perceptive, and need an actual review and evaluation of

each lesson after the flight in order to satisfy their need for an estimate of their progress.

The demands on an instructor to serve as a practical psychologist are much greater than is generally realized. Only by a keen analysis of his students, and a continuing deep interest in them can he live up to his responsibilities and be an effective flight instructor.

3. Safety Practices.—The flying habits of the flight instructor, both during his flight instruction and as he is observed conducting other piloting operations, have a vital effect on safety. Each flight instructor is a paragon of flying to his students, who will, consciously or unconsciously, imitate his flying habits. Their observations of his piloting practices are not limited to the flying involved in the instruction he gives them, and his description and advocacy of safety practices become meaningless when he is observed to violate them.

For this reason, a flight instructor must not only meticulously observe the safety practices he teaches his students, but he must also maintain *the appearance of constantly doing so.* A good example is the use of a checklist before takeoff. If a student sees his instructor start up an airplane and take off without observing his reference to a printed checklist, no amount of instruction in the use of a checklist will ensure that the student will use one conscientiously when he begins flight operations under his own responsibility.

A flight instructor must also carefully observe all regulations and recognized safety practices during all of his flight operations if he is to preserve his image as a professional flight instructor. A pilot who is observed to fly without apparent regard to loading limitations or weather minimums creates an image of irresponsibility which many hours of conscientious flight instruction cannot correct.

Habitual observance of regulations, of safety precautions, and of the precepts of courtesy in all of his public appearances will enhance and support the instructor's image of professionalism. Further and more important, they make him a more effective instructor by inculcating in his students the same habits of care and respect for their airplanes and the safety of other pilots.

The instructor must go beyond the requirement to develop technically proficient flight students who are knowledgeable in the areas of their equipment and flight maneuvers. He must not only teach the student to know his limitations and those of his equipment, but he must also teach him to respect and be guided by what he knows.

B. The Teaching Process

There are four basic steps in the teaching process, without which effective instruction is impossible. These are (1) preparation, (2) explanation and demonstration, (3) trial and practice, and (4) review and evaluation. These four basic steps in teaching are often explained in different terms, listed in different orders, or broken down in greater detail, but they are always recognized in any serious consideration of the teaching process.

1. The preparation necessary for each lesson or period of instruction includes the instructor's determination of what is to be covered, the objectives of the lesson, and the goals which he hopes to attain. It may also include home study or other special preparation by the student for the scheduled lesson.

The instructor's preparation may be relatively informal, or it may include actual reference to the syllabus for the course involved and a study of course and stage objectives. It must include the development of a lesson plan if the instruction period is to be effective.

The instructor's lesson plan may be prepared mentally in the case of an experienced instructor planning a simple period of instruction, or it may be worked out with care and prepared in written form. The lesson plan is simply the instructor's statement of the lesson objectives, the procedures and facilities to be used for presenting it, the specific goals to be attained, and the means to be used for evaluating the results achieved. Lesson plans will be described in detail later in this chapter.

2. Explanation and demonstration constitute the instructor's presentation of the knowledge and skills which make up the lesson. This phase may be divided in the case of flight instruction into preflight instruction and flight demonstrations of maneuvers or operations. Explanations must be clear, pertinent to the objectives of the lesson, and based on the known experience and knowledge of the student.

The demonstrations should be presented to implement the explanations which introduce them. As little extraneous activity as possible should be included, and the student should clearly understand that the instructor is accurately performing the actions he has described. Any deviation in performance from that described which is caused by unanticipated circumstances should be immediately acknowledged and explained. Failure to do so may diminish the student's confidence in the instructor and the training he is receiving.

3. Trial and practice constitute the student's activity during the lesson. In classroom instruction, this may consist of recitation or solving problems. In flight instruction, it means trying for himself the performance of the maneuver or operation explained and demonstrated, and practicing it until he achieves an understanding of the factors involved.

Actually, although they are technically separate segments of the lesson, portions of the instructor's explanation and demonstration activity are usually alternated with portions of the student's trial and practice activity. It is rare that the instructor completes his explanation and demonstrations, and then allows the student to accomplish his trial and practice activities without interruptions for corrections and further demonstrations.

4. Review and evaluation are integral parts of each lesson. Before the completion of the instruction period, the instructor should recapitulate what has been covered during the lesson, and require the student to demonstrate the extent to which he has met the lesson objectives. The instructor's evaluation may be informal, and noted only for his use in planning the next lesson for the student, or it may be recorded to certify the student's progress in his course.

In either case, the student should be aware of his progress and the advances and deficiencies noted at the conclusion of the lesson. The failure of the instructor to ensure that the student is cognizant of his progress, or his lack of it, may impose a barrier between them. Though it may be slight it will make further instruction more difficult.

The instructor must remember that it is rather difficult for a student to obtain a clear picture of his progress since he has little opportunity for a direct comparison with others, particularly in the early phases of his training. The student recognizes that he is in a competitive situation which is unlike any other he has experienced. His unseen competitor is that intangible "proficiency" which he must achieve.

The student's own evaluations can only be subjective. Direct comparisons for him are only possible with the performance of his flight instructor. This tells him very little about his performance in comparison with that of other students with similar background. Only the flight instructor can provide him a realistic evaluation of his performance and progress.

In addition to knowledge and skills learned during the instruction period just completed, each lesson should include a review and evaluation of things previously learned. If this evaluation reveals a deficiency or fault in the knowledge or performances on which the present lesson is predicated, it must be corrected before the new lesson can begin. For example, the trial and practice of ground reference maneuvers should not be initiated for a student whose performance of medium turns is deficient.

If deficiencies or faults not associated with the present lesson are revealed, they should be carefully noted and pointed out to the student. Such corrective measures as are practicable within the limitations of the situation should be taken immediately, but more thorough remedial actions must be included in future lesson plans for the student involved.

The evaluation of the student's performance and accomplishments during the lesson should be based upon the objectives and goals that were established in the instructor's lesson plan for that lesson. Evaluations for the purpose of certifying the completion of stages of training, or for executing student pilot certificate endorsements, should be based on the standards of the training syllabus concerned.

C. Planning Instructional Activity

Any training activity, whether it be at the kindergarten or the college level, must be competently planned if it is to be effective. The principles which govern the effectiveness of this planning are equally applicable to all types of training activity. Most of the basic planning necessary for flight instruction is already provided for the flight instructor by the pilot knowledge and skill requirements of the Federal Aviation Regulations, approved school curriculums, and many authoritative texts on flight training. A short review is provided here to give the prospective flight instructor a background for the planning he must do in the field.

1. Determination of Overall Objectives.— Before any important instruction can begin, a determination of objectives and standards is necessary. In the case of pilot training, the overall objective is obvious and the minimum standards are provided by the regulations.

The general overall objective of pilot training is to qualify the student to be a competent, efficient, safe pilot for the operation of specific aircraft types under stated conditions. The criteria by which we determine whether the training has been adequate are the passing of written examinations and flight tests required for the issuance of pilot certificates.

The conscientious flight instructor, however, does not limit his objectives to meeting the minimum published requirements for a pilot certificate. He establishes as his objectives the training of each student to have the knowledge necessary to service an airplane properly, to maneuver and operate it accurately within its limitations, and to analyze and make prompt decisions with respect to foreseeable problems and emergencies. The student must also develop correct habit patterns and the personal objective to consistently maneuver his airplane accurately and effectively, to operate it safely in the most efficient manner possible, and to provide for all reasonably foreseeable flight situations. This is only a partial list of general objectives, but is illustrative of the major planning which is the basis of any training endeavor.

An awareness of such objectives is necessary for any instructor who prepares and administers training courses, and all instructors who prepare effective lesson plans for lessons which are part of these courses.

2. Identification of Blocks of Learning.— It is not practicable for an instructor to proceed immediately toward the overall objectives he has established for a major training activity he is undertaking. Training for any such complicated and involved skill as piloting an aircraft requires the development and assembly, in their proper relationships, of many "blocks" of learning. In this way, a student can master segments of the overall pilot performance requirements individually, and can progressively combine these with other related segments until their sum meets the final objective.

Seen in this manner, training is much like building a pyramid—each block is an identity in itself, but the pyramid is incomplete if any one is missing. The instructor and the student must both recognize the interrelationship of the blocks, and the place of each in the total objective of the lesson.

After the overall training objectives have been established the next step is the identification of the blocks of learning which constitute the necessary parts of the total objective. Just as in building a pyramid, some blocks are submerged in the structure and never appear on the surface, but each is an integral necessary part of the structure. While identifying the blocks of learning to be assembled during the proposed training activity, the planner must examine each carefully to see that it is truly an integral

part of the structure. Extraneous blocks of instruction are expensive frills, especially in flight instruction, and detract from rather than assist in the completion of the final objective.

The blocks of learning identified during the planning of a training activity should be progressively smaller in scope. They should represent units of learning which can be measured and evaluated—not a sequence of periods of instruction. For example, the training of a private pilot might be divided into the following major blocks: Achievement of the skills necessary for solo, the skills necessary for solo cross-country flights, and the skills appropriate for application for a private pilot certificate. Each of these, in turn, should be broken into component blocks of learning.

The skills necessary for the first solo flight might be broken down as in-flight maneuvering; airspeed control, including slow flight, stalls, and descents at approach speed; maneuvering by ground references; normal takeoffs and landings; maximum performance operations; etc. Each of these, in turn, must be subdivided to produce effective lesson plans for each period of instruction.

As seen from the illustration cited, the possibility for breaking down and categorizing training objectives is infinite. For practical planning, the test for a useful size of a minimum block of learning is whether it contains sufficient learning to (1) provide a challenge for the student, (2) to promise a reasonable return in accomplishment for the training effort necessary, and (3) to provide measurable objectives. If it meets all of these requirements, and is determined to be an integral, necessary part of the overall objectives of the training undertaken, it should be assigned a place in the training syllabus.

As training progresses and these blocks of training are completed and the student's performance of each confirmed to be at an acceptable level, the related blocks will be combined to form larger segments of the total training objective. For example, acceptable performances of airspeed management, maneuvering by ground references, and inflight maneuvering may be combined to provide the capability of flying a traffic pattern about an airport. In this manner, the use of a properly planned syllabus makes it possible for the instructor to direct each period of instruction directly toward the completion of blocks of learning, which are in turn combined with others to lead directly toward the overall objective.

3. The Syllabus.—The flight training syllabus is the backbone and framework of the training curriculum. It consists of the blocks of instruction to be completed in the most efficient order. It does not include the amount of instruction in the blocks, the training procedures to be used, or the standards for their completion. These are properly parts of the training curriculum.

The flight instructor may develop his own syllabus after he has established his overall objectives, and has identified his blocks of learning. However, there are available many tried and proven syllabuses which he may use. These are found in various training manuals, approved school curriculums, and special publications. Among them is the FAA *Private Pilot (Airplane) Flight Training Guide,* Advisory Circular No. 61–2A, which provides a syllabus for the student preparing to apply for a private pilot certificate.

Any practical flight training syllabus must be flexible, and should be used primarily as a guide. The order of training can and should be altered, when necessary, to suit the progress of the student and the exigencies of special circumstances. In departing from the order prescribed by the syllabus, however, it is the responsibility of the flight instructor to consider the relationships of the blocks of learning affected. It is often preferable to skip to a completely different part of the syllabus when the conduct of a scheduled lesson is impossible, rather than proceeding to the next block, which may be predicated completely on skills to be developed during the lesson which is being postponed.

4. The Lesson Plan.—Instruction is adequately planned only when the instructor has a lesson plan for each period or unit of instruction. As is seen from the above discussions, the lesson plan is the culmination and

e direct application of general and specific anning which must be the basis of all effec- 'e *instruction*. Teaching success depends re upon lesson planning than it does on sentation, personality, flying ability, or erience. Teaching is somewhat like a tle, in that effort, strength, and sincerity not win if the strategy of its conduct is ty. The finest workmanship and mate- will not build a good airplane if the design is faulty.

n experienced flight instructor who has ed many students is able instinctively to ruct an effective lesson plan for a rou- period of instruction, or at least without itting it to writing. However, an in- or who has been through the course few times, or an experienced instruc- o must modify his procedures to effect emphasis, should always prepare a n lesson plan. This lesson plan may be rief, topical in nature, and need not a prescribed format. It is prepared instructor's own benefit, and should in the form most useful to him.

lesson plan may be more or less de- nd may include the special or associ- siderations which should be covered an instruction period. A lesson plan for one student is rarely appro- another without some modification. sson plan, however, must include at following items if it is to result in organized instruction:

esson objectives. The objectives hould be established in terms of hat is to be learned by the student, e mechanical skills to be developed, d the standard of performance ex- cted at the end of the lesson.

ements involved. A statement of elements of knowledge and skills ich will be necessary for the ful- ment of the lesson objectives. se may include elements previ- ly learned and elements to be oduced during this lesson.

cation of time available. The in- ctor should estimate the propor- of the lesson to be devoted to element to be learned and the presentation and practice of each new operation. If the time available does not allow adequate coverage, the lesson objectives should be revised.

d. *Equipment.* A review of all equipment required for the lesson, including the airplane, aircraft equipment, charts, computers, IFR hoods, etc.

e. *Instructor's actions.* A determination of the instructor's responsibilities, and his proposed procedures for presenting the elements of knowledge and performance involved.

f. *Student's actions.* The anticipated and the desired responses of the student to instruction, and a reasonable estimate of the practice needed to understand the elements involved.

g. *Evaluation.* The means and the program proposed to evaluate the student's learning and accomplishments. These should include the standards of learning and proficiency expected.

The lesson plan may be carried by the instructor to assist him as a checklist in the administration of the lesson, or he may study it until he is confident that he cannot be easily diverted from his planned procedure.

Once the lesson has begun, the instructor should not allow the application of his lesson plan to be diverted to other subjects and procedures. This does not mean that the planned instruction should not be modified by circumstances, or by the discovery of pertinent deficiencies in the student's knowledge or in performance of elements essential to its effective completion. It is possible that the whole lesson may have to be abandoned in favor of a review of knowledge and operations previously covered.

To facilitate this, each lesson should begin with a brief review of elements covered during previous lessons, and any practice necessary to bring the student's performance up to the proficiency assumed for the start of the present lesson. If this review grows to unanticipated proportions, or necessitates the abandonment or significant revision of the lesson plan, the instructor must be prepared to mentally construct a new lesson

plan to guide the remainder of the instruction period.

The mechanics of constructing a lesson plan for each period of instruction may seem cumbersome, and unduly burdensome. However, the conscientious development and use of lesson plans is the most effective means of developing orderly and effective teaching habits. The procedure soon becomes habitual, and each segment falls into place for the experienced instructor with little effort on his part.

The use of a standard, or preprepared, lesson plan for all students is rarely effective because each student requires a slightly different approach. Assistance from an experienced flight instructor in preparing lesson plans is often helpful for a new instructor, but a lesson plan prepared by someone else is not so helpful to an instructor as one he has devised himself.

Figure 2 illustrates a possible lesson plan for an early dual instruction period. It should be noted that it contains all of the essential items, although each is shown by a topical heading. To be fully informative, each heading would have to be amplified to detail the teaching activities proposed by the instructor who prepared the lesson plan, and the performance expected. Such amplification is usually not effected, except as an exercise in teaching procedures.

5. The Flight Instruction Breakdown.— The "Flight Instruction Breakdown" is a maneuver analysis developed for the individual instructor for his own use in preparing meaningful lesson plans, and for guidance in offering effective instruction. It consists of a written outline of the important steps, "doing units," and the key points, "knowing units," which are involved in the correct teaching of a specific flight maneuver or procedure.

Figure 3 illustrates a flight instruction breakdown for the teaching of *Takeoff and Departure Stalls*. Instruction breakdowns may be effectively prepared on simple forms such as the one illustrated, or on plain paper. Since they are intended to serve only the instructor who prepares them, he should arrange them in the form he finds most useful.

Preparation of a flight instruction brea down requires a careful personal analysis the maneuver covered, and of the procedu the instructor proposes for teaching it. T instructor will always find in using his i struction breakdown that changes are su gested or necessitated by unanticipat elements and factors encountered during t lesson. For this reason, it is recommend that instruction breakdowns be prepared f insertion in loose leaf binders, so that th may be easily corrected and amended.

It is recommended that each flight instru tor prepare and maintain a complete set flight instruction breakdowns covering ea maneuver and procedure in the flight s labus he teaches.

D. Maintaining Student Interest

The flight instructor is fortunate in havi a subject to teach which has universal appe to active people. Probably the most fas nating and intriguing aspect of flying is dynamic quality. Conditions of flight a never twice the same. One day may bright, clear, and windy, while the next d may be unexpectedly grey. Rough air 3,000 feet may take the place of smooth co ditions at 5,000 feet as one descends for landing. A front moving from the nort west may be of no concern to an eastbou pilot, but a matter of vital concern to a we bound flight.

Flying is an ever-changing occupation pastime. None of its factors is fixed. M and his physical and psychological make are in a constant state of flux. Just so aviation; the flying machine is subject to t stresses and strains of operation, and to va iations in characteristics with changes loading, temperature, and altitude. Just society presents a constantly changing aspe to man, the weather conditions are nev identical on two separate flying trips.

Learning how to profit from the expe ences of others is one of the things whi sets man apart from all other living being Plants and animals can make minor adapt tions to their environment, or profit fro their own experiences, but only man has d veloped ways of benefiting from the expe

LESSON GROUND REFERENCE MANEUVERS STUDENT _____ DATE _____

OBJECTIVES	PLANNING & FOLLOWING A PATTERN OVER THE GROUND	
	COMPENSATING FOR WIND DRIFT AT VARYING ANGLES	
ELEMENTS	USE OF GROUND REFERENCES TO CONTROL PATH	
	OBSERVATION & CONTROL OF WIND EFFECT	
	CONTROL OF AIRPLANE ATTITUDE, ALTITUDE & HEADING	
SCHEDULE	PREFLIGHT INSTRUCTION	:20
	INSTRUCTOR DEMONSTRATIONS	:15
	STUDENT PRACTICE	:45
	POSTFLIGHT CRITIQUE	:10
EQUIPMENT	BLACKBOARD FOR PREFLIGHT INSTRUCTION	
	IFR VISOR FOR MANEUVERS REVIEWED	
INSTRUCTOR'S ACTIONS	EXPLAIN OBJECTIVES & DIAGRAM S TURNS, TURNS ABOUT A POINT & RECTANGULAR COURSES ON BLACKBOARD	
	FLIGHT DEMONSTRATIONS OF ELEMENTS: & FOLLOWING A ROAD, S TURNS, TURNS ABOUT A POINT AND RECTANGULAR COURSES AS STUDENT LEARNS EACH SUCCEEDING MANEUVER	
STUDENT'S ACTIONS	DISCUSS OBJECTIVES & RESOLVE QUESTIONS	
	REVIEW & PRACTICE STRAIGHT & LEVEL FLIGHT, SLOW FLIGHT, AND TURNS TO HEADINGS.	
	PERFORM EACH NEW MANEUVER AS DIRECTED, AND PRACTICE	
EVALUATION	LESSON IS COMPLETE WHEN STUDENT CAN RETAIN ORIENTATION, HEADINGS WITHIN 15°, ALTITUDE WITHIN 100 FEET, AND INITIATE WIND COMPENSATION ACTION IN PROPER DIRECTION.	

FIGURE 2.—Sample lesson plan for a flight instruction period.

MANEUVER *TAKE OFF AND DEPARTURE STALLS* INSTRUCTOR *JACK MOSLEY*

OBJECTIVE *To teach the safe recognition of and recovery from stalls*

DOING UNITS (STEPS)	KNOWING UNITS (KEY POINTS)
1. Preflight discussion - review aerodynamics of stalls	a. Angle of attack b. Stall recognition clues c. Recovery techniques
2. Instructor's demonstration - altitude 3,000 AGL, Clearing turns, Cage gyros, use take off configuration	a. Climbing power b. 30° bank at normal climb speed c. Maintain bank and rate of turn d. Increase pitch with elevators e. Initiate recovery when stall is recognized f. Reduce angle of attack g. Stop turn h. Regain straight and level flight i. Reset power and trim.
3. Require student to describe procedure	a. Stall recognition b. Control usage c. Reason for stall
4. Directed student practice	a. Use verbal corrections ···don't ride controls b. Correct wrong procedures at once
5. Encourage student experimentation	a. Effects of power settings b. Effects of delay on altitude loss c. Effects of configurations
6. Review of maneuver, emphasizing instrument indications	a. Hazards involved in stalls b. Emphasize control coordination c. Acknowledge student progress

PERFORMANCE ELEMENTS	GRADING CRITERIA
Airspeed control	Accuracy of procedure
Altitude loss - not more than 300'	Stall recognition
Maintenance of turn	Altitude conservation
Smoothness of control usage	Reaction time
	Attitude control
	Student understanding

FIGURE 3.—Sample flight information breakdown.

ences of others. The process by which this occurs is called learning, and arranging circumstances and facts so that related experiences are used profitably is called instruction.

Instruction can be effective and learning can proceed at an efficient rate only when people are truly interested in learning. All types of motivation may create, and sustain to a certain degree, an interest in learning. The most effective of these are the positive motivations. The strongest of these are those which promise pleasurable experiences, which are novel and different, and which present challenges to the student. Flight instruction can easily be presented in a way which support these motivations perfectly.

The student's interest can be used to great advantage by the flight instructor all through his training by observing basic well-known techniques of instruction.

1. Using the Student's Motivations.—In his original analysis of the student, the instructor has attempted to determine what things interest the student, and what motivations have led him to take up flying. These motivations are seldom recognized by the student himself, and are occasionally concealed because of self-consciousness. The instructor should from the first flight carefully note what interests the student, and to which motivations he shows the strongest reactions. While these are usually the motivations the instructor has originally identified with the student, this may not always be the case.

The instructor must be careful not to project his own motivations or those he has observed with other students. Motivations vary, and while the student response to the motivations which work with others may seem genuine, they may not be effective in arousing and holding his interest. One student may derive satisfaction from exploring strange areas, while others may be interested by precision maneuvers or acrobatics, challenging assignments, or in the operation of aircraft systems.

When using the student's motivations to encourage him and to maintain his interest, the instructor must direct them in a positive manner, so that the instruction offered is furthered, not deterred or retarded. For example, a student who enjoys sightseeing should not be allowed to spend the instruction time just riding. The instructor might take care to select interesting areas for practice air work, and to provide different areas for different lessons. The student who enjoys flight maneuvers should not be drilled for extended periods on pattern maneuvers which bore him, but should have his interest wakened regularly by the occasional introduction of review and the practice of such operations as steep turns and stall maneuvers.

Most students have a strong desire to take control of the flight situation as soon as possible. While early solo flights are impracticable and not conducive to good pilot preparation, this motivation can be used by assigning all reasonable responsibilities to the student as soon as he is prepared to accept them. Starting and runup procedures can be delegated to the student early in his training, as can the preflight inspection and servicing of the airplane. Shuttle flights to and from practice areas should be turned over to the student as soon as he has developed a sense of ease at the controls.

The whole flight training process is actually a transfer from the instructor to the student of the necessary functions and responsibilities of the pilot. If the student is made to recognize these responsibilities as they are assigned to him, his interest will be maintained, and he will eagerly accept them as evidences of his progress toward his final goal.

2. Using All of the Student's Senses.—People learn through their perceptions. They display greater interest and learn more rapidly when information is gained through more than one of their senses. In teaching the use of the elevator control, for example, the student's interest will be better maintained if he *hears* what to expect, and the changes in the sounds of flight which result from its operation; *sees* the effect of its use on the attitude of the airplane; and *feels* the forces which oppose its movement, and the change in flight attitude which results.

The instructor should habitually reinforce each bit of his demonstrations by describing

the sensations to be expected, and by pointing out each physical perception which is involved in its performance. Vision, hearing, and feeling are of primary importance for this, but the kinesthetic recognition of changes in rates and directions of motion must not be overlooked. This last is most useful in teaching the coordination of flight controls and smoothness.

The student whose attention is called to all of the perceptions available to him in each flight operation soon learns to examine his own sensory inputs with great benefit to his performance and rate of learning. He becomes an interested participant in all maneuvers, rather than a passive passenger.

3. Contriving Experiences.—Since people learn best from their own perceptions, the instructor should contrive situations in which desired perceptions are likely to occur. These contrived situations need not be involved, and should never be allowed to appear artificial to the student. They may consist of such simple procedures as allowing the student who has not managed his fuel supply properly to recognize his oversight when the engine falters.

People who learn from actual experiences, contrived or not, are much more interested in the knowledge of skill attained, and benefit from the exercise in evaluating the situation for themselves. To assure maximum learning and retention, the flight instructor should create situations in which the same circumstances can be perceived in several different ways.

Such contrived situations can be quite simple. For example, the instructor may slowly reduce the power setting during cruising flight without being observed by the student. This may result in a reduction in engine speed, a loss of altitude, a loss of airspeed, or a combination of these. In analyzing the true cause, the student must consider the possibility of carburetor ice, faulty trim setting, prolonged down drafts, or errors in control usage resulting from inattention.

The knowledge and skills involved in flying are varied and often complex. The use of contrived situations to foster the exercise of all available channels of perception in presenting them to the student's mind will emphasize the important elements without boring the student or diminishing his interest.

4. Teaching From the Known to the Unknown.—All learning proceeds from the known to the unknown. Descartes, the French philosopher, founded his whole conception of man's knowledge on the simple premise "I think, therefore I exist." From this simple assumption of one fact, he proceeded to others which he combined, developed, and refined to support everything we accept as truth today.

This, on a smaller scale, is exactly what each instructor must do in every field of instruction. Only the points of departure and the objectives are different. The instructor takes the experience and knowledge which the student brings with him, gives it meaning toward the subject which he is to teach, and adds directed experiences, perceptions, and insights.

Perceptions are personal meanings within the individual which he derives from his experiences. The teacher takes the student from where he finds him toward the objective he seeks. He arranges the ideas to be learned and the experiences he provides so that the student is constantly moving from the familiar to the unfamiliar, a step at a time.

This is the principle of the "building block" concept of learning which has been explained in an earlier section. Each new flight experience should be made to isolate and identify one piece of the totality of piloting. In a like manner, each lesson should also help the student pilot to tie a specific piece of learning to the overall task of learning to pilot an aircraft.

The instructor works two ways at once. He must segregate bits of learning from the overall goal so that the student sees precisely the effect of each small element, such as power setting at altitude. At the same time, he should assist the student in developing insights concerning the relationships of power setting to altitude, trim, control effectiveness, airspeed, and all other factors

which are affected by this one small element of piloting.

Each new bit of learning must be experienced in many ways, and with many different associations to guarantee retention and understanding. Instruction which disregards what was learned yesterday leads to inadequate learning and wastes time. Accomplishing a new maneuver without recognizing and understanding the previously learned elements involved is poor instruction, and results in disinterest and forgetting. Each lesson should present some new knowledge and skills, but each lesson should also require the student to recall and to apply his previous learning.

Telling, showing, and in other ways presenting to a student an experience, which is not based on or associated with things previously learned, will have little meaning to the student, and little learning will occur. To ensure that his instruction is meaningful, the instructor must be sure that it is based on perceptions which are meaningful to the student because of his previous knowledge and experiences.

5. "Watch Your Language."—The jargon of aviation is a language all its own. Aviation terms are sometimes technical, often picturesque, but rarely self-explanatory.

The student new to aviation is entering a world of new concepts and experiences which are strange to him. He is also encountering new and strange terms which sometimes fascinate, and often puzzle him. Talk of "flaps," "base legs," "stalls," and "ground loops" presents words which are familiar to him, but uses them with entirely new meanings. Coined words, such as "omni," "unicom," and "pireps" are incomprehensible. Terms such as "flare it out," "do a one-eighty," and "guard the tower" all present pictures to him which are not necessarily what the instructor intended them to be.

The flight instructor does, and properly he should, use these terms in his instruction. Although the language of aviation is new and strange to the novice student, it is a part of the new world of flying, and he is eager to learn and adopt it. Difficulty arises, however, when the instructor introduces these new terms for the first time to his student in an in-flight situation which may be difficult for the student under the best of circumstances.

At the beginning of the student's flight course, and before each flight lesson during his early dual instruction, the instructor should carefully define for him the terms which will be used during the forthcoming lesson. He should then be careful to limit his instruction to these terms, unless he immediately explains the exact meaning and intent of any new term he uses.

The most serious student errors and confusion involving unfamiliar terms result from the use of the colloquial terms of aviation, which are rarely specific, and have endless variations. Instructing the student to "give it the needle," "throw the cobs to it," or "firewall it" when he is expected to open the throttle for takeoff may be picturesque and brighten the instruction given, but it can have serious consequences if one is used for the first time in a critical flight situation. There is the apocryphal story of the pilot of a large airplane faced with an emergency pullup who shouted "takeoff power" to the flight engineer who immediately shut all four throttles.

6. Emphasize the Positive.—Almost everyone has his own "image" of flying. Flying can be a completely enjoyable experience, or one laden with fear, discomfort, frustration, and failure. The flight instructor effects a tremendous influence on the student's "image" of flying. The way he conducts himself, the way he develops his teaching, and the way he builds his lesson plans will all contribute to the formation of a *positive* or *negative* impression for the student. The success of a flight instructor depends in a large measure on his ability to frame his instruction so that his students develop a positive image of flying, which is so important to a favorable learning situation.

We have learned that negative self-concepts inhibit the perceptual process, that fear adversely affects the student's perception, that threats limit an individual's ability to perceive, and that negative motivations

are not as effective as are positive motivations. A knowledge of these factors which have such a profound influence on the learner's ability to receive instruction is not enough. Instructors must keep a constant vigil to assure that these and other negativisms are not allowed to creep into their instruction.

It is interesting to consider how the following not-too-exaggerated first flight lesson might impress a new student pilot without previous experience in aviation:

a. An exhaustive indoctrination in preflight procedures, with emphasis on the extreme precautions which must be taken before every flight because mechanical failures in flight are often disastrous.
b. Instruction in the extreme care which must be taken in taxiing an airplane, because "if you go too fast, it's likely to get away from you."
c. A series of stalls, because "this is how so many people lose their lives in airplanes." (The side benefit of this performance on the first lesson is likely airsickness).
d. An introduction to control of the airplane by reference to instruments, to allow "survival" in case of inadvertent flight into the clouds.
e. A series of simulated forced landings, because one should always be prepared to cope with an engine failure.

These are a series of new experiences which might make the new student wonder whether learning to fly is a good idea or not.

For contrast, one might consider a first flight lesson in which the preflight inspection is presented to familiarize the student with the airplane and its components, and the flight consists of a perfectly normal flight to a nearby airport and return. Following the flight, the instructor can call the student's attention to the ease with which the trip is made in comparison with the modes of transportation he has been accustomed to, and the fact that no critical incidents were encountered or expected.

This by no means proposes that preflight inspections, stalls, and emergency procedures should be omitted from the student's training. It only illustrates the "positive" approach, in which the student is not overwhelmed with the critical possibilities of aviation before he has an opportunity to see its potential and pleasurable features. The introduction of emergency procedures after he has developed an acquaintance with normal operations is not so likely to scare him away, discourage him, or retard his rate of learning by the imposition of fear.

There is no creed in aviation which demands that a flight student must suffer as a part of his flight education. This has too often been the case because of the unthinking use of "negative" explanations and motivations for all flight operations. Every effort should be made to assure that flight instruction is given under the most favorable conditions.

Recent surveys have revealed that of the total number of students who start flight training, less than half go on to receive their pilot certificates. There are several reasons for this, but one which seems to be a prime factor is the learning environment. Instructors should seriously assess this learning environment to fully appreciate the outlook of the student learning to fly.

There is the unfamiliar vibration, the strange noises, the eerie sensations due to "g" loads, or the "woozy" feeling in the stomach. The instructor, if he is to be effective, cannot ignore the existence of these negative factors, nor can he ridicule the student who is adversely affected by them. Rather, these negativisms must be overcome or overmatched by positive instruction.

An instructor may explain to a student that a flight maneuver or procedure must be accomplished in a certain manner. To perform it otherwise, the instructor points out, is to flirt with disaster or to suffer serious consequences. Justifications such as these may be very convenient, and the instructor may consider such negative justifications sufficiently dramatic to ensure that his point is committed to memory. The final test, however, must be whether the stated reasons contribute to the learning situation. With very few exceptions, the results which can be expected should be very apparent. Nega-

tive teaching generally results in negative learning.

Most new flight instructors tend to adopt those teaching methods used when they were students. These methods may or may not have been good. The fact that one has learned to fly under one system of instruction does not mean that this is necessarily the best way it can be done, regardless of the respect he retains for the ability of his original instructor. Some students learn to fly in spite of their instruction, rather than because of it.

In his teaching, the most successful instructor will use positive explanations and motivations. Instead of emphasizing the dire consequences of an incorrect performance, he will cite the advantages of a correct one. Instead of berating the student for his errors, he will praise his correct performances. In this way, the student will be encouraged to seek out the correct performances, rather than concentrating on the avoidance of forbidden errors.

The new flight instructor has his choice of either positive or negative teaching. Throughout his career as an instructor he will be constantly and daily tempted to use negativisms as tools of teaching. In making his choice, he should examine the record. Every reason and every experience points to the advantages of emphasizing the *positive* and minimizing the *negative.*

E. Use of Training Aids

The use of mechanical training aids is increasing in popularity for pilot instruction. These may consist of anything from the use of very simple models for illustrating aircraft flight attitudes to the use of audiovisual courses and sophisticated aircraft flight simulators. With all of these, they are valuable only as aids to good instruction, and none has been yet devised which has successfully eliminated the need for an instructor.

1. Models.—Models used for pilot instruction aids may be scale or stylized models of complete aircraft, mockups of components and systems, or complete layouts of aviation facilities such as complete airports. The simplest, and often the most effective models for flight instruction, are inexpensive toy airplanes which can be used to illustrate flight maneuvers and flight situations during preflight and postflight instruction. More complicated models may have movable control surfaces and other refinements. These are most useful for classroom instruction, since they tend to be fragile and are not as portable.

Mockups of aircraft components and systems are useful for classroom instruction and, when readily accessible, for preflight and postflight instruction. They may be relatively simple devices, either fixed or movable, or they may consist of such advanced aids as mockups of whole systems using aircraft components, cutaway engines, and sectionalized aircraft.

While possibly they cannot properly be considered models, large or actual-size photographs of cockpit layouts and aircraft controls are often used effectively for the original instruction in aircraft familiarization. These are sometimes used in primary instruction, but are most useful for checkouts and qualification in complex aircraft.

2. Charts, Diagrams, and Performance Tables.—Wall charts, diagrams of systems or flight maneuvers, and tables of aeronautical and aircraft performance data are excellent teaching aids. They are usually provided as poster-type displays for mounting on a wallboard or easel in the classroom. Such displays are most appropriate to classroom instruction, but may be used effectively for preflight and postflight instruction if they can be made conveniently available in the ready room.

Many valuable presentations of this type are also available in reference books, texts, and especially in aircraft flight manuals. Their use for flight instruction and assigned home study by flight students is most effective in providing the understanding of the airplane systems and its flight operations which is essential for effective learning.

3. Audiovisual Courses.—The use of a filmstrip or slide projector with a provision for playing recorded commentaries has in-

creased tremendously in recent years as a training aid in pilot ground school courses. The FAA has permitted the use of such audiovisual aids in approved pilot ground school courses, provided they are administered by certificated instructors.

While most audiovisual pilot courses are designed expressly for use in classroom instruction, certain portions of them may be profitably used in flight courses by flight instructors.

The use of authoritative audiovisual courses as aids to ground instruction by a qualified instructor has been found to be very effective. Attempts to use such courses by themselves, with students watching as they would a movie or television show, have not been generally successful.

In addition to prepared audiovisual courses, motion pictures, slide projectors, and delineascope projectors can be used successfully for pilot instruction. Tape or disc recordings have also been found effective, especially in teaching radio and traffic-control procedures. Because of the complications involved in their use, all visual and audio aids are most profitably used for group instruction, but they are equally effective for individual instruction or small classes if their use can be made practicable.

Self-made visual aids, such as slides, flip charts, and blackboard diagrams, are often effective when carefully prepared and appropriate to the instruction concerned. They are rarely effective if their application to the lesson at hand is not carefully prepared in advance by the instructor.

Leaving visual aids in view as the instructor progresses to other subjects detracts both from their effectiveness and from the students' attention to the subsequent instruction.

4. Programed Instruction.—The interest in programed instruction for pilot courses is increasing. Programed instruction courses usually provide workbooks or study material as an introduction to a subject to be covered, and then continue with questions and statements on the subject which are to be answered by the student and marked in the textbooks or answered on a tape. The "teaching machine" is one form of programed instruction.

Properly prepared, programed instruction is based on the "building block" principle of teaching in that it takes the student by small steps from familiar facts to the unknown and on to the more technical information which is the objective of the training. Students are led to develop their insights naturally through simple perceptions which they achieve by inserting bits of information into the blanks provided.

Programed instruction has not, at its present state of development, been made directly applicable to flight instruction. It is included in this chapter only because of its similarity to audiovisual training courses, and because of the developments in its use which are rapidly taking place.

5. "Handees" (Gestures and improvisations).—The importance of the most elementary training aids to flight instruction is often overlooked, probably because their development is usually natural and undirected. Most flight instructors tend to develop a system of effective "handees" as they gain teaching experience.

These handees are very similar in some respects to the old system of hand signals used by flight instructors in open-cockpit airplanes, but go far beyond them in their application. Handees are a very simple positioning or motion of the hands to illustrate flight situations or maneuvers. For example, the instructor may illustrate with his flat extended hand above a tabletop how an airplane is landed by increasing the angle of attack to allow the airplane to settle, rather than by flying into the ground as novice students assume that it is done.

Handees are especially valuable in flight instruction because no equipment or preparation is required for their use. They may be used effectively in the classroom, on the flight line, and in flight. The beginning flight instructor who is developing his own set of handees should be guided by two basic considerations. Their use and application should be uniform—the same motions should be used consistently to illustrate the same flight operation. They should be kept as simple as possible. Complex and continued

gestures tend to produce only confusion in the cockpit.

F. Evaluation

Evaluation is one of the basic steps in the teaching process described earlier in this chapter. The evaluation of the student's learning is a continuing process, carried on throughout each period of instruction. The instructor's evaluation may consist of simple observations of the student's rate of comprehension as evidenced by his performance, by the administration of oral or written quizzes on pertinent aeronautical knowledge, or by formal check flights.

1. Oral Quizzing.—Regular and continuing evaluation of the student's learning is necessary for judging the effectiveness of instruction given, and for planning the emphasis and pace of subsequent instruction. The most practical means of evaluation for this purpose is direct or indirect questioning of the student by the instructor.

Proper quizzing by the instructor can have a number of desirable results:

a. It reveals the effectiveness of his own training procedures.
b. It checks the student's retention of what he has learned.
c. It reviews material already covered by the student.
d. It can be used to retain the student's interest and stimulate his thinking.
e. It emphasizes the important points of training.
f. It identifies points which need more emphasis.
g. It checks the student's comprehension of what he has learned.
h. It promotes active student participation, which is important to effective teaching.

Effective quizzing requires preparation. Good questions are rarely spontaneous. Questions which are ambiguous, not clearly associated with the subject at hand, or which do not solicit specific answers are of little value. They provide little information useful to the instructor, and are confusing or frustrating to the student.

Asking "Do you understand?", or "Have you any questions?", has no place in effective quizzing. Assurance by the student that he does understand, or that he has no questions to propose provides no evidence of his comprehension, or that he even knows the subject which is under discussion.

Other typical types of questions which must be avoided are:

The puzzle—"What action do you take if a tricycle-geared airplane is turning to the right in a crosswind?"

The oversize—"What do you do before you land?"

The toss-up—"Should the temperature read 82° or 83° at the completion of your climb?"

Bewilderment—"In reading the altimeter —you know you set a sensitive altimeter for the nearest station pressure—if you take temperature into account, as when flying from a cold air mass through a warm front, what precaution should you take when in a mountainous area?"

Catch questions should be avoided at all times. The student will soon develop the feeling that he is engaged in a battle of wits with the instructor, and the whole significance of the subject of the instruction involved will be lost.

Irrelevant questions should be avoided. The teaching process must be an orderly procedure of building one block of learning upon another in orderly progression, until a desired goal is reached. Diversions, and the introduction of unrelated facts and thoughts will only obscure this orderly process and retard the student's progress. Answers to unrelated questions are not helpful in evaluating the student's knowledge of the subject at hand.

Leading questions are a waste of instructional time. A question which suggests its own answer is a much less efficient means of teaching than is a direct explanation. "Pumping" questions which seek to extract an answer from the student which is considered to be within his knowledge are a waste of time. Answers which he is unable to recall would be of no use to him in a flight situation. If the question has been clearly stated

and properly presented, the student's failure to answer must be accepted as evidence that he would not respond correctly in the flight situation described.

Quizzing may be used effectively in several ways by the flight instructor. He may ask questions of the student, he may permit the student to ask questions, or he may present written questions for the student's consideration and answers. The principles of questioning, as described, apply to both verbal and written quizzes by the instructor.

The answering of students' questions must also conform with certain considerations if it is to be an effective teaching method. The instructor must be sure that he understands the question before attempting to answer. He should display interest, by words and attitude, in the student's question, and frame as direct and accurate an answer as possible. After completing his response, the instructor must seek to determine that he has completely answered the student's request for information, and that the student is satisfied with his answer.

Sometimes it may be unwise to introduce the more complicated or advanced considerations, necessary to completely answer a student's question, at the current point in his training. When this is the case the instructor should carefully explain to the student that he has asked a good and pertinent question, but that the answer would, at this time, unnecessarily complicate the learning tasks at hand. The instructor should advise the student to reintroduce the question later at the appropriate point in his training, if it has not in the meantime been resolved in the normal course of instruction.

Occasionally, a student asks a question which the instructor cannot answer. In such cases, the instructor should freely admit that he does not know the answer. He should promise to get the answer, or if practicable, offer to help the student look it up in available references.

In all quizzing conducted as a portion of the instruction process, "yes" and "no" answers should be avoided. Questions must be framed so that the answers may be specific and factual, but one word answers may well be the product of a good guess and not truly representative of the learning or ability of the student. This applies to instructors' answers to students' questions, and to students' answers to quizzes used in the furtherance of training.

2. Demonstrations of Ability.—Demonstration of piloting ability is one of the basic elements of flight instruction. In flight instruction, the instructor determines by quizzing the student that he understands the flight operation or maneuver to be learned, demonstrates its performance, allows the student to try it out and practice it under direction, and then evaluates his accomplishment by observing his performance of the maneuver or operation concerned.

Evaluation of demonstrated ability during flight instruction must be based upon established standards of performance, suitably modified to apply to the student's experience and stage of development as a pilot. The evaluation, to be meaningful to the instructor, must consider the student's mastery of the elements involved in the maneuver, rather than merely the overall performance.

In flight instruction, demonstrations of piloting ability are important for exactly the same purposes as are quizzes. They have additional special significance, however, in being directly applied to the qualification of student pilots for solo and solo cross-country privileges. Also associated with pilot skill evaluations during flight instructions are the stage completion checks conducted in approved flying courses, and flight checks for pilot certification flight-test recommendations.

In evaluating student demonstrations of piloting ability, as in quizzing and other instructional processes, it is important for the flight instructor to keep the student informed of his progress. This may be done as each maneuver or procedure is completed, or during postflight discussions.

Corrections or the explanations of errors in performance should point out the elements in which the deficiencies are believed to have originated, and if possible, appropriate corrective measures should be suggested. Correction of student errors should not include the practice of taking the controls

away from the student every time he makes a mistake.

Student demonstrations of flight maneuvers and operations will sometimes be correctly performed by a student who does not fully understand the principles involved and the objectives of the exercise. When this is suspected by the instructor, the student should be required to vary his performance of the maneuver slightly, combine it with other operations, or apply the same elements to the performance of other maneuvers. A student who does not understand the principles involved will probably not be able to do this successfully.

3. Examinations and Tests.—The conduct of written examinations for flight students at regular intervals, or at stated points in the flight syllabus, is very valuable for evaluating the student's understanding of the training provided, and his ability to accept and effectively apply further instruction. Such examinations must be simple and direct, call for specific answers, and be readily graded and evaluated by the instructor on the spot.

Written examinations on flight training should have direct application to the flight instruction received. Any tendency to cover material more appropriate to classroom instruction is extraneous, and should be better applied elsewhere.

Flight checks are required for endorsements for solo and solo cross-country privileges for student pilots, and for flight instructors' recommendations for pilot certificate flight tests. Additionally, stage checks are required for the completion of curriculum stages in approved flying courses conducted by certificated pilot schools.

The coverage and standards for these flight checks are prescribed by the pertinent regulations and FAA Flight Test Guides. When conducting check flights for the evaluation of student pilot performance and qualifications, the instructor serves in the role of examiner, and is at least theoretically not responsible to provide corrections for flight deficiencies, or any flight instruction. In fact, it is considered good practice for frequent cross-checks to be conducted by an instructor other than the one who has provided the bulk of the student's training. Stage checks in approved flying courses are conducted by the chief instructor designated for the course concerned.

When he approves a flight check leading to an endorsement for solo or solo cross-country privleges for a student pilot, the flight instructor is accepting the responsibility for determining that the student is qualified for the privleges proposed. If there is any question in his mind concerning the student's mastery of any element of performance, it is better for him to withhold his endorsement until the question has been resolved. He must remember that he is executing an endorsement which will permit solo operations not only in the present instance, but subsequently under all conditions and circumstances which the student elects to undertake.

When he approves a formal stage check he has conducted, or executes a recommendation for an official flight test, the flight instructor is certifying that the student possesses the skill required by the applicable training curriculum for stage completion, or that he meets the standards of the regulations and appropriate flight-test guide for the certificate or rating sought.

In either case, the flight instructor's finding is subject to review and confirmation by a higher authority. Any tendency to overlook some requirements and standards is soon detected, and reflects unfavorably on the competence and integrity of the instructor. Such a tendency is also unfair to the student who has employed him, and may result in an unexpected disqualification on a certification test, or even the persistence of a hazardous deficiency in his piloting technique.

4. Operational Safety—Collision Avoidance.—It is esential that the instructor prepares each of his students to conduct all of his flight operations with primary attention to safety. This safety habit must become habitual, so that no flight is undertaken without it.

In today's increasing air traffic, no single factor is as important to safety as continuing vigilance for other air traffic and collision

avoidance. Collision avoidance includes not only a constant vigilance for other traffic, but also the scrupulous observance of airport traffic patterns, cruising altitudes, control and airport approach zones, NOTAM's, and air traffic control instructions.

Training in these precautions will not satisfy the instructor's responsibility; he must, by example and demanding constant student compliance, inculcate in every student the awareness of the possibility of midair collisions. He should not be made to fear other traffic, but to observe and coordinate his flight path with it in an orderly and safe manner.

5. Applying Appropriate Standards.—The criteria used for the evaluation of stage checks and pilot flight test recommendations are prescribed in the flight school curriculums and the flight-test guides concerned. The standards which must be applied by the flight instructor in his day-to-day instruction, however, must be established and administered personally.

The standards used in the course of flight instruction cannot be standardized because no two people think, react, and progress in an identical manner. One student may respond well to instruction in stall recognition, and perform acceptably after a minimum amount of practice, whereas the next may experience difficulty and require prolonged assistance and practice to achieve the same level. This one element of performance may not be at all indicative of their relative piloting ability, and the situation may be directly reversed in the case of coordination in turns, for example.

Other students may be slow but steady learners, while still others may grasp new learning tasks quickly, but make many careless errors. The professional flight instructor must learn to size up his students, become familiar with their thinking and aptitudes, and apply standards of progress appropriate to each individual. Expecting a student to be ready for solo in the same number of hours experienced by others may be completely unrealistic, and attempts to make him conform to the general standard may actually retard his overall progress.

The application of instructional and progress standards tailored to each student must not lead to the modification of performance standards for pilots prepared for certification. All pilots trained and endorsed for solo privleges or recommended for certification must meet the appropriate skill standards. It is only their training curriculum and the presentation of instruction for them which are changed.

III. AERODYNAMICS USEFUL FOR FLIGHT INSTRUCTION

A. *Critical Airspeeds*
   1. Maximum Performance Speeds
   2. Airspeed Limitations

B. *Angle of Attack*
   1. Stalls—The Separation Point
   2. Angle of Attack as an Index of Performance

C. *Airplane Loading*
   1. Effects of Weight on Flight Performance
   2. Effects of Load on Airplane Structure
   3. Effects of Loading on Stability and Controllability

D. *Use of Flaps*
   1. Effects on Flight Performance
   2. Effects on Stability

E. *Ground Effect*

F. *Torque and "P Factor"*

G. *Controllable Propellers*
   1. How a Propeller Works
   2. Purpose of Controllable Propellers
   3. Operation of Controllable Propellers

III. AERODYNAMICS USEFUL FOR FLIGHT INSTRUCTION

A flight instructor must have a practical knowledge of basic aerodynamics. In addition to possessing the aerodynamic knowledge necessary for operation as a competent professional pilot, the instructor must be able to explain the interrelationship of aerodynamic principles and their application to piloting activities. He must be capable of providing novice student pilots with the basic knowledge necessary for the safe, effective operation of aircraft. He must also be able to explain to the knowledgeable student the reasons for the performance characteristics and limitations of the airplane he uses. This chapter is directed to a number of basic areodynamic considerations important to flight instruction which have often been overlooked in pilot training.

A. Critical Airspeeds

For years the operating airspeed range of small airplanes was so limited that a knowledge of the stalling speed and the maximum permissible dive speed was sufficient for its safe operation. We now have airplanes with level flight speed potentials which approach four times their stalling speeds. In such airplanes there is an airspeed appropriate to each flight operation, and any significant deviation from the proper speed sacrifices much of its potential performance and safety. For example, it is no longer practical to make a final landing approach at cruising speed with the expectation of stopping on the airport, as formerly could be done easily in 70-mile-an-hour airplanes.

1. Maximum Performance Speeds.—At any power setting within the normal operating range, there are two airspeeds at which an airplane will maintain level flight. One is quite slow, and accomplished at a high angle of attack approaching that which results in a stall. The other is a higher airspeed with a relatively low angle of attack. With any power setting greater than the minimum necessary to maintain level flight, there is a specific airspeed between these two level flight speeds which results in the maximum rate-of-climb.

In practice, the maximum rate-of-climb airspeed for each type of airplane is determined by flight test, and posted in the approved airplane flight manual. The use of this speed produces the greatest possible gain in altitude for each minute of climb, and results in the most efficient climb to cruising altitude on cross-country flights. Climbs at greater airspeeds will cover greater distances *during the climb*, but may prolong the climb so that a greater total time will be required for the trip.

The maximum rate-of-climb airspeed should be used for maximum efficiency on all normal climbs, except in cases when the airplane manufacturer recommends a higher climb speed to provide better engine cooling or for other reasons.

In addition to the maximum rate-of-climb airspeed, there is another airspeed which results in the maximum angle-of-climb in calm wind conditions. This airspeed is usually slower than the maximum rate-of-climb airspeed, and is important for use in clearing obstructions, such as trees or ridges on takeoff, because it gives the greatest altitude gain for a given distance over the ground.

For a pilot or flight instructor who is interested in seeing how these airspeeds are determined, a simple practical procedure will come very close to duplicating the officially established data for a specific power setting and density altitude.

Repeated climbs at the selected power setting should be performed through the

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same altitudes at airspeed intervals of 5 or 10 knots, and the resulting rates-of-climb determined with a sensitive altimeter and a stopwatch. The climb at each speed should be measured only after the airspeed and climb have stabilized, and timed for at least 1 full minute. The rate-of-climb for each 5- or 10-knot airspeed interval between the slow and fast level flight speeds should be noted and recorded.

The rates of climb thus established can then be plotted on a graph similar to that illustrated in figure 4, and a climb curve can be laid out from the points established. The peak of the climb curve occurs at the airspeed which will always produce the maximum rate-of-climb at the power setting used and existing density altitude. A line drawn from the zero point on the level flight-line tangent to the climb curve will contact it at the point which indicates the maximum angle-of-climb airspeed.

A number of other useful and interesting facts can be noted by examining this climb curve. The two level flight speeds, (1) and (2), occur at slightly above the stalling speed, and at just the speed where diving begins, respectively. The portion of the curve which extends slightly below the slower level flight speed, (1) on the graph, represents flight speeds at which level flight or climb is impossible with the power available. The area near and below point (1) on the climb curve represents the area often termed "the back side of the power curve." A higher rate of climb is possible only by increasing the power, if possible, or by increasing the airspeed.

Of special interest to multiengine pilots is the fact that the airplane will climb as indicated at all airspeeds between the two level flight airspeeds, so long as the power, gross weight, and density altitude remain constant. If climb is decreased or becomes

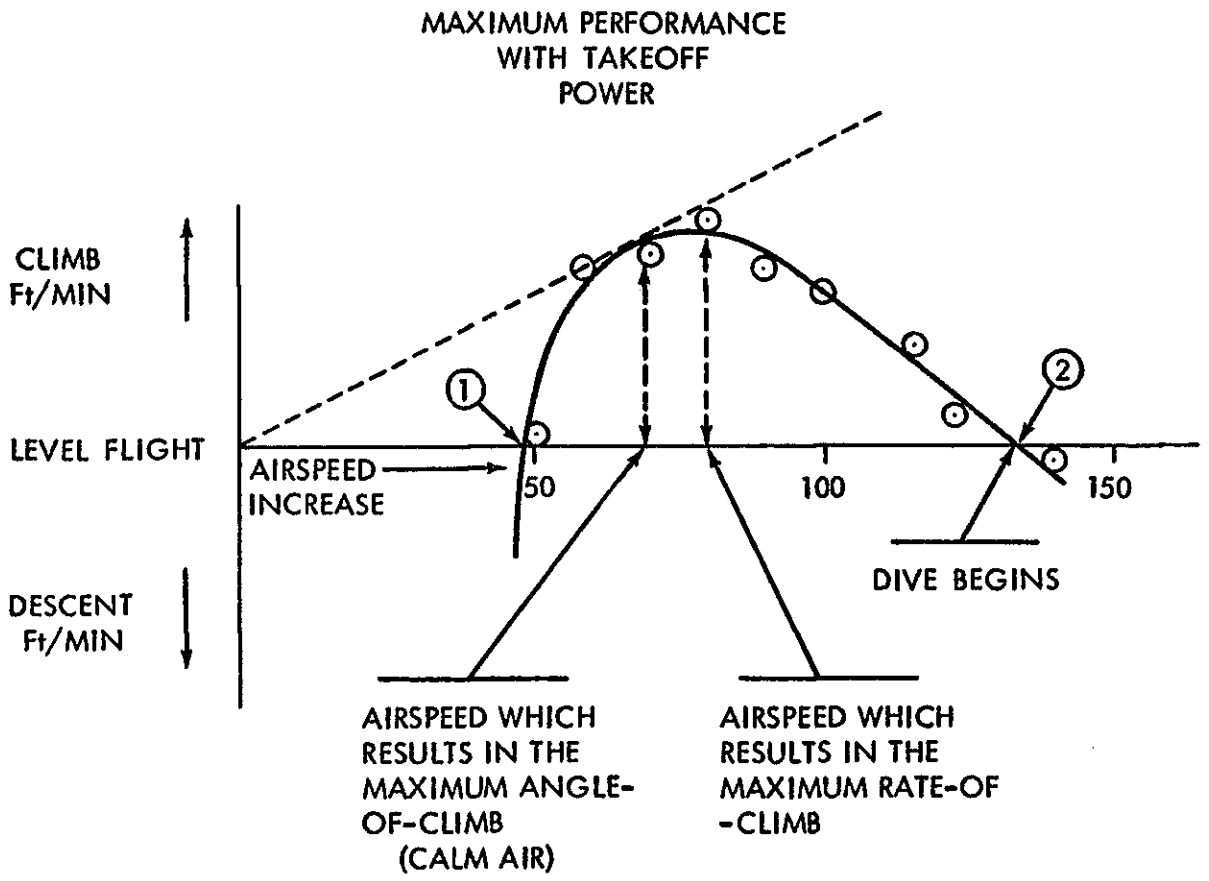


FIGURE 4.—Plot of maximum climb airspeeds.

impossible because of the failure of an engine, however, the maintenance of the maximum rate-of-climb airspeed will result in the best possible climb or slowest rate of descent.

The development and posting of data to construct a climb curve such as that shown in figure 4 is not an exercise which can be profitably introduced to all student pilots. It will, however, be beneficial for any student pilot with sufficient technical background to appreciate the significance of the procedures used, and may provide valuable information on an older airplane for which climb speed data are not available or are inadequate. This is an exercise only—for accurate performance data, climbs must be measured under carefully controlled conditions, and at various power settings and altitudes.

2. Airspeed Limitations.—Airspeed limitations are, with the exception of the stalling speed, structural limitations which must be observed to avoid the hazard of structural damage to the airplane. They are usually indicated by colored radials and arcs on the airspeed indicator, often posted on placards adjacent to the airspeed indicator, and are listed in the airplane flight manual. It is essential for the flight instructor to be thoroughly familiar with these, and explain them to his students.

The stalling speed is essential to safety, in that it is the speed below which further controlled flight is impossible under stated conditions. Because the stall is a function of the angle of attack, rather than the direct result of a minimum airspeed, it is essential for the student to understand that the stalling speed varies significantly with airplane loading, density altitude, temperature, and load factors imposed by abrupt maneuvers.

Airspeed structural limitations include the maximum flap speeds, the maneuvering speed, landing gear speeds, the caution range for consideration in abrupt maneuvers or turbulent air, and the never-exceed dive speed. Each of these has its application to normal airplane operation, and habitual disregard for any of them will sooner or later result in structural damage to the airplane. Although the margin of safety built into modern airplane designs means that structural damage may not result from the first time an airspeed limitation is violated, this margin may decrease with each repetition, and with the many minor deteriorations which result as the airplane accumulates flight time.

The violation of an airspeed limitation may also have immediate aerodynamic results which may cause control difficulties as well as structural damage in high performance airplanes. The most important of these are flutter and the effects of compressibility.

Flutter is a distinct possibility in an airplane when exceeding the "never-exceed" speed limit and when encountered at such speeds usually results in the immediate disintegration of at least the structural components involved. Compressibility becomes a factor as the mach limitations of very high performance airplanes are approached, and may result in immediate control problems, as well as the hazard of structural damage.

Reduced cruising speeds are prescribed for the operation, in turbulent air, of all but the slowest airplanes, to reduce the possibility of structural damage by gust loads. This is a valid precaution, and should be observed in all airplanes. The attention of the pilot should be called to the precaution contained in the flight manuals for many high-speed airplanes which also prescribes a *minimum* airspeed for operation in turbulent air. This is advisable because extreme turbulence may result in variations of airspeed sufficient to cause an unanticipated stall unless a margin of 30 to 40 knots above stalling speed is maintained.

The maneuvering speed of an airplane is the speed at which full sudden deflection of the flight controls will not cause structural damage. Damage by turbulence to an airplane flying at this speed is most unlikely.

B. Angle of Attack

The angle of attack of an airplane wing in flight is the angle between its mean chord and the direction in which it moves through the air. It is sometimes described as the "relative wind" affecting the wing. The angle of attack is probably the best single index of the performance of a wing in flight. The effect of the angle of attack in producing

a stall has been well understood by pilots for some time, but the conception of using the angle of attack as a performance indication for normal flight is only now becoming general.

1. Stalls—The Separation Point.—The stalling of an aircraft wing in flight depends entirely on the angle at which it meets the air through which it is moving. The airspeed, the load carried within the airplane, the density altitude, and load factors imposed by flight maneuvers all affect the angle of attack. The angle of attack is the same as the airplane's pitch attitude with respect to the horizon only when the airplane is flying at a constant altitude. It is possible for the wing to pass through the air at a high angle of attack when the airplane descends in level flight attitude. Conversely, the angle of attack may be near zero in a steep dive. Figure 5 illustrates this effect.

Stalling is the most obvious effect of a high angle of attack. The lift produced by an airplane wing depends on the downward force it imparts on the air through which it moves. Any flight situation in which the wing fails to "hold" the flow of air against its upper surface produces very little lift. Every airfoil shape (wing section) has an angle of attack beyond which the air through which it moves tends to tear away from its upper surface. This is true at any airspeed within the normal flight range.

The flow of air along the surface of a wing is rarely uniform and smooth, notwith-

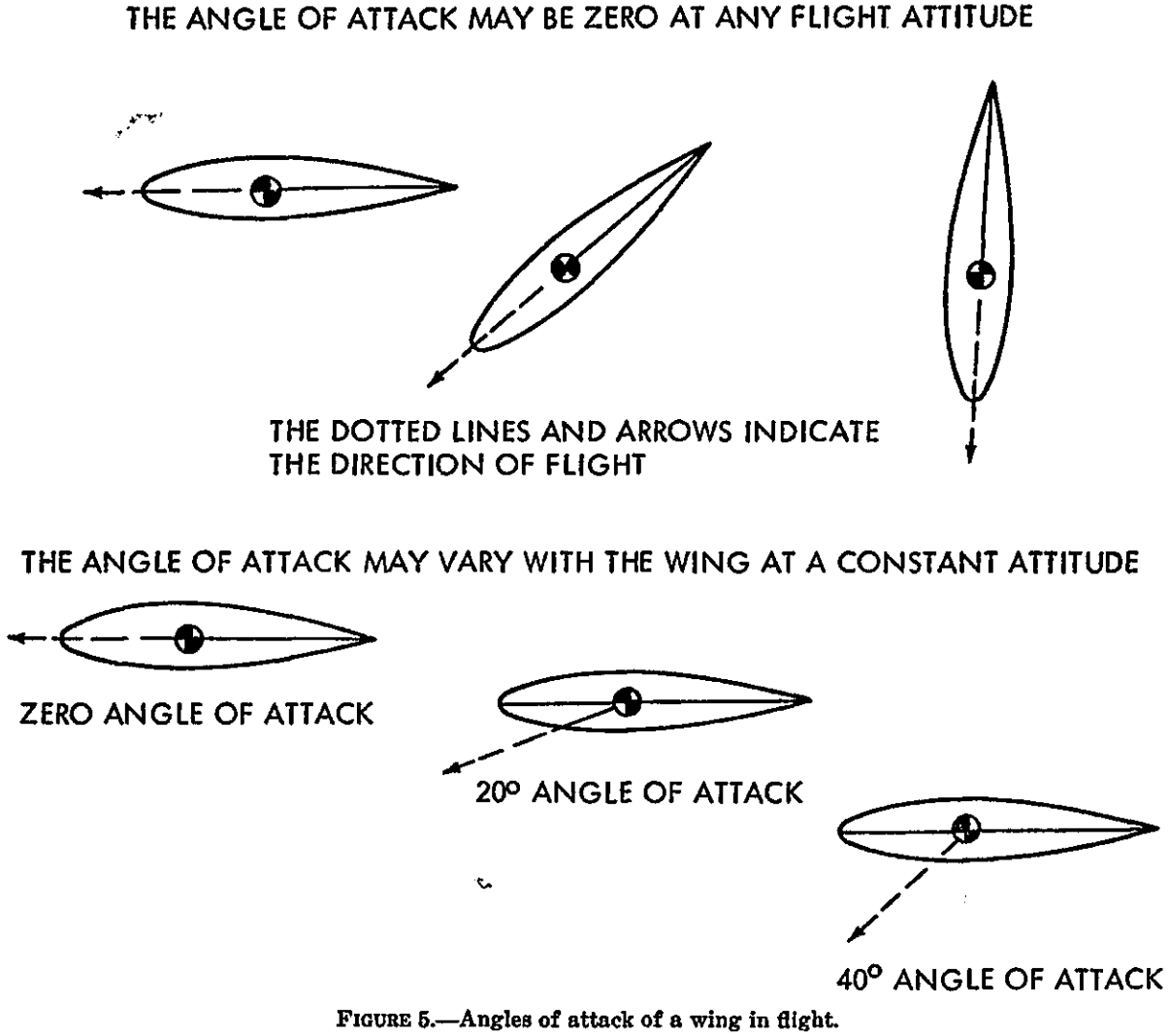


FIGURE 5.—Angles of attack of a wing in flight.

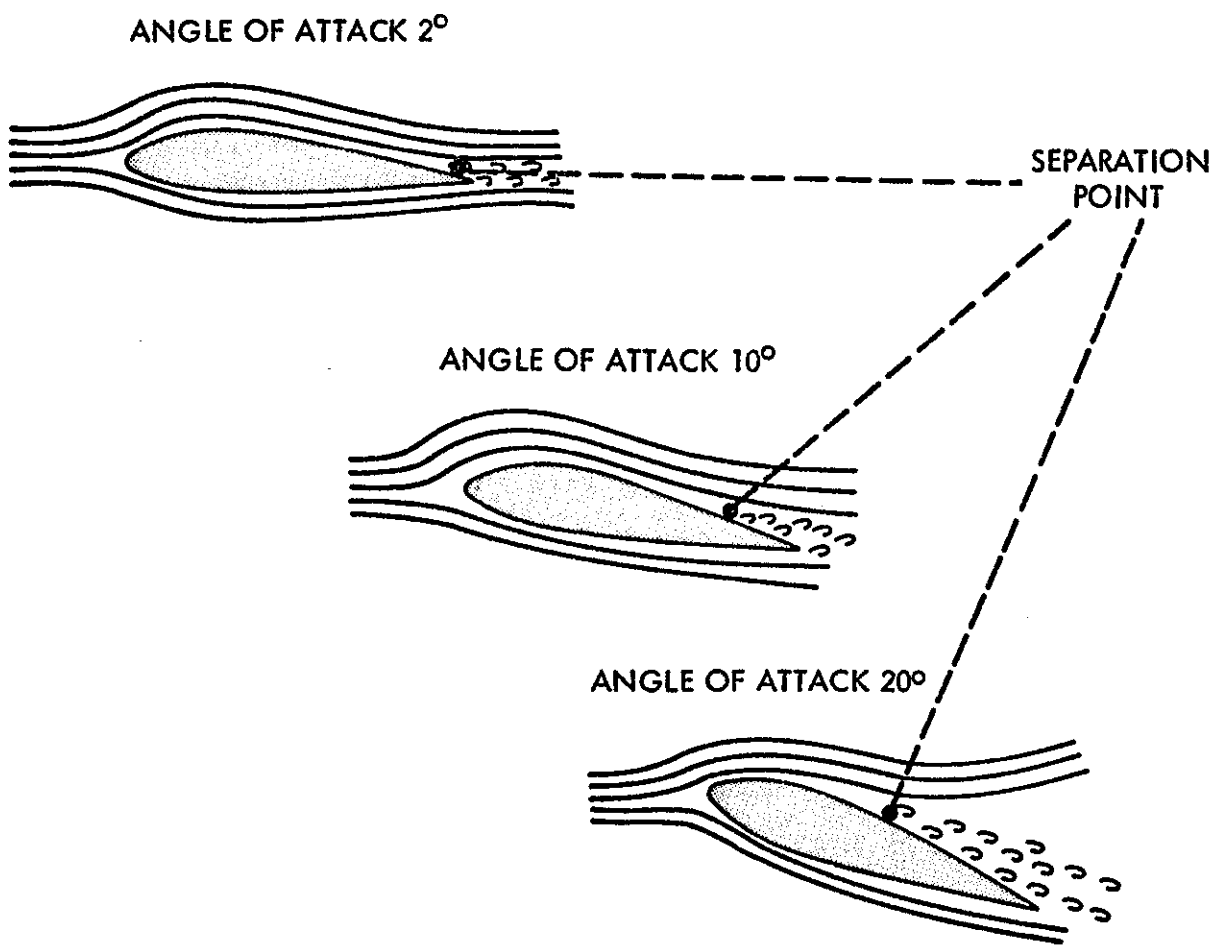


FIGURE 6.—Effect of angle of attack on the separation point.

standing the claims for laminar flow-wing sections. The point along the upper chord at which the smooth flow of air breaks away from the surface of the wing is called the "separation point." This separation point moves forward more and more rapidly as the angle of attack is increased, especially as the critical angle is approached. Figure 6 illustrates the forward movement of the separation point as the angle of attack increases.

The importance of the separation point as an index of stalling has increased with the general adoption of symmetrical or laminar flow wing sections for personal and training airplane types. Formerly, such airplanes commonly had "high lift" wing sections designed for maximum lift at slower airspeeds, which were inefficient at higher cruising airspeeds. With such wing sections, lift was generated at an effective zero angle of attack by the principle of physics known as "Bernoulli's Theorem." This principle states that when a fluid (or gas) is in motion, the pressure decreases as the speed is increased.

Most high-lift wing sections use this principle by providing a high, curving upper surface and a nearly flat bottom surface. Air diverted over the upper surface travels further in the same time than the air passing beneath the wing, causing a lower pressure above the wing, which results in the desired lift. The more efficient high-speed wing sections, now popular, have identical, or nearly identical curvatures on both upper and lower surfaces, and so must be flown at a positive angle of attack if lift is to be produced.

At high cruising speeds this positive angle of attack is very low, and the separation point is nearly at the trailing edge. At any slower speed, the angle of attack must be

increased to prevent a descent, and the separation point moves forward. It should be noted that common stall warning indicators measure either the angle of attack by vanes on the leading edge of the wing, or the separation point by vanes on the upper surface.

2. Angle of Attack as an Index of Performance.—The angle of attack of a wing in flight is a direct indication of the efficiency with which it is doing its job. Unfortunately, a low priced satisfactory angle of attack indicator is not yet available for general aviation usage.

Each wing has specific angles of attack at which it delivers its most efficient performance in climbs, level flight, and descents. The use of airspeed indications to maintain the most efficient performance is completely effective only if the loading of the airplane is taken into account. In some large, high-performance airplanes, for example, it is necessary to compute the gross weight for each landing if the appropriate approach speeds are to be maintained. One large bomber uses enough fuel in the traffic pattern so that each successive approach during takeoff and landing practice is made at an approximately 2-knot-slower airspeed.

The use of an effective angle of attack indicator makes such computations unnecessary, since the same angle of attack is the objective of all gross weight and approach speed computations. Navy fighters now regularly use angle of attack references in preference to airspeed indications for approaches to aircraft carriers.

Although an accurate conception of the angle of attack involved in flight maneuvers is not practicable for student pilots, flight instructors should have a thorough understanding of its significance to stalling, landing approaches, and abrupt maneuvering. It also provides an excellent explanation of the flight situation sometimes described as "behind the power curve."

C. Airplane Loading

The reasons for airplane loading limitations, and the possible effects of improper loading are not generally understood. If new pilots are to be properly informed on these important considerations, it is essential for flight instructors to understand them fully. Three principal considerations govern the load which may be carried safely in an airplane. These are (1) the takeoff and climb performance of the airplane; (2) the strength of all affected airplane components, including the wing structure, the landing gear, and the fuselage floor and seats; and (3) the effects on stability and controllability in flight.

1. Effects of Weight on Flight Performance.—The takeoff and climb performance of an airplane is determined on the basis of its maximum allowable takeoff and landing weights. A heavier gross weight will result in a longer takeoff run and shallower climb, and a faster touchdown and longer landing roll. An apparently minor overload may make it impossible for an airplane to clear an obstacle on takeoff which has not been seriously considered on takeoffs under more favorable conditions.

The detrimental effects of overloading on performance are not limited to the immediate hazards involving takeoffs and landings. Overloading has an adverse effect on all climb and cruise performance which leads to overheating during climbs, added wear on engine parts, increased fuel consumption, slower cruising speeds, and reduced range.

The effect of the position of the center of gravity on the load imposed on an airplane wing in flight is not generally realized, although it may be very significant to climb and cruising performance. Contrary to the beliefs of some pilots, an airplane with forward loading is "heavier" and consequently slower than the same airplane with the center of gravity further aft.

Figure 7 illustrates the reason for this. With forward loading, "nose up" trim is required in most airplanes to maintain level cruising flight. Nose-up trim involves setting the tail surfaces to produce a down load on the aft portion of the fuselage, which adds to the total lift which must be obtained from the wing if altitude is to be maintained. This requires a higher angle of attack, which results in more drag, and produces a higher stalling speed.

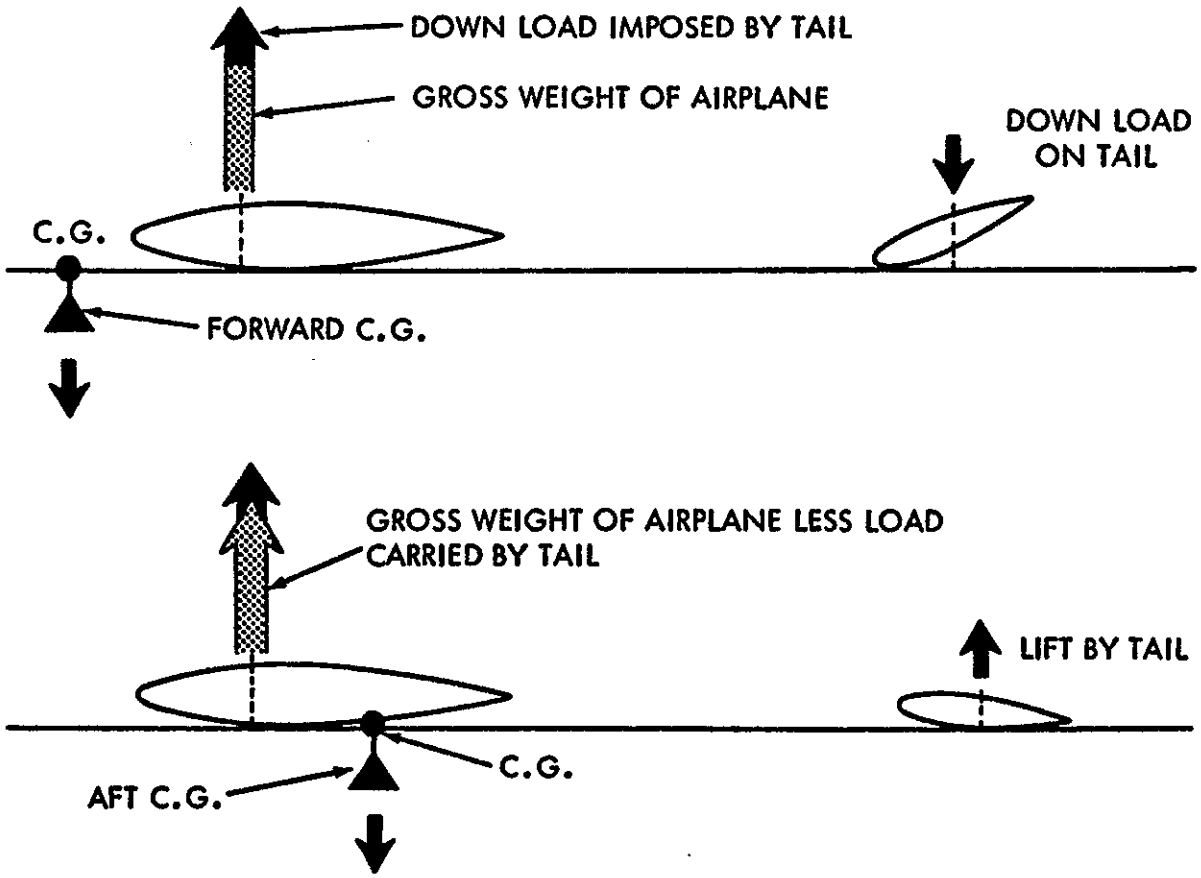


FIGURE 7.—Effect of CG location on load carried by the wing. This does not represent a normal flight condition.

With aft loading and "nose down" trim, the tail surfaces will impose less down load, thus requiring less lift from the wing to maintain level flight. Caution must be used in taking advantage of this fact to avoid imposing a down load on the tail by exceeding the permissible aft CG limit, because modern airplanes are designed to require a down load on the tail for stability and controllability in slow flight and stall conditions. The nearest to a neutral load on the tail surfaces permitted by the established CG of limits will normally produce the most efficient overall performance and the fastest cruising speed.

If he experiments with this effect, the instructor should remember that the zero indication on the trim tab control is not necessarily the same as neutral trim because of the downwash from the wings and the fuselage on the tail surfaces.

2. Effect of Load on Airplane Structure.— The effect of additional weight on the wing structure of an airplane is not readily apparent. Airworthiness requirements prescribe that the structure of an airplane certificated in the normal category (in which acrobatics are prohibited) must be strong enough to withstand a load factor of 3.8 to take care of dynamic loads caused by maneuvering and gusts. This means that the primary structure of the airplane can withstand a load of 3.8 times the approved gross weight of the airplane without failure. If this is accepted as indicative of the load factors which may be imposed during operations for which the airplane is intended, a 100-pound overload imposes a potential structural overload of 380 pounds. The same consideration is even more impressive in the case of utility and acrobatic category airplanes, which have load factor requirements of 4.4 and 6.0, respectively.

Failures which result from overloading

may be dramatic and catastrophic, but more often they affect structural components progressively in a manner which is difficult to detect and expensive to repair. One of the most serious results of habitual overloading is that its results tend to be cumulative, and may result in complete failure later during completely normal operations. The additional stress placed on structural parts by overloading is believed to accelerate the occurrence of fatigue failures.

3. Effects of Loading on Stability and Controllability.—The effects of overloading on stability are not generally recognized. An airplane which is observed to be quite stable and controllable when loaded normally may be discovered to have very different flight characteristics when overloaded. Although the distribution of weight has the most direct effect on this, an increase in gross weight may be expected to have an adverse effect on stability, regardless of the location of the center of gravity.

The stability of many certificated airplanes is completely unsatisfactory if the gross weight is exceeded.

The effects of the distribution of the useful load of an airplane can have a significant effect on its flight characteristics, even when the airplane is loaded within its center of gravity limits and permissible gross weight. Important among these effects are reduced controllability, decreased stability, and an increase in the actual load imposed on the wing.

Generally speaking, an airplane becomes less controllable, especially at slow flight speeds, as the center of gravity is moved further aft. An airplane which recovers from a prolonged spin cleanly with the center of gravity at one position may fail completely to respond to normal recovery attempts when the center of gravity is moved aft by 1 or 2 inches.

As a matter of fact, it is common practice for airplane designers to establish aft center of gravity limits which are within 1 inch of the maximum which will allow normal recovery from a one-turn spin. When certificating an airplane in the utility category to permit intentional spins, the rearward center of gravity limit is usually established at several inches forward of that permissible for certification in the normal category.

Another factor affecting controllability which is becoming more important in current airplane designs is the effect of long moment arms to the positions of heavy equipment and cargo. The same airplane may be loaded to gross weight within its center of gravity limits by concentrating fuel, passengers, and cargo near the center of gravity; or by dispersing fuel and cargo loads in tip tanks and cargo bins forward and aft of the cabin.

With the same total weight and center of gravity, maneuvering the airplane or maintaining level flight in turbulent air will require the application of greater control forces when the load is dispersed. This is true because of the longer moment arms to the positions of the heavy fuel and cargo loads which must be overcome by the action of the control surfaces. An airplane with full outboard wing tanks or tip tanks tends to be sluggish in roll when control situations are marginal, while one with full nose and aft cargo bins tends to be less responsive to the elevator controls.

As a general rule, airplanes tend to be more stable with forward loading, and less stable as the center of gravity moves aft. This is not serious in airplanes loaded within their approved center of gravity and gross weight limits, but accounts for some of the "hunting" and altitude variations which are annoying to the meticulous pilot, especially in instrument flying.

D. Use of Flaps

There is considerable difference of opinion and misunderstanding among pilots concerning the proper use of flaps. Although a discussion of airplane operation is not within the province of this handbook, the following considerations are considered appropriate to effective flight instruction.

1. Effects on Flight Performance.—The landing flaps typically used on personal and training type airplanes are not primarily designed for the purpose of reducing the ap-

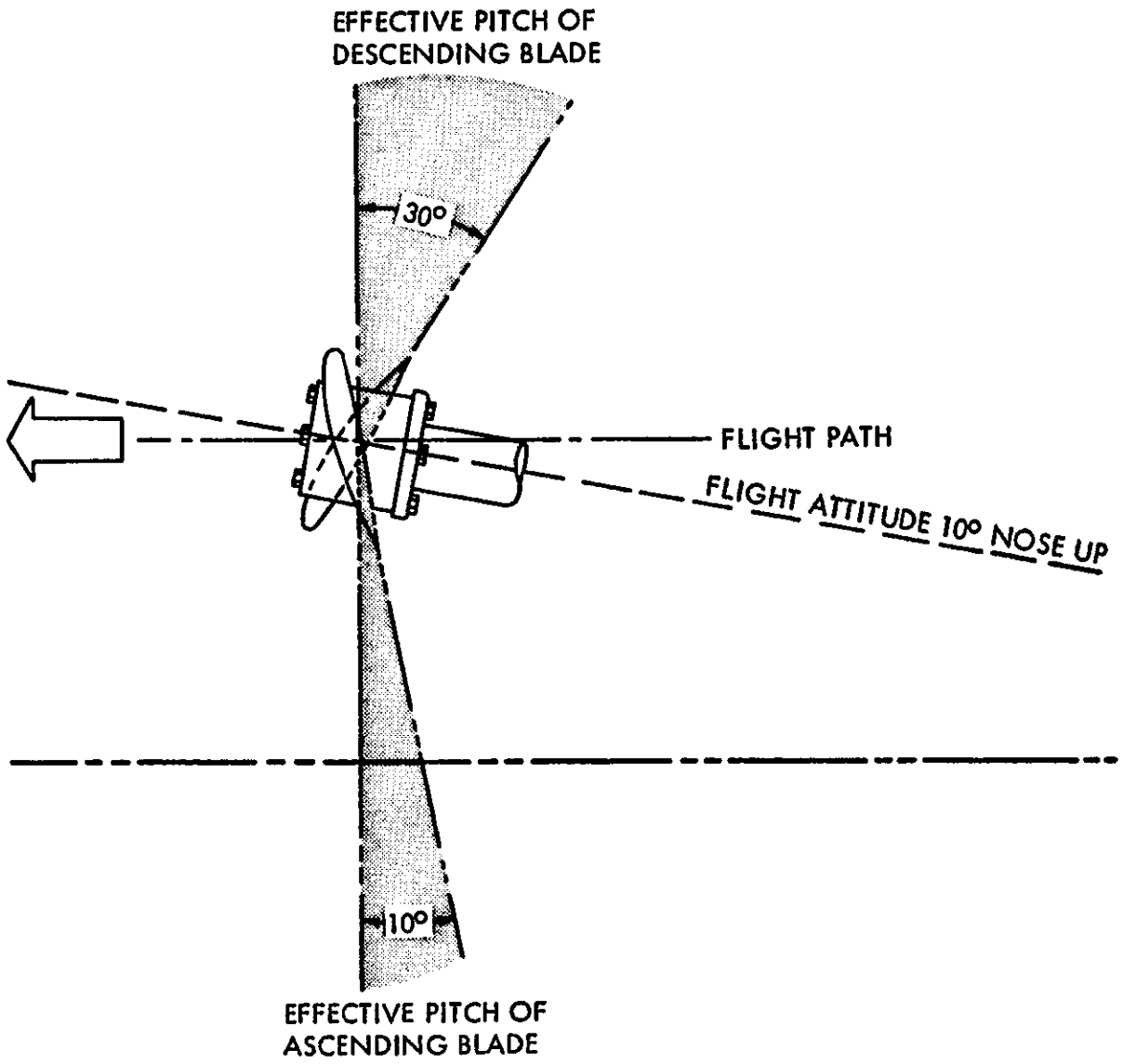


FIGURE 9.—Diagram showing difference in relative pitch of descending and ascending propeller blades when flying in a nose-high attitude.

other forces which tend to turn the airplane to the left on takeoff.

G. Controllable Propellers

The almost universal adoption of controllable propellers for use on general aviation airplanes has made an understanding of the principles and function of these propellers essential for all pilots. In the past, there has been a tendency for pilots to think of the propeller as a sort of blower, which blows the air back past the airplane, and needs no special consideration or operating technique to achieve maximum efficiency. With controllable propellers, this is far from the case.

1. How a Propeller Works.—Every airplane propeller blade has a cambered airfoil section very similar to that of a wing. It "flies" through the air just as a wing does, and depending on the speed of flight and the engine r.p.m., it may "climb," "cruise," or even stall, just as a wing does.

The airfoil shapes of propeller blades vary from the thick, "high lift" sections commonly used on slow speed or geared engines to the thinner symmetrical shapes used on

higher speed engines. The most simple propeller, the single-piece, two-blade, fixed-pitch propeller, is essentially a very short screw which screws itself through the air like a bolt screws through a nut.

The pitch of a propeller may be designated in degrees, but it is more common to specify it in inches. A propeller designated as a "74–48" would be 74 inches in length and have an effective pitch of 48 inches. The pitch in inches is the distance which the propeller would screw through the air in one revolution if there were no slippage.

A simple computation of pitch and revolutions per minute serves to illustrate graphically the efficiency of airplane propellers. A 48-inch pitch propeller, which is typical of those used on light trainers, would advance 8,800 feet (1.66 miles) in 1 minute at 2,200 r.p.m. *if there were no slippage* at all. This is equal to slightly less than 100 m.p.h., which is very little more than the actual cruising speeds of such airplanes. At 90 miles per hour, the slippage would be less than 10 per cent, as the airplane would fly 7,920 feet (1.5 miles) per minute, or 43.2 inches for each revolution of the propeller at 2,200 r.p.m.

When the airplane is at rest on the ground with the engine turning up, or moving slowly for takeoff, the propeller efficiency is very low because the propeller is restrained from advancing with sufficient speed to permit its fixed-pitch blades to be efficient. In this situation, each propeller blade is turning through the air at an angle of attack which produces relatively little thrust for the amount of power required to turn it.

When specifying a fixed-pitch propeller for a new type of airplane, the manufacturer usually selects one with a pitch which will operate efficiently at the expected cruising speed of the airplane. Unfortunately, however, every fixed propeller must be a compromise, because it can be efficient at only a given combination of airspeed and r.p.m. The pilot does not have it within his power to change this combination in flight.

2. Purpose of Controllable Propellers.— The installation of a controllable propeller allows the pilot to select in flight a pitch which is suitable to each flight situation and power setting. Controllable propellers may permit setting to any desired pitch in flight, continuous control to a preset r.p.m. by a centrifugal propeller governor, or the selection of either of two preset pitch settings.

Fully variable pitch and constant-speed propellers can be set by the pilot to any pitch within their controllable range which the pilot selects as appropriate to his flight situation. At slower flight speeds, it is appropriate to use lower (high r.p.m.) pitch settings to reduce the angle of attack of the blades and to permit the engine to operate as the higher speeds which allow a higher horsepower output. At higher flight speeds, higher (low r.p.m.) pitch settings are used to maintain a positive blade angle of attack and to prevent excessive engine speeds.

The use of a controllable propeller is only partly analagous to the use of the gearshift in an automobile. This is true because the pitch of the propeller does not "gear" the airplane engine to the ground, as is more nearly the case with the automobile. Changing the pitch of a propeller is more like changing the angle of attack of the wing. Additional "lift" is generated by increasing the pitch of a propeller just as it is by raising the nose of the airplane in flight, but if the appropriate increase in power is neglected in either case efficiency will suffer and the "lift" will soon fall off.

With two-position controllable propellers, the two pitch stops are commonly set at pitch settings appropriate for takeoff and climb, and for cruising flight. This does not make it possible for the pilot to select an exact pitch appropriate to each flight situation, but it does have a tremendous advantage over fixed-pitch types in that it provides for efficient operation in the two most important flight situations.

3. Operation of Controllable Propellers.— The effective use of controllable propellers requires a knowledge of the power and performance settings appropriate for each airplane type. The pilot must know where to find and how to use the engine and airplane performance information available in the

proach or landing speeds. Flaps make possible the maintenance of a steeper approach slope without an increase in airspeed, and their setting may be changed during an approach to compensate for changing conditions and small errors in judgement.

Most landing flaps reduce the stalling speed slightly. Because they do so, approaches with flaps extended may be made at slower airspeeds with the same margin of safety above stalling, but care must be exercised in doing this because the loss of airspeed when a flare is started is much more rapid than it is without flaps.

The sudden retraction of the flaps in flight will result in an abrupt loss of altitude, unless the angle of attack is increased as the flaps are retracted. With careful control coordination it is possible to retract the flaps for a go-around at any speed above the flaps-up stalling speed. The retraction of flaps in flight near the ground should be accomplished with great care, however.

No conventional airplane will climb more rapidly with the flaps extended than it does with them retracted. Most airplanes will, however, take off with a shorter ground run and climb at a steeper angle with the flap setting recommended by the airplane flight manual for takeoff. The use of a flap extension greater than that recommended by the airplane flight manual may actually retard, rather than assist the takeoff and climb.

There is no serious control hazard associated with the performance of slips with flaps extended. The performance of slips with flaps extended is usually superfluous, however, if the approach speed is correct. An approach error which cannot be corrected by the application of full flaps at approach speed is probably so great that an immediate go-around is appropriate. A pilot who does use a slip with flaps extended must remember that the rate of sink after recovery from the slip is much greater than it is without flaps.

2. Effects on Stability.—The extension of landing flaps adversely affects the stability of any conventional airplane. This is because of the reduced speed of the air flow over the control surfaces, and because of the increase in the effective angle of attack of the portion of the wings forward of the flaps.

For this reason, the extension of the flaps as a precaution in rough air, especially in instrument flight conditions, is not recommended.

The flight instructor should know, and should train his students that greater attention must be devoted to heading, bank, and pitch control when the flaps are extended. This is especially important in the control of heading after applying takeoff power for an emergency go-around with the flaps extended.

E. Ground Effect

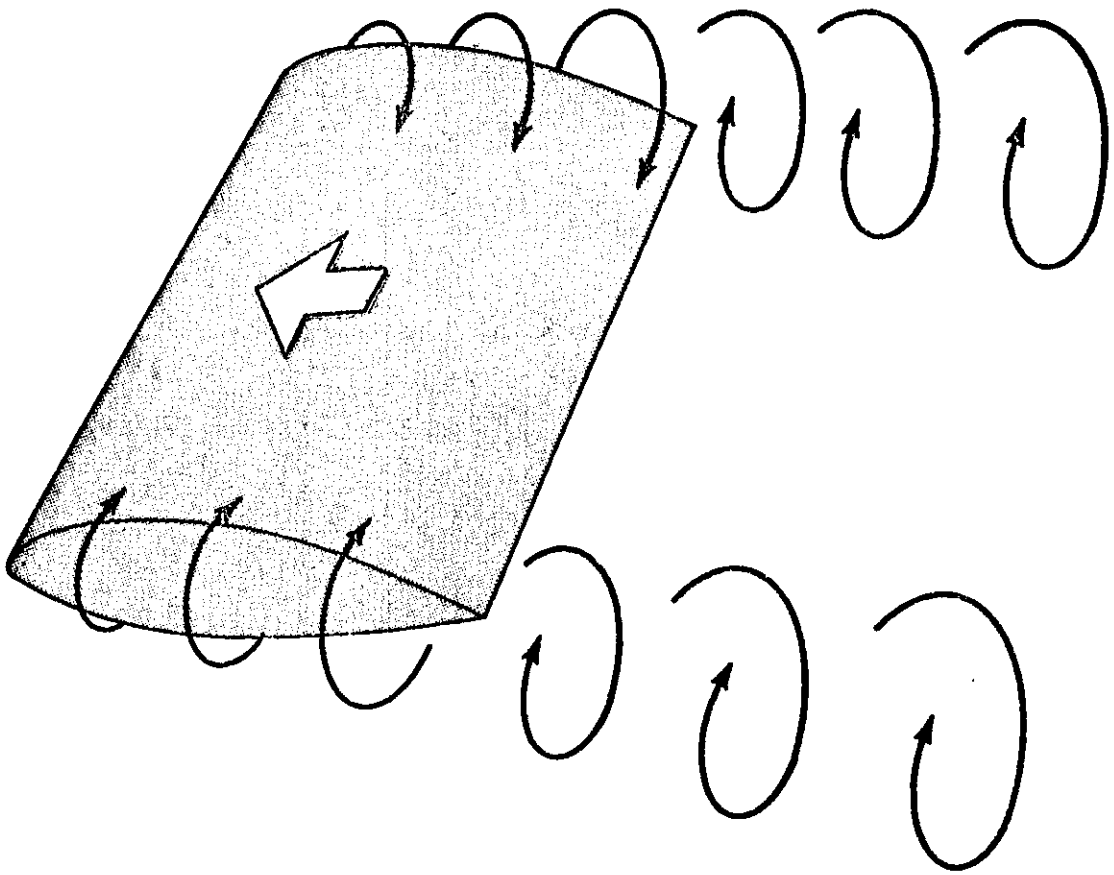
It is possible to fly an airplane just off the ground at a slightly slower airspeed than that required to sustain level flight at higher altitudes. This is the result of a phenomenon which is better known than understood by experienced pilots.

Ground effect is due to the interference of the surface with the airflow patterns about a wing in flight. The compression of air between the wing and the ground is a factor, but does not completely explain the effect. Figure 8 illustrates the downwash on top of a wing, which results from the air escaping around the wingtip in flight, and the effect of flight near the ground in reducing the force of this downwash.

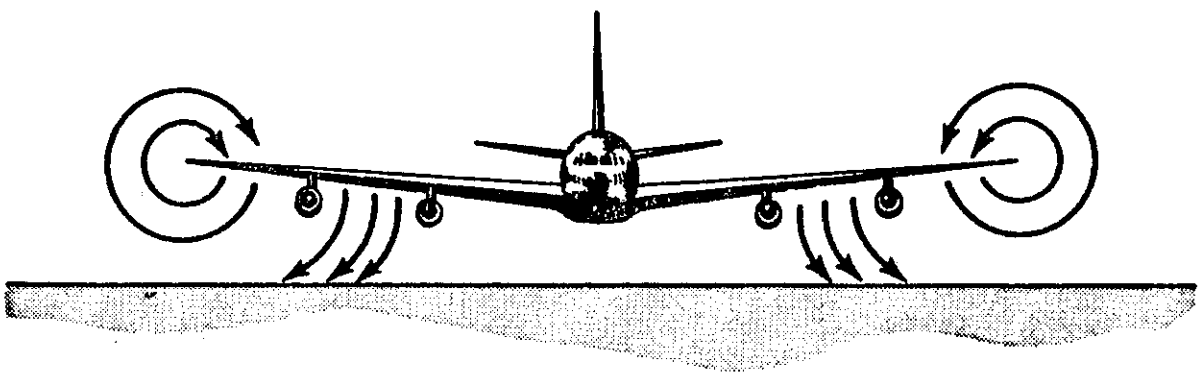
The phenomenon of ground effect has a number of interesting and important effects on normal flight operations. One of the most serious of these effects is that it is possible to get an airplane off the ground with insufficient power or too great a load to permit it to climb over the fence or trees at the end of the field. This leads to a type of accident most often encountered in aerial application operations.

"Floating" on landings is in part a result of ground effect. The student is puzzled because his airplane continues to remain airborne just off the surface at a speed which would have resulted in an immediate stall at a higher altitude.

Ground effect has been used in emergencies to continue flight in a multiengine airplane over water with one or more engines inoperative. It has been found possible to



FORMATION OF VORTICES AT TIPS OF A WING IN FLIGHT



INTERFERENCE OF GROUND WITH TIP VORTICES AND RESULTING DOWN WASH DURING FLIGHT VERY CLOSE TO THE GROUND

FIGURE 8.—Downwash on a wing, and the effect of flight near the ground.

fly just clear of the surface with a power output which would not maintain flight at higher altitudes. The practice is very critical, however, because the margin for possible airspeed variation is almost nonexistent.

Ground effect is measurable at a higher altitude above the ground than might be expected. As a general rule of the thumb, the results of ground effect can be detected and measured up to an altitude equal to one wingspan above the surface.

Ground effect is important to normal flight operations in cushioning stall-type landings, especially in low-wing airplanes, and in the performance of soft and rough field takeoffs and landings. The procedure for takeoff from an unsatisfactory surface is to take as much of the weight on the wings as possible during the ground run, and to lift off with the aid of ground effect before true flying speed is attained. It is then necessary to reduce the angle of attack gradually until normal flightspeed is attained before attempting to climb away from ground effect.

F. Torque and "P Factor"

One of the most controversial factors in normal flying is the cause of an airplane's tendency to turn, to the left in most American airplanes, during the takeoff run and climbout. This is sometimes explained as the effect of "torque," and is sometimes said to result from "P factor." Since both contribute to the same result in a takeoff situation, both should be thoroughly understood by the instructor who must teach his students to counter their effects. Such an understanding would be valuable, but not essential for flight students.

Torque is a force which tends to produce a rotating or twisting motion. In the case of propeller driven airplanes, the most significant torque force is that produced by the engine in rotating the propeller. This force causes the propeller to rotate to the right, as seen from behind by the pilot, and at the same time tries to rotate the airplane to the left because the engine is mounted on the airplane structure.

To counter this force which is constantly exerting a rolling moment on the airplane in flight, it is common practice to rig a slightly higher angle of incidence in the left wing. In the event the engine drives the propeller in the opposite direction, or is arranged in a pusher configuration, the effect is reversed and the higher angle of incidence is rigged into the right wing.

This higher angle of incidence, or "wash in," to compensate for the torque originating in the engine can provide the exact amount of force necessary to counter the torque only at a specific power setting and airspeed. To provide the maximum benefit to the pilot, the power and airspeed values for which the wings are rigged are those used for cruising flight in the airplane concerned.

Because the extra lift demanded from the left wing (usually) causes a slight extra drag, the airplane tends to turn to the left unless it is restrained by some compensating force. To provide such a force, the leading edge of the vertical stabilizer, or fin, is usually offset to the left, giving the same effect as a slight application of right rudder. The amount of this offset is just sufficient to overcome the left-turning tendency at cruising speed.

The effect of these rigging provisions is easily demonstrable. If the airplane is correctly rigged to fly straight and level in a cruising situation, raising the nose with the trim control only will cause the airplane to roll and turn to the left as the airspeed decreases. This is true because the fixed settings of the wing and fin are insufficient at less than cruising airspeed to counter the torque produced by the engine.

If the airplane is then nosed down with the trim control only, it will tend to roll and turn to the right as the airspeed increases to above the cruising speed. This is because at higher-than-cruising airspeed the fixed settings are more than sufficient to overcome the torque produced by the engine.

The rolling effect of torque is greatest at the maximum power settings used for takeoff and climb. Accordingly, during flight operations with high-power settings it is necessary to use some force on the aileron controls to maintain laterally level flight. This application of aileron control, usually to the right, adds to the drag on the left wing,

and the tendency of the airplane to turn left during takeoff and climb.

It has been customary to explain to students that they must hold right rudder during takeoff and climb "to take care of torque." To a certain extent this is true, but there are several other factors which also contribute to the tendency of an airplane to turn on takeoff. These should be understood by the flight instructor, and explained to students as they develop sufficient background to understand the factors involved.

The asymmetrical thrust delivered by the propeller, sometimes called the "P factor," is an important factor, especially in single-engine airplanes. So long as a propeller screws its way through the air in a direction absolutely parallel to the shaft on which it is mounted, the thrust it produces is uniform all around its plane of rotation. If, however, it is held at an angle to the direction in which it is moving through the air, as in a nose-high climb, significantly greater thrust is produced at one side of its plane of rotation.

In the case of a conventional single-engine airplane in a steep climbing attitude, as on liftoff, this is caused by the fact that each propeller blade as it descends on the right side of its plane of rotation has a much higher angle of attack to the air it penetrates than it has on the left side as it ascends. Because most conventional American airplanes turn their propellers to the right, as seen from behind by the pilot, the extra thrust from each blade as it descends at the right of the centerline of the airplane tends to turn it to the left.

The greater the angle between the shaft on which the propeller is mounted and the actual climb path of the airplane, the greater will be the turning effect caused by "P factor." This situation is characteristic of tailwheel-type airplanes during the takeoff run, and with all airplanes upon liftoff.

Figure 9 illustrates the reason for the production of asymmetrical thrust by a propeller moving at an angle to the air through which it travels.

Unlike the drag induced by the rigging and control actions used to counter the rolling tendency caused by torque, the effect of asymmetrical thrust from the propeller is significant when the airplane is rolling on the ground in a tail-low attitude with takeoff power. On the ground, at slow speed, the only turning tendency caused by torque results from the additional load imposed on the landing gear at the side on which the propeller blades ascend.

The effects of torque and asymmetrical thrust are both present in multiengine airplanes as well as single-engine airplanes. They are not of as much concern to multiengine pilots, however, because the force moments generated by each engine operate about that engine only, and may even tend to be self-canceling to a certain extent.

Two factors which have lesser effects on the tendency of an airplane to turn left on takeoff are gyroscopic precession, and the spiral nature of the propeller blast at slow speeds.

The propeller is itself an excellent gyroscope when turning. Like all gyroscopes, it tends to turn abruptly in a direction 90° from any force applied to change its plane of rotation. This means that when the propeller is turning rapidly on an airplane at rest or rolling on the ground, raising the tail rapidly will tend to make the airplane turn right or left, depending on the direction of rotation of the propeller. This effect is especially important in tailwheel-type airplanes with short fuselages.

The effect of the spiral characteristic of the propeller blast is not so well established as the forces explained above. When turning rapidly at slow flight or takeoff speed, the propeller thrusts air aft with considerable velocity. This blast of air does not flow smoothly aft from the propeller, but tends to spiral in the direction the propeller turns as it blows back past the fuselage of an airplane with a tractor engine arrangement.

With normal right-hand propeller rotation, as seen from behind by the pilot, the propeller blast above the fuselage is crossing from left to right at an angle as it moves aft. Since the vertical fin on most airplanes extends above, rather than below, the centerline of the fuselage, it tends to be pushed to the right by the spiraling propeller blast. This force acts in the same direction as the

airplane flight manual. If he habitually uses the same propeller pitch settings under all circumstances for takeoff and for cruising flight, he is sacrificing much of the performance available from his airplane.

While simplification in the use of all aircraft systems and procedures is desirable for the purposes of instruction, the flight instructor must avoid the implication that two propeller settings are all the student will ever need to know. The student should understand the reasons for controlling the pitch of the propeller, and have a real appreciation of the variables which enter into the proper operation of the engine and propeller controls.

IV. AEROMEDICAL INFORMATION IMPORTANT TO FLIGHT INSTRUCTORS

A. *Introduction*

B. *General Health*

C. *Specific Aeromedical Factors*
   1. Fatigue
   2. Hypoxia
   3. Alcohol
   4. Drugs
   5. Vertigo
   6. Carbon Monoxide
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   8. Middle Ear Discomfort or Pain

D. *SCUBA Diving*

E. *Psychological Aspects of Piloting*
   1. Anxiety
   2. Normal Reactions to Stress
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IV. AEROMEDICAL INFORMATION IMPORTANT TO FLIGHT INSTRUCTORS

A. Introduction

The flight instructor should impress upon his student the importance of providing regular checks of the pilot's body and nervous system, just as each aircraft receives regular airworthiness checks and maintenance. Pilots are required to undergo regular medical examinations to ensure their fitness to fly. The physical standards which they are required to meet are minimum standards. Pilots do not have to be supermen to fly. Many defects can be compensated for, as for example, the correction of visual defects by the wearing of glasses. Some applicants may be required to demonstrate by medical flight tests that they can compensate for other defects of potential significance to flight safety.

Each student pilot should visit a Designated Aviation Medical Examiner before spending too much money and time on flight instruction, to determine that he meets the medical standards for a pilot certificate.

It should be remembered that humans are essentially earthbound creatures. However, if we are aware of certain aeromedical factors, and pay attention to them, we can leave the earth and fly safely. What follows is not intended as a hard, comprehensive lesson on aviation medicine. It merely points out the more important factors with which the flight instructor must be familiar, and which he should call to the attention of his flight students.

The modern aircraft industry's record of providing reliable equipment is very good. When the pilot enters an aircraft, however, he becomes an intregal part of the man-machine system. His performance is just as essential to successful flight as is that of the control surfaces, for instance. To ignore the pilot in preflight preparation would be as senseless as failing to consider the integrity of the control surfaces, or any other vital parts of the machine. The pilot himself has the sole responsibility for determining his own reliability prior to entering the cockpit for each flight.

B. General Health

While piloting an aircraft, the pilot should be free of all conditions which are harmful to alertness, the ability to make correct decisions, and to rapid reactions. Persons with conditions which are likely to produce sudden incapacitation, such as epilepsy, serious heart trouble, uncontrolled diabetes mellitus requiring hypoglycemic agents, and certain other conditions hazardous to flight, cannot be medically certificated according to the Federal Aviation Regulations. Conditions such as acute infections, anemias, and peptic ulcers are temporarily disqualifying. The pilot should consult his Aviation Medical Examiner when in doubt about any aspect of his health, just as he should consult a certificated mechanic when in doubt about the condition of his aircraft.

C. Specific Aeromedical Factors

The following aeromedical factors must be familiar to and considered by every competent pilot if he is to operate aircraft with safety to himself and others. It is the responsibility of the flight instructor to see that the student has access to this information, and that he realizes its importance.

1. Fatigue.—The precise action of fatigue is unknown, but it is observed to cause a general slowing of the reactions, a tendency to "daydreaming," and can even lead to a trancelike state in which the outside world is only dimly perceived. "Fatigue" used in

this sense is related to tiredness and boredom, but it is not identical with either. The fatigue which concerns the pilot and the flight instructor is an all-pervading sense of weariness which may result from combinations of late hours, boredom, physical exertion, concentration on complex tasks, tenseness, and the process of learning to fly an airplane.

The flight instructor must be alert to detect when his student is suffering fatigue, as evidenced by his disinterest, slow reactions, and random errors. When such a state is observed, the scheduled lesson should be postponed, or if fatigue occurs during the lesson, the flight should be terminated.

The flight instructor should constantly evaluate his own condition in respect to fatigue, especially toward the end of each difficult day of instruction. Attempts to instruct while he is in a state of fatigue result in inferior instruction, and can give rise to hazardous flight situations.

There are definite precautions which the instructor can take to minimize the incidence of fatigue during his flight instruction. The most important of these is the maintenance of student interest. This may be accomplished by the use of effective motivations, the avoidance of unnecessary repetition and drill on maneuvers already learned, and by changes of pace introduced by the occasional demonstration or review of different maneuvers and procedures.

On long cross-country flights, fatigue can be minimized by keeping active and occupied. Continuing ground reference checks; radio position plotting; and time, speed, and distance computations will assist a pilot to remain mentally active, and will retard the onset of fatigue. Occasional changes in the seat adjustment or the seating position will also be found helpful.

2. Hypoxia.—Hypoxia is, in simple terms, a lack of sufficient oxygen to keep the brain and other body tissues functioning properly. Wide individual variation exists with respect to susceptibility to hypoxia. In addition to the decrease in the amount of oxygen in the atmosphere at higher altitudes, anything which interferes with the blood's ability to carry oxygen can contribute to hypoxia, such as anemias, carbon monoxide, and certain drugs. Alcohol and tobacco both decrease the brain's tolerance to hypoxia.

The body has no built-in alarm system to let one know when he is not getting enough oxygen, and no physical distress is obvious to the victim until he is incapacitated for precise operations or any activity which requires clear thinking. Further, it is impossible to predict exactly when or at what flight level hypoxia will occur, or how it will manifest itself.

A major early symptom of hypoxia is an increased sense of well-being, referred to as euphoria. This progresses to slowed reactions, impaired thinking ability, unusual fatigue, and a dull headache feeling.

The symptoms are slow but progressive, insidious in onset, and most marked at altitudes above 10,000 feet. Night vision, however, can be impaired at lower altitudes. Heavy smokers may also experience early symptoms of hypoxia at altitudes lower than they appear for nonsmokers.

If a pilot observes the general rule of not flying above 10,000 feet without supplemental oxygen, he will not be likely to get into trouble because of hypoxia.

3. Alcohol.—A pilot must never fly when he is under the influence of alcohol. Even small amounts of alcohol in the system can adversely affect one's judgment and decision-making abilities. An excellent rule to observe is to allow 24 hours between the last drink and takeoff time.

The body metabolizes alcohol at a fixed rate. No amount of coffee or other medication will alter this rate. It is also important not to fly with a "masked hangover" (symptoms suppressed by aspirin or other medication).

4. Drugs.—Self-medication, or taking medicine in any form when he is flying can be extremely hazardous to a pilot. Even simple home or over-the-counter remedies and drugs such as aspirin, antihistamines, cold tablets, cough mixtures, laxatives, tranquilizers, and appetite suppressors may seriously impair the judgment and coordination

4. Handling the "Difficult Student."—The flight instructor should recognize that every student pilot is both attracted to and fearful of flying initially. The instructor should do everything possible to minimize and dispell this fear for all students.

Fear can be countered by reinforcing the student's enjoyment of flying, and by teaching him to cope with his fears. The most effective procedure for furthering the coping with his fears by the student is treating these fears as a natural reaction, rather than by seeking to ignore or suppress them.

Anxiety, for student pilots, is usually associated with the performance of certain flight maneuvers and operations. Such maneuvers should be introduced with care by the instructor before they are first performed, so that the student knows what to expect, and what his reactions should be. When introducing stalls, for example, the instructor should first explain the aerodynamic effects involved, and then carefully describe the sensations to be expected and the responses demanded of the pilot.

Student anxieties can be minimized throughout training by emphasizing the benefits and pleasurable experiences which can be derived from flying, rather than by continuously citing the unhappy consequences of faulty performances. Safe flying practices should be presented as conducive to satisfying, efficient, uninterrupted operations, rather than as necessary only to prevent catastrophe.

The flight instructor must be alert to consider his own feelings toward the student. He must take care that he does not allow his own negative feelings to provoke retaliation toward a difficult student, or to color his evaluation of that student's personality and potential as a safe pilot.

5. Instructor's Action for Student Who is Seriously Abnormal.—The flight instructor who believes, after careful consideration of all evidence available to him, that his student may be suffering from a serious psychological abnormality has a legal and moral responsibility to refrain from certifying him to be a competent pilot until he satisfies himself that the student is fully competent.

His primary legal responsibility concerns his decision whether to certify the student to be competent for solo flight operations, or to execute a flight-test recommendation leading to certification as a pilot. If, after consultation with competent medical authority, he is satisfied in his own mind that the student suffers a serious psychological deficiency, he must not sign such authorizations and recommendations.

The flight instructor's moral responsibility is an obligation to the student himself, and to the public. There will always be people who desire to learn to fly, but whose judgment, reactions, and psychological makeup are such that as pilots they would be hazardous to themselves and to everyone who might ride with them.

It is the instructor's personal responsibility to see that such a person does not continue in aviation to the extent that he becomes certificated as a pilot. To accomplish this, the following steps are available to him.

a. If he believes that a student may have a disqualifying psychological defect, he should request another flight instructor, without previous acquaintance with the student, to ride with him. After the flight, he should confer with the other instructor to determine whether they agree that further investigation or action is justified.
b. An informal discussion should be initiated with the local General Aviation District Office, suggesting that the student may be able to meet the required skill standards, but that he may be unsafe psychologically. This should be done as soon as the question of his fitness arises, and not left until the student believes he is ready to solo.
c. A discussion should be had with a local Aviation Medical Examiner, preferably the one who issued the student's medical certificate, to obtain advice, and as to a possible further examination of the student.

needed when flying. The safest rule is to take no medicine while flying, except on the advice of an Aviation Medical Examiner. The pilot should also consider the possibility that the condition for which the drug is required may of itself be very hazardous to flying, even when its symptoms are suppressed by drugs.

Several common drugs and remedies have been identified with recent flight accidents. Among them are:

a. *Antihistamines*—widely prescribed for hayfever and other allergies.
b. *Tranquilizers*—prescribed for nervous conditions, hypertension, and similar conditions.
c. *Reducing drugs*—amphetamines and other appetite-suppressing drugs can produce a sensation of well-being which has an adverse effect on judgment.
d. *Barbiturates, nerve tonics, or pills*—prescribed for digestive and other disorders, barbiturates produce a marked suppression of mental alertness.

5. Vertigo.—Vertigo involves a disorientation in space, during which a person is unable to sense his attitude accurately with respect to the natural horizon. A pilot suffering vertigo is unable to perceive by his own senses whether his airplane is climbing, diving, or turning.

In normal circumstances on the ground, we perceive our attitude with respect to the earth by seeing fixed objects about us, by feeling the weight of our body on our feet and other parts, and by the vestibular organs in our inner ear. We are able to orient our person by any one of these means for short periods of time.

In an airplane in flight, however, all three of these normal means of orientation can be obscured or confused. The pilot may be able to see only objects which are in or attached to his aircraft when references on the ground are obscured by clouds or darkness. Sensing the direction of the earth's gravity by the weight on one's body parts and by its effect on the vestibular organs can be confused and misled by accelerations in different directions caused by centrifugal force and turbulence. The senses are unable to discriminate, for example, between the force of gravity and the horizontal force resulting from a steep turn.

Because of this fact, gyroscopic instruments are necessary if a pilot is to fly more than a few minutes without visual access to reference points outside his airplane. The use of such instruments does not insure freedom from vertigo. They do enable a pilot to overcome it, however, if he trains himself to accept the psychological discomfort which results from acting in accordance with instrument indications and disregarding the false impressions received from his senses.

For a person without aeronautical experience, vertigo usually means dizziness, a swimming of the head, and a feeling of uneasy discomfort. During his early piloting experience, the student may experience frequent short periods of vertigo, usually when he concentrates on something within the airplane such as a map, or during the performance of abrupt maneuvers. As he gains aeronautical experience, such periods of vertigo will become rare, but will persist under instrument flight conditions.

All student pilots should, during maneuvers performed by the instructor, have the opportunity to experience and consider the sensation of vertigo during an early stage of their training. The maneuvers and procedures used to invoke vertigo can be quite simple. Attempts to read a map or manual during coordination exercises, or watching the upper wing tip in a prolonged steep turn will usually be found quite effective. Once experienced and understood, later unanticipated incidents of vertigo can be more easily controlled or overcome.

Closing the eyes for a short time may help, as will watching the flight instruments and controlling the airplane by sole reference to their indications. All student pilots are required to obtain familiarization with the use of flight instruments to control an airplane in flight before their application for a private pilot certificate. The flight instructor should definitely ascertain that the student is fully capable in this respect, notwithstanding instances of vertigo.

Pilots are susceptible to vertigo at night and in any other flight condition when outside visibility is reduced to the extent that the horizon is obscured. Concentrating on something within the airplane, or watching the ground directly beneath the airplane during flight maneuvers may also produce brief periods of vertigo.

There are other special causes of vertigo in addition to the spatial disorientation which results from the curtailment of visual reference to fixed objects. Among them is the imposition of a flickering light or shadow at a constant frequency. "Flicker vertigo" can result from a light flickering at from 4 to 20 times a second, and may produce unpleasant and dangerous reactions in some persons. These reactions may include dizziness, nausea, unconsciousness, or even reactions similar to those of an epileptic fit. They are especially insidious because the subject is often not aware of the cause of his distress.

In a single-engine airplane flying toward the sun, the propeller can cause a vertigo-producing flickering effect, especially when the engine is throttled for a landing approach. The flickering shadows of helicopter blades have been known to cause flicker vertigo, as has been the bounce-back from rotating beacons operated in or near the clouds at night. Slight changes in propeller or rotor r.p.m. will usually effect relief when the effect cannot be avoided otherwise.

6. Carbon Monoxide.—Carbon monoxide is a colorless, odorless, tasteless gas which is always present in the exhaust fumes of an internal combustion engine. The amount of carbon monoxide in exhaust fumes varies, but it is generally greater during operations with a rich mixture setting. Rich mixtures are characteristic of idling, fullpower operations for takeoff and climb, and during cruising flight at altitude without accurate leaning with the mixture control. The breathing of any exhaust gas, no matter how minute, must be considered extremely dangerous.

For biochemical reasons, carbon monoxide has a greater ability to combine with the hemoglobin of the blood than does oxygen. Furthermore, once carbon monoxide is absorbed into the blood, it sticks like glue to the hemoglobin and actually prevents the oxygen from attaching to it. The onset of symptoms is insidious, with blurred thinking, a possible feeling of uneasiness, and subsequent dizziness. Later headache occurs. Complete incapacity, unconsciousness, and death are rapid.

The effect of carbon monoxide is cumulative in that "airing out" after exposure to it does not return the pilot to the physical condition which existed before exposure. Each additional exposure will add to the amount of carbon monoxide in the blood until the critical level is reached. It may take several days to fully recover and clear the body of carbon monoxide.

The exposure to carbon monoxide is a much more important possibility in aircraft than it is in automobiles because of the fact that most aircraft heaters derive their heat from jackets surrounding the exhaust manifolds and header pipes. Any defective joint or crack can allow exhaust gas to escape into the heater system. For this reason, the exhaust system is inspected regularly, and students should be cautioned to report immediately any time they smell or detect exhaust fumes when using the cabin heater.

When exhaust fumes are detected or suspected in flight, all cabin heaters should be shut off immediately, all windows and vents opened, and a landing should be made at the first available airport where the exhaust and heater system can be thoroughly inspected. If symptoms of carbon monoxide poisoning are experienced, those affected should consult a competent physician, preferably an Aviation Medical Examiner before engaging in any further piloting operations.

A number of inexpensive carbon monoxide detectors are now appearing on the market, which are designed to provide warning of hazardous quantities of carbon monoxide in aircraft cabins. Many of these are effective, and are recommended by the Federal Aviation Agency for all flight operations, especially in winter weather. Advice on the effectiveness of such devices is usually available from local fire departments and mine safety stations.

7. Vision.—Reduced or impaired vision imposes a potential hazard in any occupation. In flying, any reduction in or interference with visual acuity is hazardous.

The fact that a student pilot has been examined and issued a medical certificate indicating that his vision has been determined to be satisfactory does not mean that it will be so under all future circumstances. Many factors, such as hypoxia, fatigue, carbon monoxide, drugs, alcohol, and even rain on the windshield or bright sunshine can adversely affect vision. The instructor must be alert for these effects on his student, and teach him to consider them in conducting his own flight operations.

Three good general rules for all pilots to observe are:

a. Make use of good sunglasses on bright days to avoid eye fatigue.
b. Keep cockpit lights at low settings and use red covers on flashlights during night flights to minimize adverse effects on night adaptation of the eyes.
c. Always consider that drugs, alcohol, heavy smoking, and fatigue have deleterious effects on visual acuity.

8. Middle Ear Discomfort or Pain.—Many persons, both pilots and passengers, have difficulty balancing airloads on their eardrums when descending from higher altitudes. This can be only annoying or very painful, and is particularly troublesome if a head cold or throat inflammation keeps the eustachian tube from opening properly.

Beginning flight students should be instructed that this feeling is to be expected, but that its discomfort can be minimized by simple actions on their part. If the trouble occurs during a prolonged descent, the student should be advised to try swallowing or yawning at regular intervals. If this is ineffective, he should try to exhale with the mouth and nose held shut. This should be done with care, as the reaction tends to be immediate and startling the first time it is attempted.

If no relief is obtained by these measures, the descent should be stopped for a while, or the airplane should even be climbed back up until the pain is relieved. A descent can then be conducted by steps as the comfort of the affected person will permit. A nasal inhaler often affords relief, especially for persons affected by head colds.

In the event the discomfort caused by a prolonged descent persists for more than a few hours after landing, the student should be advised to contact his physician or an Aviation Medical Examiner.

D. SCUBA Diving

The recent increase in the popularity of SCUBA (Self-Contained Underwater Breathing Apparatus) diving has presented a new potential hazard to pilots. It is not generally recognized that dives to 30 feet below the surface impose a pressure change on the diver's system equal to the total pressure exerted by the earth's atmosphere. The pressure change in a dive to 15 feet below the surface is approximately equal to a descent from 18,000 feet above the ground.

Operation of aircraft immediately after extended diving operations can be extremely dangerous. Under the increased pressure of the water, an excess of nitrogen has been absorbed into the diver's body, which can be released as bubbles in his blood stream when the pressure is relieved, causing disabling cases of the bends.

The possibility of such an occurrence is increased significantly even when a pilot flies to an altitude as low as 10,000 feet soon after an extended dive. Students should be cautioned never to fly after SCUBA diving operations until the body has had ample time to rid itself of excess gas.

E. Psychological Aspects of Piloting

To a greater extent than he probably realizes, the professional flight instructor must be a practical psychologist. The instructor must be able to evaluate the student's personality, his way of thinking, and his mood at the time of each lesson if he is to suit his technique and presentation of instruction to the student's needs. While it is obviously impossible for each flight instructor to become an accomplished psychologist, there are a number of general considerations which

will assist him in learning to analyze his students before and during each lesson.

1. Anxiety.—Anxiety is probably the most significant psychological factor affecting flight instruction. This is true because flying is a potentially threatening experience for persons who are not accustomed to being off the ground. The fear of falling is almost universal.

Anxiety is described by Webster as "a state of mental uneasiness arising from fear * * *." It results from the fear of anything, real or imagined, which threatens the person who experiences it, and may have a potent effect upon his actions and his ability to learn from his perceptions.

The responses to anxiety vary greatly. They range from a hesitancy to act to the impulse to "do something, even if it's wrong!" Some persons affected by anxiety will react appropriately and adequately, and more rapidly than they would in the absence of threat. Many persons, on the other hand, may be frozen in place and incapable of doing anything to correct the situation which has caused their anxiety. Others may do many things without rational thought or reason.

Both normal and abnormal reactions to anxiety and tension are of concern to the flight instructor; the first because they indicate a need for special instruction to relieve the anxiety which causes them, and the second because they may be evidence of deep-seated trouble.

2. Normal Reactions to Stress.—When a threat is recognized or imagined, the brain alerts the body. The adrenal gland then pours out adrenalinlike hormones which prepare the body to meet the threat, or to retreat from it. The heart rate quickens, certain blood vessels constrict to divert blood to the organs which will need it, and other changes take place.

The normal individual begins to respond rapidly and exactly, within the limits of his experience and training. Many of his responses may be automatic, which points up the need for proper training in emergency operations prior to an actual emergency. The affected individual thinks rapidly, acts rapidly, and is extremely sensitive to all aspects of his surroundings.

3. Abnormal Reactions to Stress.—With certain persons the same bodily reaction to stress does not produce the actions which we regard as normal. With them, response to anxiety or stress may be completely absent or at least inadequate. Their responses may be random or illogical, or they may be more than is called for by the situation.

In flight instruction, the flight instructor is usually the only person who observes the student when the "heat is on." He is therefore the only person in a position to differentiate between a potentially "safe" and "unsafe" pilot psychologically.

He may accept the following student reactions as indicative of abnormal reaction to stress. None of them provides an absolute indication, but the presence of any of them under conditions of stress is reason for careful observation by the instructor.

a. Autonomic responses such as sweating (especially in the palms), rapid heart rate, paleness, etc.
b. Inappropriate reactions, such as extreme overcooperation, painstaking self-control, inappropriate laughter or singing, vary rapid changes in emotions, and motion sickness under conditions of stress.
c. Marked changes in mood on different lessons; such as excellent morale followed by deep depression.
d. Severe anger at the flight instructor, service personnel, or others.

The flight instructor faced with a psychologically abnormal student may develop the feeling that he is failing to meet the needs of the student. He may believe that the student's actions are intended to insult him, or more often, find that the student's actions are simply confusing. In difficult situations of this sort, the flight instructor must examine carefully the student's responses and his own responses to the student. These may be the normal products of a complex learning situation, but they can be indicative of psychological abnormalities which can be harmful to learning, or potentially very hazardous to future piloting operations.

V. THE INTEGRATED METHOD OF FLIGHT INSTRUCTION

A. *Definition*

B. *Objectives*
   1. Development of Habit Patterns
   2. Accuracy of Flight Control
   3. Operating Efficiency
   4. Emergency Capability

C. *Procedures*

D. *Precautions*

E. *Flight Instructor Qualifications*

V. THE INTEGRATED METHOD OF FLIGHT INSTRUCTION

A. Definition

"Integrated flight instruction" is flight instruction during which students are taught to perform flight maneuvers both by outside visual references and solely by reference to flight instruments FROM THE FIRST TIME EACH MANEUVER IS INTRODUCED. No distinction in the pilot's operation of the flight controls is permitted, regardless of whether outside references or instrument indications are used for the performance of the maneuver.

When this training technique is used, instruction in the control of an airplane by outside visual references is "integrated" with instruction in the use of flight instrument indications for the same operations.

B. Objectives

Integrated flight instruction was introduced on a national scale in 1959, when an amendment to the Civil Air Regulations established certain instruction and competency in the use of flight instruments as prerequisites for the issuance of private pilot certificates. The objective of this training was, and still is, the formation of firm habit patterns for the observance of and reliance on flight instruments from the student's first piloting experience. Such habits have been proved to produce more capable and safer pilots for the efficient operation of today's airplanes. The ability to fly in instrument weather is not the objective of this type of primary training, although it does greatly facilitate later instrument flight training.

1. Development of Habit Patterns.—The continuing observance of and reliance upon flight instruments is essential to the efficient, safe operation of modern high-performance airplanes. The habit of monitoring instruments constantly is difficult to develop after one has accustomed himself to relying exclusively on outside references for heading, altitude, airspeed, and attitude information, a procedure which was adequate in most older airplanes.

General aviation accident reports provide ample support for the belief that habitual reference to flight instruments is important to safety. The safety record of pilots who hold instrument ratings is significantly better than pilots with comparable flight time who have never had formal instrument flight training.

A student pilot who has been required to perform all normal flight maneuvers by reference to instruments, as well as by outside references, will develop from the start the habit of monitoring his own and the airplane's performance continuously. This habit would be much more difficult for him to develop after he has had extensive piloting experience without it, as veteran pilots who begin formal training for an instrument rating can readily testify.

The early establishment of the habit of reliance on flight instruments is a tremendous help to a pilot who later undertakes formal instrument instruction, but it is not intended that the integrated primary instruction recommended for student pilots should in any way prepare students for flight in instrument weather conditions.

2. Accuracy of Flight Control.—During early experiments with the integrated technique of primary flight instruction, it was soon recognized that students trained in this manner are much more precise in their flight maneuvers and operations. This applies equally to all of their flight operations, not

just when flight by reference to instruments is required.

Notable among their achievements are better monitoring of power settings, and the more accurate maintenance of desired headings, altitudes, and airspeeds. As the habit of monitoring his own performance by reference to instruments is developed, the student soon begins to make corrections without prompting from the instructor.

The habitual attention to instrument indications leads to better landings because of better airspeed control, superior cross-country navigation, better coordination, and a generally better overall pilot competency.

3. Operating Efficiency.—As the student becomes more proficient in monitoring and correcting his own flight technique by reference to flight instruments, the performance he obtains from an airplane increases noticeably. This is particularly true of modern, high performance airplanes, which are responsive to the use of correct operating airspeeds.

The use of correct power settings and climb speeds, and the accurate control of headings during climbs result in a measurable increase in climb performance. The maintenance of headings and altitudes in cruising flight will definitely increase the cruising speeds realized on long flights. The accuracy of landing approaches and the precision of touchdown on landings is markedly better when the approach path and airspeed have been accurately controlled.

4. Emergency Capability.—The use of integrated flight instruction provides the student with the ability to control an airplane in flight for limited periods under favorable circumstances if outside references are cut off. This ability could save the pilot's life and those of his passengers in an actual emergency, but repeated ventures into bad weather with no more than this training will eventually end with a serious accident.

During the conduct of integrated flight training, the flight instructor must emphasize to his students that their introduction to the use of flight instruments does not prepare them for operations in marginal or instrument weather conditions. The possible consequences, both to himself and to others, of experiments with flight operations in weather worse than those required for VFR operations before he is instrument rated should be constantly impressed on each student.

C. Procedures

The conduct of integrated flight instruction is simple. The use of an airplane equipped with flight instruments and an easily demountable means of simulating instrument flight conditions, such as an extended visor cap, are needed. The student's first briefing on the function of the flight controls should include the instrument indications he should expect, as well as the outside references he should use to control the attitude of the airplane.

Each new flight maneuver should be introduced using either outside references or instrument indications, as the instructor prefers. The student's visor should then be raised or lowered, whichever is appropriate, and the same maneuver performed by the use of the other set of references. New students, having no inhibitions about instrument flying, rapidly develop the ability to maneuver an airplane equally well by instrument or outside references. They accept naturally the fact that the manipulation of the flight controls is identical, regardless of which references are used to determine the attitude of the airplane.

This practice should continue throughout the student's dual instruction for all flight maneuvers but those which require the use of ground references.

Compliance with pilot certification requirements by giving distinct periods of instrument instruction before solo and in preparation for the private pilot flight test does not constitute integrated flight instruction. To fully achieve the demonstrated benefits of this type of training, the use of visual and instrument references must be constantly integrated throughout the training. Failure to do so will lengthen the dual instruction necessary for the student to achieve the competency required for a private pilot certificate.

D. Precautions

During the conduct of integrated flight instruction, the flight instructor must be especially vigilant for other air traffic while his student is operating by instrument references. He must guard against having his attention diverted to his student's performance for extended periods.

At the same time, he must be sure that each student develops, from the start of his training, the habit of watching for other air traffic at all times when he is not operating under simulated instrument conditions. If the instructor allows the student to assume that he has accepted all responsibility for avoiding other traffic, the student cannot develop the habit of keeping a constant watch which is essential to safety. Any observed tendency of a student to enter flight maneuvers without first making a careful check for other possible air traffic must be briskly dealt with by the instructor.

In the earlier stages of his training, a student pilot may find it easier to perform flight maneuvers by reference to instruments than by outside references. The fact that he can perform better by reference to instruments may cause him to concentrate most of his attention on the instruments, when he should be using outside references.

This must not be allowed to continue, because it will cause him considerable difficulty when he must maneuver by reference to ground patterns later in his training. It will also incur a hazard by tending to limit his vigilance for other air traffic. The instructor should carefully observe his student's performance of maneuvers during the early stages of integrated flight instruction to insure that this habit does not develop. If it is detected, he should make the student concentrate on maneuvering by outside references with the gyroscopic instruments caged or covered.

During the conduct of integrated flight instruction, the instructor should constantly make it clear that the use of instruments is being taught to prepare the student to monitor his and his airplane's performance accurately, not to qualify him for IFR operations. The instructor must avoid any indication to the student, by word or action, that the proficiency sought is intended solely for use in difficult weather situations.

E. Flight Instructor Qualifications

Although an instrument rating is not presently required for flight instructors, it is essential for instructors to familiarize themselves thoroughly with the functions, characteristics, and effective use of all standard flight instruments. Qualification for and the maintenance of an instrument rating is a worthwhile investment for any flight instructor.

It is the personal responsibility of each flight instructor to maintain his familiarity with current pilot training techniques and requirements, and certification requirements. This may be done by constant use of new periodicals and technical publications, personal contacts with Federal Aviation Agency inspectors and designated pilot examiners, and by participation in pilot and flight instructor symposiums and clinics. The application of outmoded instructional procedures, or the preparation of student pilots for obsolescent certification requirements is inexcusable.

VI. THE FLIGHT TRAINING SYLLABUS

A. *Importance of a Planned Syllabus*
   1. Progression of Learning
   2. Coverage of Training

B. *Provision of the Flight Syllabus*
   1. Approved Flying Courses
   2. The Private Pilot Flight Training Guide
   3. Preparation by the Instructor

C. *Sample Private Pilot Flight Syllabus*

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required by the Federal Aviation Regulations before the first solo and first solo cross-country flights, and the flight experience prescribed for a private pilot certificate at the completion of the syllabus.

The notation "(VR and IR)" is used to indicate maneuvers and operations which should be performed by both visual references and instrument references during the conduct of integrated flight instruction.

VI. THE FLIGHT TRAINING SYLLABUS

A. Importance of a Planned Syllabus

To be effective, all instruction must follow some type of planned syllabus, as explained in chapter II of this handbook. If he is to teach efficiently, a flight instructor must have the benefit and guidance of a planned flight syllabus, either mental or written, personally prepared or obtained from an authoritative agency. The following sections point out the major functions of such a syllabus used in flight training.

1. Progression of Learning.—Flight instruction can cover only four basic elements of flight: straight and level flight, turns, climbs, and descents. To apply these effectively to the operation of an airplane, the student pilot must learn and practice many special training and operational flight maneuvers.

Each of these flight training maneuvers incorporates one or more of the basic elements of flying, and each provides a unique or extended application of these elements which is different from their application during the performance of maneuvers previously learned. Using the "building block" principle of teaching dictates that the presentation of these maneuvers must be made in a sequence and at a stage of training where their association by the student with other maneuvers already learned will be assembled to form correct insights and provide mastery of advanced skills.

An effective flight training syllabus enables the flight instructor to present training maneuvers in the best sequence and association to foster the development of progressive major "blocks" of pilot skills. A maneuver which incorporates the elements used in the preceeding maneuvers and extends their application, or associates them with other flight elements, provides much more effective training than does a maneuver which is completely foreign to the proceeding maneuver.

The flight syllabus should provide a step-by-step progression of learning, with provision for regular review and evaluation at prescribed stages of learning. The length of each lesson in the syllabus, and of each stage, should be established on the basis of units of learning, not merely the time devoted to instruction and practice. For example, the first stage of a pilot training syllabus might include all of the presolo dual instruction. If this is the case, the stage is not complete when eight, ten, twelve, or any number of hours of dual instruction have been given, but when the student has qualified and actually made his first solo flight.

If the syllabus used by the flight instructor is made available to his student, it will facilitate his association of the principles covered in each lesson, and enable him to anticipate the goals, or blocks of learning, toward which he is progressing. When a student does have access to his flight syllabus, the instructor must be sure that anticipation of more interesting features of the training does not detract from the student's interest in the necessary fundamentals.

2. Coverage of Training.—The use of a planned syllabus is necessary to assure adequate and uniform coverage of a student's instruction, especially if different instructors are involved. Without a specific syllabus for reference, any flight instructor who takes over a student's training must repeat many items of instruction to establish what the student has already learned. Otherwise serious gaps in his instruction are possible,

[illegible] later only with a greater amount of instruction than would have been required at the proper time in his training.

When a student has the misfortune to be trained at an operation where he is not regularly assigned to the same instructor, or when he patronizes several different operations during his flight training, the administration of a planned syllabus is almost impossible. It is necessary for each flight instructor to examine the student's logbook to determine what he has been taught, and to try to devise a flight lesson which will provide a logical progression in his flight course. Such an instructional procedure, however, is never efficient.

The use of an organized syllabus is equally important for flight instruction conducted by the same flight instructor. While it is true that an instructor who conducts the same course of instruction over a period of years soon becomes completely familiar with the syllabus used, he still follows that syllabus. In the case of relatively inexperienced flight instructors, or instructors conducting unfamiliar courses, reference to a written syllabus is necessary to avoid the risk of gaps and repetitions in the training course provided.

B. Provision of the Flight Syllabus

1. Approved Flying Courses.—Each approved flight course conducted by a certificated pilot school is given in strict accordance with a syllabus provided or specifically approved by the Federal Aviation Agency. Compliance with the appropriate approved syllabus is a condition for graduation from such courses. A student who has not been trained in accordance with the pertinent syllabus is not eligible for certification as an approved school graduate.

2. The Private Pilot Flight Training Guide.—The FAA *Private Pilot Flight Training Guide* is available from the Government Printing Office for $1. This guide was prepared to provide an effective flight syllabus for the use of flight instructors engaging in flight training at other than certificated pilot schools. It contains a suggested curriculum, with provision for the flight instructor to initial off each training item and sign for each lesson as it is completed.

Conscientious use of the guide should result in the observance of a good course of training, without gaps or unnecessary repetition of instruction. It may also be used as a student pilot logbook up until qualification for a private pilot certificate.

3. Preparation by the Instructor.—The individual flight instructor may prefer to prepare a flight training syllabus of his own. This may be a completely original one, suited to his own instructing technique, aircraft, and training situation, or it may be a modification of other standard courses. In either case, it should be committed to writing, and carefully followed during flight training.

The fact that a syllabus should be carefully followed does not imply that it should be inflexible and unchangeable. Every flight syllabus should be so stated that the course can be adapted to weather conditions, aircraft availability, and other special circumstances without disturbing the teaching process or suspending training.

Following a syllabus faithfully is the only way in which its effectiveness can be realistically evaluated. When any feature of the syllabus used is found to be impracticable or ineffective, it should be changed immediately and the instruction rescheduled accordingly. Only in this way can an efficient training syllabus be evolved.

C. Sample Private Pilot Flight Syllabus

The sample private pilot flight training syllabus which follows is adapted from the FAA *Flight Training Manual* and the *Private Pilot (Airplane) Flight Training Guide*. It is included to be illustrative of the preparation and organization of a training syllabus, and not necessarily as the most effective private pilot flight syllabus.

It should be noted that each lesson prescribes a unit of training, not a specified period of instruction and flight time. The student must have at least the instruction

LESSON 1. DUAL FLIGHT

The first lesson consists of familiarization with the airplane and its operating procedures, the sensations of flight, and the local flight areas, and the use of the flight controls and instruments. A short out-and-back cross-country flight to a nearby airport is often effective in stimulating the new student's interest.

1. *Airplane familiarization*	Ground instruction.
Preflight inspection.	
Cockpit familiarization.	
The airplane flight manual.	
2. *Starting the engine*	Demonstration.
3. *Radio communications*	Do.
4. *Taxiing*	Demonstration or directed performance.
5. *Pretakeoff check*	Demonstration with student participation.
6. *Takeoff, traffic pattern, and climbout*	Demonstration.
7. *Familiarization flight*	Demonstration, and performance by student as feasible (Visual and Instrument References).
Control effects and usage.	
Flight area familiarization.	
Straight and level flight.	
Pitch and bank control.	
Approach, traffic pattern, landing, and parking.	
8. *Postflight discussion.*	
9. *Preview of next lesson.*	
Straight and level, climbs, turns, and descents.	
Slow flight and power-off stalls.	

LESSON 2. DUAL FLIGHT

During his second lesson, the student should learn to perform the four basic flight maneuvers (straight and level, climbs, turns, and descents) without assistance, and slow flight and power-off stalls under the direction of his instructor.

1. *Preflight discussion*	Review, as required.
2. *Starting engine*	Directed practice.
3. *Radio communication procedures*	Do.
4. *Taxiing*	With close surveillance by instructor.
5. *Pretakeoff check*	Directed performance.
6. *Takeoff and traffic pattern*	Demonstration, with student follow-through.
7. *Climbing turns*	Demonstration and student performance (VR and IR).

8.	*Straight and level*	Directed practice (VR and IR).
9.	*Medium turns*	Demonstration and student performance (VR and IR).
10.	*Slow flight*	Do.
11.	*Power-off stalls*	Do.
12.	*Steep turns*	Demonstration only.
13.	*Confidence maneuvers*	Demonstration and practice.
14.	*Descents and gliding turns*	Demonstration and student performance (VR and IR).
15.	*Approach, traffic pattern, and landing*	Demonstration, with student follow-through.
16.	*Taxiing and parking*	Directed performance.
17.	*Postflight discussion.*	
18.	*Preview of next lesson.*	

Takeoff, traffic pattern, and departure.
Coordination exercises.

LESSON 3. DUAL FLIGHT

During this lesson, the student should attain reasonable proficiency in the performance of the four basic flight maneuvers, and learn to perform without assistance slow flight, power-off stalls, and simple coordination exercises.

On this lesson, and hereafter, the student should be responsible for the preflight inspection, starting, radio communications, taxiing, and parking without direction from the instructor, except in unusual circumstances or in new, unfamiliar situations.

1.	*Preflight discussion*	Instruction and review.
2.	*Takeoff*	Student performs, with instructor follow-through.
3.	*Traffic pattern and departure*	Directed performance.
4.	*Climbs and climbing turns*	Directed practice (VR and IR).
5.	*Level-off from climbs and glides*	Do.
6.	*Straight and level, medium turns*	Practice (VR and IR).
7.	*Coordination exercises*	Demonstration and practice.
8.	*Speed changes in level flight*	Directed practice (VR and IR).
9.	*Slow flight and power-off stalls*	Practice (VR and IR).
10.	*Glides and gliding turns*	Do.
11.	*Airport approach and traffic pattern*	Directed performance.
12.	*Postflight discussion.*	
13.	*Preview of next lesson.*	

Power stalls.
Ground reference maneuvers.
Landing approaches.
Elementary forced landings.

LESSON 4. DUAL FLIGHT

During this lesson, the student should achieve the ability to recognize and recover smoothly from stalls without direction, fly prescribed patterns by ground references, and execute a traffic pattern and landing approach with the instructor's direction.

1. *Preflight discussion* ..... Instruction and review.
2. *Takeoff, traffic pattern, and departure* ..... Directed performance.
3. *Straight and level, turns, climbs, and descents.* Review and practice (VR and IR).
4. *Slow flight and stalls* ..... Practice (VR and IR).
5. *Turns to headings* ..... Directed performance (VR and IR).
6. *Ground reference maneuvers* ..... Directed practice.
   - Following road or stream.
   - S turns across a road.
   - Rectangular course.
7. *Elementary forced landing* ..... Demonstration and student performance.
8. *Traffic pattern and landing approach* ..... Directed performance.
9. *Postflight discussion.*
10. *Preview of next lesson.*
    - Takeoffs and landings.
    - Emergency procedures.

LESSON 5. DUAL FLIGHT

Lesson 5 is a review of the flight maneuvers and procedures already covered in preparation for serious work on takeoffs and landings and on traffic pattern operations. Reasonable proficiency in all coordination, airspeed control, and ground reference maneuvers should be achieved before takeoff and landing practice is initiated.

1. *Preflight discussion* ..... Instruction and review.
2. *Preflight operations* ..... Demonstration by student.
3. *Coordination maneuvers* ..... Demonstration by student (VR and IR).
4. *Slow flight and stalls* ..... Student demonstration (VR and IR).
5. *Ground reference maneuvers* ..... Do.
6. *Emergency procedures* ..... Demonstrations, and performance by student.
7. *Takeoff and landing* ..... Directed performance.
8. *Traffic pattern observance, entry, and departure.* Directed practice.
9. *Postflight discussion.*
10. *Preview of next lesson.*
    - Takeoffs and landings.
    - Steep turns.
    - Accelerated stalls.

LESSON 6. DUAL FLIGHT

Concentrated practice of takeoffs and landings should begin with this lesson. To provide an occasional change of pace, reviews of previously introduced flight maneuvers should be practiced, and steep turns and accelerated stalls should be introduced.

By the completion of this lesson, the student should be able to make directed takeoffs and landings without assistance on the controls. Simulated forced landings should be introduced at unannounced points during this lesson, and hereafter.

1. *Preflight discussion* ..... Instruction and review.
2. *Takeoffs and landings* ..... Directed practice.
3. *Traffic pattern operations* ..... Practice.

4. *Steep turns* ..... Student performance (VR and IR).
5. *Accelerated stalls* ..... Demonstration and student performance.
6. *Postflight discussion.*
7. *Preview of next lesson.*
   Slips.
   Crosswind takeoffs and landings.
   Balked takeoffs and emergency go-arounds.

LESSON 7. DUAL FLIGHT

Crosswind takeoffs and landings, as well as slips, should be added to the practice of normal takeoffs and landings. At the completion of this lesson, the student should be able to make unassisted takeoffs and landings, and fly an accurate traffic pattern.

Short reviews of previously covered maneuvers should be introduced occasionally as a change of pace during takeoff and landing practice.

1. *Preflight discussion* ..... Instruction and review.
2. *Takeoffs and landings* ..... Practice.
3. *Crosswind takeoffs and landings* ..... Demonstration and student performance.
4. *Slips* ..... Do.
5. *Use of flaps for takeoffs* ..... Do.
6. *Balked takeoffs* ..... Directed performance.
7. *Emergency go-arounds* ..... Do.
8. *Review of earlier maneuvers* ..... Practice (VR and IR).
9. *Postflight discussion.*
10. *Preview of next lesson.*
    Turns about a point.
    Cross-control stalls.
    Maximum performance takeoffs.

LESSON 8. DUAL AND FIRST SOLO FLIGHT

At the completion of the dual portion of this lesson, the student should have achieved reasonable proficiency in all the flight training maneuvers he has received, be able to make safe takeoffs and landings consistently without assistance or direction, and recover from poor approaches and bad bounces. He should have demonstrated the ability to solve all ordinary problems to be encountered on local flights.

Three solo flights are recommended during the first solo period, if his observed performance is satisfactory, to build the student's confidence. No further solo flights should be authorized until after a rest period and further dual review of basic maneuvers.

1. *Preflight discussion* ..... Instruction and review.
2. *Takeoffs and landings* ..... Practice.
3. *Slow flight and stalls* ..... Review (VR and IR).
4. *Coordination exercises* ..... Do.
5. *Emergencies* ..... Review.
6. *Turns about a point* ..... Directed performance.
7. *Cross-control stalls* ..... Demonstration.

Pilotage.
Dead reckoning.
Tracking VOR radial.

3.	*Cross-country emergencies*	Directed practice.
4.	*Unfamiliar airport procedures*	Directed performance.
5.	*Use of radio for enroute communications*	Do.
6.	*Postflight discussion.*	
7.	*Preview of next lesson.*	
	Local solo practice flight.	

LESSON 14. SOLO FLIGHT

This lesson includes solo practice on flight maneuvers, takeoffs and landings, and on the use of navigational radio.

1.	*Preflight discussion*	Assignment of procedures and practice areas.
2.	*Takeoffs and landings*	Solo practice.
3.	*Crosswind takeoffs and landings, slips*	Solo practice, as practicable.
4.	*Slow flight and stalls*	Solo practice.
5.	*Tracking to and from VOR range (advise flight service station).*	Do.
6.	*Steep turns*	Do.
7.	*Flight maneuvers specifically assigned by instructor.*	
8.	*Preview of next lesson.*	
	Dual cross-country flight using radio aids.	

LESSON 15. DUAL CROSS-COUNTRY FLIGHT

This is a cross-country flight over a triangular flight requiring approximately 3 hours of flight time, using pilotage, dead reckoning, and VOR ranges. At the completion of this lesson, the student should be prepared for VFR navigation over strange courses, and have the ability to cope with common cross-country emergencies.

1.	*Preflight discussion*	Flight planning and preparation.
2.	*VFR navigation*	Practice.
	Pilotage.	
	Dead reckoning.	
	Use of radio aids.	
3.	*Lost procedures*	Directed performance.
4.	*Simulated inadvertent encounter with adverse weather conditions.*	Directed practice (VR and IR).
5.	*Unfamiliar airport procedures*	Practice.
6.	*Use of radio for enroute communications*	Do.
7.	*Cross-country emergencies*	Do.
8.	*Postflight discussion.*	
9.	*Preview of next lesson.*	
	Short- and soft-field takeoffs and landings.	
	Emergency radio assistance (DF and Radar).	

LESSON 16. DUAL FLIGHT

This lesson concentrates on procedures appropriate to possible cross-country flight emergencies in preparation for extended solo cross-country flights. At lesson completion, the student should be competent to cope with common navigational and weather emergencies encountered on solo cross-country flights.

1. *Preflight discussion*	Instruction and review.
2. *Short-field takeoffs and landings*	Demonstration and practice.
3. *Soft-field takeoffs and landings*	Do.
4. *Slips and crosswind takeoffs and landings* (if practicable).	Directed practice.
5. *Flight maneuvers, including steep turns*	Review (VR and IR).
6. *Slow flight and stalls*	Do.
7. *180° and 360° gliding approaches*	Directed practice.
8. *Obtaining assistance by radio* (DF and radar steers, orientation by terrain features).	Directed performance (Make prior arrangement with ATS facility).
9. *Postflight discussion.*	
10. *Preview of next lesson.* Solo cross-country flight. Assignment: Prepare materials. Prepare flight log.	

LESSON 17. SOLO CROSS-COUNTRY FLIGHT

This solo cross-country flight should be over a relatively simple course with landings at two or more unfamiliar airports, preferably at least one with a control tower. A VFR flight plan should be filed when feasible, and flight following service should be requested.

1. *Preflight discussion*	Approval of flight plan and weather analysis.
2. *VFR navigation.*	
3. *Unfamiliar airport procedures.*	
4. *Filing of flight plans.*	
5. *Postflight discussion*	Critique on all unanticipated events and operations.
6. *Preview of next lesson.* Dual night flight.	

LESSON 18. DUAL NIGHT FLIGHT

This lesson familiarizes the student with the special considerations and problems characteristic of flight at night. Solo flights in the traffic pattern may be permitted at the instructor's discretion. It is recommended that the period start in twilight, so that the student has experience in the transition from daylight to night flight conditions.

1. *Preflight discussion*	Instruction and review.
2. *Differences in visual references available at night.*	Demonstration.
3. *Takeoff and departure alignment techniques.*	Directed performance.

8. *Maximum performance takeoff* ..... Demonstrations.
9. *The solo flight* ..... Instructor observes.
10. *Postflight discussion.*
11. *Preview of next lesson.*
    Maximum performance climbs.
    Precision turns.

LESSON 9. DUAL AND SOLO FLIGHT

The introduction of and instruction in additional maneuvers and procedures should continue after the first solo flight, and progressively higher standards of performance should be required for maneuvers previously learned.

This lesson should consist of a review of presolo flight maneuvers, and the introduction and practice of maximum performance takeoffs and climbs and precision turns. Four or five solo flights in the traffic pattern should be permitted, depending on the student's performance.

1. *Preflight discussion* ..... Instruction and review.
2. *Review of presolo maneuvers* ..... Practice (VR and IR).
3. *Maximum performance takeoffs and climbs.* Directed practice.
4. *Precision turns* ..... Directed practice (VR and IR).
5. *Takeoffs and landings* ..... Dual and solo practice.
6. *Postflight discussion.*
7. *Preview of next lesson.*
   Precision approaches.
   Use of the compass.
   Area checkout.

LESSON 10. DUAL FLIGHT

This lesson contains a refamiliarization with local practice areas and a review of flight maneuvers in preparation for local solo practice flights. Precision 180° and 360° approaches, and the use of the magnetic compass should be introduced. At the completion of the lesson the student should be ready for local solo flights in assigned practice areas.

1. *Preflight discussion* ..... Instruction and review.
2. *Flight maneuvers* ..... Practice (VR and IR).
3. *Recovery from unusual attitudes* ..... Directed performance (IR).
4. *Ground reference maneuvers* ..... Review.
5. *Slow flight and stalls* ..... Review (VR and IR).
6. *Precision Approaches* ..... Demonstration and student performance.
7. *Use of magnetic compass* ..... Directed performance (VR and IR).
8. *Takeoffs and landings* ..... Practice.
9. *Postflight discussion.*
10. *Preview of next lesson.*
    First solo flight outside traffic pattern.
    Elementary flight maneuvers.
    Takeoffs and landings.

LESSON 11. SOLO FLIGHT

This is the first lesson during which the student is permitted to solo without previous dual checkout, provided conditions permit it. It should include the practice of specified maneuvers and procedures within assigned practice areas, and normal takeoffs and landings. At its completion, the student should have confidence and a sense of ease in flight which will make him receptive to new areas of instruction.

1. *Preflight discussion* ..... Assignment of maneuvers and areas.
2. *Flight maneuvers and procedures* ..... Solo practice, as assigned.
3. *Takeoffs and landings* ..... Solo practice.
4. *Postflight discussion.*
5. *Preview of next lesson.*
   Review of flight procedures and maneuvers.
   Stalls from critical flight situations.

LESSON 12. DUAL AND SOLO FLIGHT

This lesson should be equally divided, approximately, between dual and solo flight. At its completion, the student should have demonstrated his ability to maneuver and land the airplane confidently without direction or assistance, and be prepared for cross-country instruction.

1. *Preflight discussion* ..... Instruction and review.
2. *Slow flight and stalls* ..... Review (VR and IR).
3. *Stalls from critical flight situations* ..... Demonstration and student performance.
4. *Coordination maneuvers* ..... Review (VR and IR).
5. *Ground reference maneuvers* ..... Review.
6. *Crosswind takeoffs and landings* ..... Practice.
7. *Takeoffs and landings* ..... Practice.
8. *Solo practice* ..... As directed.
9. *Postflight discussion.*
10. *Preview of next lesson.*
    Assignment:
    Procure materials for cross-country flight.
    Plot and prepare cross-country flight log.

LESSON 13. DUAL CROSS-COUNTRY FLIGHT

This lesson should be equally divided, approximately, between ground instruction and dual flight instruction. Flight preparation should be thorough, and each step carefully explained to the student. The flight should consist of an out-and-back flight over a 1-hour course, approximately.

1. *Preflight preparation* ..... Ground instruction—course plotting and preparing cross-country log sheet.
2. *Cross-country flying* ..... Directed performance (VR and IR).

4. *Power approach and landings* ..... Do.
5. *Use of landing lights* ..... Do.
6. *Interpretation of aircraft and obstruction lights.* Directed Practice.
7. *Flight maneuvers over dark areas* (when feasible). Do.
8. *Postflight discussion.*
9. *Preview of next lesson.*
   Solo cross-country flight.
   Assignment:
   Procure necessary equipment.
   Prepare flight log.

LESSON 19. SOLO CROSS-COUNTRY FLIGHT*

This solo cross-country flight should be planned to meet the private pilot certification requirement for a landing at an airport at least 100 miles from the point of departure. At least one leg should be flown on airways using radio aids, under a VFR flight plan, and flight-following service.

1. *Preflight discussion* ..... Instructor's approval of flight log and weather analysis.
2. *Filing and closing of flight plan.*
3. *VFR navigation.*
4. *Enroute radio communications.*
5. *Unfamliar airport procedures.*
6. *Servicing airplane.*
7. *Postflight discussion* ..... Critique of any unanticipated incidents.
8. *Preview of next lesson.*
   Review of flight maneuvers.
   Emphasis of precision on all maneuvers.

LESSON 20. DUAL AND SOLO FLIGHT

Active preparation for the private pilot flight test begins with this lesson. The FAA *Private Pilot Flight Test Guide* should be used for guidance on the procedures and standards to be applied to all flight maneuvers. At the completion of this lesson, the student should be prepared for solo practice on the correct performance of flight test maneuvers.

1. *Preflight discussion* ..... Flight test standards and review.
2. *Slow flight and stalls* ..... Directed (VR and IR) and solo (VR only) practice.
3. *Medium turns to headings* ..... Do.
4. *720° turns about a point* ..... Directed and solo practice.
5. *Normal and crosswind takeoffs and landings.* Do.
6. *Full stall landings, or wheel landings in tailwheel airplanes.* Directed practice.

* This lesson may be switched with Lesson No. 21, when required by weather conditions or other special circumstances.

7. *Recovery from unusual attitudes* ..... Directed practice (IR only).
8. *Postflight discussion.*
9. *Preview of next lesson.*

Solo cross-country flight.

Assignment:

Provide necessary equipment.

Prepare flight log.

LESSON 21. SOLO CROSS-COUNTRY FLIGHT*

This lesson provides additional cross-country experience, with emphasis on unfamiliar airport procedures. A 4-hour cross-country flight, or series of flights, should be arranged so as to include as many airports as practicable. At the completion of this flight the student should be competent to make VFR cross-country flights at his own responsibility.

1. *Preflight discussion* ..... Instructor's approval of flight plan and weather analysis.
2. *VFR navigation.*
3. *Unfamiliar airport procedures.*
4. *Radio communications.*
5. *Postflight discussion* ..... Critique of unanticipated occurrences.
6. *Preview of next lesson.*

Local practice flight.

LESSON 22. SOLO FLIGHT

This lesson provides solo practice to develop precision in the performance of the flight maneuvers required for a private pilot certificate. It is suggested that emphasis be directed to coordination and to airspeed control maneuvers.

1. *Preflight discussion* ..... Assignment of maneuvers and practice areas.
2. *Airspeed control maneuvers, including stalls.*
3. *Coordination maneuvers, including turns to headings and steep turns.*
4. *Other maneuvers as directed by the instructor.*
5. *Postflight discussion.*
6. *Preview of next lesson.*

Local solo practice flight.

LESSON 23. SOLO FLIGHT

This lesson should include solo practice of ground reference maneuvers, maximum climbs, and traffic pattern procedures. At the completion of this lesson, the student should be satisfied that he can perform his "air work" to a standard acceptable for a private pilot flight test.

* This lesson may be switched with Lesson No. 19 when required by weather conditions or other special situations.

1. *Preflight discussion* ..... Assignment of maneuvers and practice areas.
2. *Ground reference maneuvers.*
3. *Coordination maneuvers* ..... Review only.
4. *Airspeed control maneuvers* ..... Do.
5. *Maximum performance climbs.*
6. *Traffic pattern entries and departures.*
7. *Normal and crosswind takeoffs and landings.* As incident to traffic pattern practice.
8. *Maneuvers specifically assigned by instructor.*
9. *Postflight discussion.*
10. *Preview of next lesson.*

Instructor's review of air work.
Solo practice as directed.

LESSON 24. DUAL AND SOLO FLIGHT

This lesson consists of the instructor's evaluation of the flight maneuvers practiced during the previous two lessons, and directed solo practice as needed. At the completion of this lesson, the student's performance of his "air work" should be at an acceptable level for the private pilot flight test.

1. *Preflight discussion* ..... Instruction and review.
2. *Coordination maneuvers* ..... Review and evaluation (VR and IR).
3. *Recovery from unusual attitudes* ..... Evaluation (IR only).
4. *Ground reference maneuvers* ..... Review and evaluation.
5. *Airspeed control maneuvers* ..... Review and evaluation (VR and IR).
6. *Traffic patterns* ..... Review and evaluation.
7. *Postflight discussion.*
8. *Preview of next lesson.*

Solo practice flight.
Takeoffs and landings.

LESSON 25. SOLO FLIGHT

During this lesson, the student should practice to achieve the standard of performance required by the private pilot flight test on special types of takeoffs and landings.

1. *Preflight discussion* ..... Assignment of maneuvers and practice areas.
2. *Short-field takeoffs and landings.*
3. *Soft-field takeoffs and landings.*
4. *Slips, and crosswind takeoffs and landings.*
5. *Power approaches and full stall landings.*
6. *Wheel landings if tailwheel airplane is used.*
7. *Other maneuvers specifically assigned by instructor.*
8. *Postflight discussion.*
9. *Preview of next lesson.*

Solo practice period.
Review of cross-country procedures.

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LESSON 26. SOLO FLIGHT

During this lesson, the student should practice the cross-country flying procedures required during the private pilot flight test.

1. *Preflight discussion* ..... Assignment of procedures and practice areas.
2. *Pilotage and map reading.*
3. *Time, speed, and distance computations between checkpoints.*
4. *Tracking to and from a VOR station.*
5. *Plotting VOR cross-bearings.*
6. *Plotting alternate courses in flight.*
7. *Other operations specifically assigned by instructor.*
8. *Postflight discussion.*
9. *Preview of next lesson.*
   Solo practice period.
   Private flight-test operations and procedures.

LESSON 27. SOLO FLIGHT

During this lesson, the student should practice for the first time the performance of all the maneuvers and procedures included in the private pilot flight test. (No simulated instrument operation shall be included). Upon completion, the student should feel confident that he can perform all required maneuvers to the standard required for a private pilot certificate.

1. *Preflight discussion* ..... Review and practice area assignment.
2. *Private pilot flight test maneuvers and procedures.* Solo practice.
3. *Preview of next lesson.*
   Instructor's evaluation of test performance.

LESSON 28. DUAL FLIGHT

This lesson consists of the instructor's first evaluation of his student's performance of the complete private pilot flight test. Any deficiencies should be carefully noted for discussion at the end of the lesson and correction in the next lesson.

1. *Preflight discussion* ..... Statement of objective.
2. *Private pilot flight test* ..... Evaluation by instructor.
3. *Postflight discussion* ..... A thorough review of the student's deficiencies, and a full explanation of the appropriate corrections.
4. *Preview of next lesson.*
   Dual and solo practice on deficiencies.

VII. FLIGHT INSTRUCTOR RESPONSIBILITIES

A. *Helping the Student Pilot Learn*

B. *Instruction of Student Pilot*
   1. Providing Adequate Instruction
   2. Demanding an Adequate Standard of Performance
   3. Student Pilot Supervision and Surveillance
   4. Student Pilot Certificate Endorsements

C. *Flight Test Recommendations*

D. *Aircraft Checkouts*

E. *Refresher Training*

F. *The Flight Instructor Image*
   1. Sincerity
   2. Acceptance of the Student
   3. Personal Appearance and Habits
   4. Strong Language
   5. Demeanor

G. *Self-Improvement*

LESSON 29. DUAL AND SOLO FLIGHT

During this lesson the instructor seeks to correct any deficiencies discovered in the student's performance of the private pilot flight test maneuvers. At the completion of this lesson, the instructor's recommendation for

[redacted]

[redacted]GHT

[redacted]test conducted by the instructor exactly [redacted]. The student should be able to per- [redacted]ance with the *Private Pilot Flight Test*

[redacted] of the private pilot flight test.
[redacted] by the flight instructor.
[redacted]ritique of overall performance.

[redacted]ion for his student, it is the responsibility of the flight [redacted]xperience requirements for a private pilot certificate, in- [redacted]lo-flight time, cross-country, and instruction in the control

VII. FLIGHT INSTRUCTOR RESPONSIBILITIES

A. Helping the Student Pilot Learn

Schools exist and instructors work to help students learn. The operation of a pilot school, or the conduct of flight instruction, is not an objective in itself, but is only the best means we have devised to date for assisting student pilots to learn the skills they desire.

A flight instructor must from the start be clear on the objectives he hopes to achieve. Once a prospective flight instructor establishes his primary objective, he must develop a thorough understanding of how learning occurs, and how to organize his teaching methods and activities to best foster learning by his students. From his own point of view the instructor does not teach, his student learns.

The instructor must take specific steps if he is to effectively foster learning by his students. He must (1) devise a plan of action, (2) create a positive instructor-student relationship, (3) present information and guidance effectively, (4) transfer responsibility to the student as he learns, (5) evaluate the student's learning and thereby his own teaching effectiveness, and (6) combine these into his total performance as an instructor.

While these distinct factors involved in his instruction are not apparent to the student as he learns, if the instructor disregards any one of them, it results in a difficult or inefficient learning experience for the student. Their proper application can result in a learning experience which is effective, is satisfying to the student, and imposes only minimal problems for the instructor.

Helping the student learn does not mean that the instructor has the responsibility for performing learning tasks which the student can do for himself. This is not effective instruction. The best instructor provides only the information, guidance, and opportunity for the student to learn, and supports his motivation while he is in a learning situation. Beyond this, learning is up to the student.

B. Instruction of Student Pilots

The basic and most important function of the flight instructor is to provide the instruction needed by the novice student pilot who desires to learn to fly. As with a novice in any other field of learning, the flight instructor's responsibilities to the student pilot are of vital importance to the student's future performance and safety as a pilot. Adequacy in the instructor's fulfillment of the following responsibilities is essential to competent performance as a flight instructor.

1. Providing Adequate Instruction.—Flight instruction must be appropriate to the individual student and the circumstances under which it is given. It must be well-planned, accurate, and effectively presented.

Instruction which may be appropriate for one student, or a given set of circumstances, may be completely unsuitable and ineffective for another. The student, being a novice, is not prepared to ask for the information and guidance he needs; he cannot always understand how the learning tasks to which he is directed, apply to his overall objective. It is the responsibility of the instructor to see that each period of instruction provides another "block" of learning in its proper position in the larger "structure" of learning which the student has set out to build.

2. Demanding an Adequate Standard of Performance.—The flight instructor must continuously evaluate his own effectiveness,

and the standard of learning and performance achieved by his student. The desire to maintain pleasant personal relationships with his student must not cause the acceptance of a slow rate of learning or a low level of flight performance. It is a fallacy to believe that accepting lower standards to please a student will effect a genuine improvement in the instructor-student relationship. Reasonable standards strictly enforced are never resented by an earnest student.

A flight instructor is actually failing to provide some of the instruction his student is paying for when he permits him to get by with a substandard performance, or without learning thoroughly some item of knowledge pertinent to safe piloting. More important, such deficiencies may in themselves allow hazardous inadequacies in the student's later performance as a pilot. They may cause instruction in more complex operations introduced later in his training to be inexplicable to him.

3. Student Pilot Supervision and Surveillance.—The flight instructor has the moral obligation to provide guidance and restraint in respect to the solo operations of his students, whether or not they are operating under his actual instruction. This applies to his observation of unsafe or inept operations by pilots who are not aware that he is observing them, as well as when they have requested his evaluation and guidance.

In the case of observed unsatisfactory performance, it is the instructor's responsibility to try to correct it by the most reasonable and effective means. If he is unable to correct the situation by personal contacts and good advice, the situation which has caused the observed deficiencies should be reported to someone in a position to take corrective action.

Valid, conscientious instruction is effected only when it is successful in influencing the behavior of the student.

4. Student Pilot Certificate Endorsements.—The authority and responsibility to endorse student pilot certificates for solo and solo cross-country flight privileges is a most important flight instructor prerogative. Although a flight instructor may tend to convey such endorsements on the basis of the specific circumstances surrounding the student's first solo flight, or one proposed cross-country flight, he should consider that he is in effect issuing a license for future operations by the student without instructor supervision.

For this reason, the flight instructor must consider carefully the qualifications of the student whose certificate he proposes to endorse, not only in terms of the flight immediately proposed, but also as they will enable him to continue solo operations safely, even without further instruction or supervision.

The Federal Aviation Regulations prescribe the minimum qualifications for student pilot certificate endorsements by flight instructors. The instructor proposing such an endorsement must determine not only that the student meets these requirements, but also that he is competent to make future solo flights within the scope of the regulations. Failure to make this determination is a deficiency in performance for which a flight instructor may be held accountable under the regulations.

Providing a solo endorsement for a student pilot who is not fully prepared to accept the responsibility for solo flight operations is also a breach of faith with the student concerned. The student can, and reasonably should, assume that the flight instructor has found him qualified in every way for normal student pilot solo operations. His deficiencies are often unknown to the student, or are, at least, disregarded.

Upon endorsing a student pilot's certificate for solo privileges, the instructor should make it clear that the solo or solo cross-country qualification is only a step on the road to qualification as a private pilot. The necessity for further dual instruction and aeronautical study should be impressed on him.

As a word of caution, it is observed that student pilots seek to "learn" to fly from pilots who are not qualified instructors, and then try to obtain student pilot certificate endorsements from certificated flight instructors who have not participated in their training. Such a procedure may not be

illegal, but it in no way relieves the flight instructor who makes the endorsement from the dual instruction and determinations prescribed by the regulations. It is his duty and responsibility to certify to the competency of the student. To support any reluctance he may have to certify to the qualifications of a student he has not trained, the flight instructor may call attention to the fact that only (1) flight instruction given by a certificated instructor and (2) *bona fide* solo flight time may be credited toward the flight time required for a private pilot certificate.

C. Flight-Test Recommendations

Provision is made on all private and commercial pilot certificate application forms for the written recommendation of the flight instructor who has prepared the applicant for the flight test involved. The signing of this recommendation imposes a serious responsibility on the flight instructor.

A flight instructor who is asked to execute a flight-test recommendation for a pilot certificate applicant owes it to the applicant and to himself to require a thorough demonstration of his qualifications for the flight test sought. This demonstration should in no instance be less than the complete test procedure prescribed in the pertinent FAA *Flight Test Guide.*

A flight test recommendation based on anything less risks the presentation of an applicant who may be totally unprepared for some feature of the official flight test. In such an event, the flight instructor is logically held accountable for a deficient instructional performance. This risk is especially great in signing recommendations for applicants who have not been trained by the instructor involved.

Present Federal Aviation Regulations require a minimum of 3 hours of dual flight test preparation for a private pilot certificate and 10 hours of such instruction for a commercial. A flight-test recommendation by an instructor who has not given the applicant at least this amount of instruction is not recommended.

FAA inspectors and designated pilot examiners rely on flight instructor recommendations as evidence of qualification for certification, and assurance that the applicant has had a thorough briefing on flight test standards and procedures. Any obvious gaps in the applicant's qualifications or preparation which are apparent when he appears for the test, or which are revealed by the test, are indications that the flight instructor who signed the recommendation has not properly examined and evaluated his qualifications.

Each flight student should be impressed with the fact that a flight instructor's recommendation for his flight test is both good insurance and a sound investment. It is very unusual for a competently prepared applicant to fail a flight test. Failure by an incompletely prepared applicant usually results in the need for a greater amount of dual instruction than would have been required for adequate preparation for the original test.

D. Aircraft Checkouts

Flight instructors are often called upon to check out certificated pilots in airplanes with which they are not familiar. In the case of student pilots, such checkouts and certificate endorsements are required for each type (make and model) of aircraft.

With the increase in popularity of high-performance personal airplanes with distinct flight characteristics and complex systems and equipment, competent checkouts are essential for their safe, efficient operation. Checkouts which consist of a demonstration of the ability to take off and land the airplane concerned are no longer adequate.

FAA Advisory Circular 61–9, *Pilot Transition Courses for Complex Single-Engine and Light Twin-Engine Airplanes,* and the *Airplane Checkout Guide* (pending) provide useful guidance for an instructor called upon to check out a pilot in an unfamiliar type of airplane. All such checkouts should, of course, be conducted to the performance standards required by the appropriate FAA *Flight Test Guide* for the grade of certificate held by the pilot involved.

For the conduct of a pilot checkout, it is essential that the flight instructor be fully qualified in the airplane to be used. He must be thoroughly familiar with its operating

procedures, approved flight manual, and operating limitations. No flight instructor should attempt to check out a pilot unless he, himself, meets the recent experience prescribed by the Regulations for the carriage of passengers in the airplane concerned.

The flight instructor who checks out a pilot in an aircraft for which a type rating is not required by the regulations is accepting a major responsibility for the safety of future passengers when he certifies the competency of the pilot. Many of these newer small airplanes are comparable in performance and complexity to transport airplanes. For these, the flight instructor's checkout should be at least as thorough as an official-type rating flight test.

For the benefit of the pilot concerned, and for the instructor's protection in the case of later question, the flight instructor should record in the pilot's logbook the exact extent of any checkout conducted. This can be done most easily by reference to the appropriate FAA *Flight Test Guide* or the *Airplane Checkout Guide.*

In the event the instructor finds a pilot's performance in the airplane used sufficiently deficient to constitute a hazard to himself and others, he should attempt by every available means to influence the pilot to obtain further instruction before continuing his operation of the aircraft concerned. If he is unsuccessful in this, and considers a real hazard to exist, it is his responsibility to bring the situation to the attention of the appropriate FAA district office.

E. Refresher Training

The conduct of refresher training for certificated pilots is not only a responsibility of the flight instructor, but it can also be a profitable opportunity for him. Enterprising instructors have built up a very profitable demand for such refresher training by offering dual-flight checks free if they cannot show the pilot some refinements to his technique and operations for which he would be willing to pay to learn. Aviation insurance companies have expressed a willingness to make rate concessions for pilots who voluntarily take regular pilot checks and refresher training.

Effective pilot refresher training must be based on specific objectives and standards if it is to be effective. The objectives should include a thorough checkout appropriate to the grade of certificate and aircraft ratings held, and the standards should be at least those required for the issuance of that grade of certificate. Before beginning any training, the pilot and the instructor should agree fully on these objectives and standards, and, as training progresses, the pilot should be made constantly aware of his progress toward their achievement.

FAA Advisory Circular No. 61–10, *Refresher Courses for Private and Commercial Pilots,* contains recommended procedures and standards for general pilot refresher courses.

F. The Flight Instructor Image

The competent and effective flight instructor must be a professional, both in terms of his ability and of his public image. The first section of chapter II of this handbook discusses professionalism in flight instruction. Flight instruction is a complex and exacting occupation, one which demands the services of a professional if it is to be properly conducted.

Flight instructors have been too often willing to accept an inferior status in the public view by relaxing in their own demeanor, appearance, and approach to their profession. A flight instructor who gives the impression that his interest in flight instruction is secondary to his interest in other activities cannot retain the reputation of a professional. This does not mean that the part-time instructor cannot be a professional. During the time he devotes to flight instruction, however, he must constantly strive to be the best instructor in the business.

Once he cancels an appointment for a period of flight instruction for the sole purpose of making a charter flight, or making a business contact, he immediately loses the confidence and regard of the student involved. For the earnest student each period of flight instruction is the most important thing he could possibly be doing at that time; so must it be with the professional flight instructor.

If the role of the flight instructor in the aviation industry is to be upgraded, it must be done by the efforts of the flight instructors themselves. The professional flight instructor commands the respect of those with whom he associates; asks and deserves better wages; and, most important, delivers better and more effective flight instruction. Following is a discussion of several simple, basic factors in performance as a flight instructor, or in any other occupation, which must be considered by everyone who seeks to be a professional in his field of endeavor.

1. Sincerity.—The professional flight instructor must be what he seems to be. Pretending to be happy when one is unhappy or worried, or attempting to hide some inadequacy with a smoke screen of unrelated instruction will make it impossible for the instructor to command the interested attention of a student.

Teaching a student pilot is predicated upon his acceptance of the flight instructor as a competent, qualified teacher and as an expert pilot. Any facade of instructor pretentiousness, whether it be real or mistakenly assumed by the student, will immediately cause a loss of confidence by the student in his instructor, and little learning will be accomplished.

The effectiveness of instructor emphasis on the precepts of safety is completely lost if the instructor appears to disregard them during his own flight operations; the same applies to his insistence on precision and accuracy in the handling of an airplane. The professional flight instructor must be honest in every way.

2. Acceptance of the Student.—The professional flight instructor must accept the student just as he is, with all of his faults and all of his problems; the instructor will work ceaselessly to correct and solve them. The student is a person who wants to learn to fly, and the instructor is a person who makes himself available to help him learn. Beginning with this understanding the professional relationship of the instructor with his student must be based on a mutual acknowledgement that both the student and the teacher are important to each other, and that both are working for the same objective.

Under no circumstances can the professional instructor do anything which implies that he is degrading the student. Acceptance rather than ridicule, and support rather than reproof will encourage learning, regardless of whether the student is quick to learn or is slow and apprehensive. "Bawling out" a student pilot who does not learn rapidly is not unlike having a doctor reprimand a patient who does not get well as rapidly as was hoped. In either case, the professional image of the offender has been impaired for the student or the patient who has been berated.

3. Personal Appearance and Habits.—Personal appearance has an important effect on the professional image of the instructor. Today's aviation customers are people who expect their grocer, garageman, and business associates to be neat, appropriately dressed, and clean. They do not buy their wife's driving lessons from a driving instructor who is dressed for washing and greasing a car, nor do they do business with a broker who is dressed for a weekend at a fishing camp.

It is not intended to imply that the flight instructor should assume formal attire which is foreign to his situation and the area in which he operates. When the instructor engages in a learning situation with professional people, however, he should be attired as the professional man he is. Effective learning cannot flourish in an atmosphere of dirty dungarees and faded sport shirts.

Personal habits have a significant effect on the professional image. The exercise of common courtesy is perhaps the most important of these. A flight instructor who is rude, thoughtless, and inattentive cannot hold the respect of his students, regardless of his personal piloting ability.

Cleanliness of body and of breath is important to flight instruction. The airplane cabin is a close, tightly-sealed area, where

an instructor and his student must work in close proximity, and where even little annoyances provide serious distractions from the learning tasks at hand. Smoking by the instructor may, for example, be most unpleasant and distracting for his non-smoking student.

The use of alcohol in public, especially around an airport, has a serious impact on the flight instructor's image. Although it is obvious that he does not drink while he is flying, even people who regularly enjoy their own libations tend to remember that a certain flight instructor had a beer in his hand when they talked with him. The smell of alcohol on an instructor's breath during a period of flight instruction is inexcusable.

4. Strong Language.—In flight instruction, as in other professional activities, the use of profanity and obscene language leads to distrust, or at best a lack of complete confidence. To many people, such language is actually objectionable to the point of being painful.

The professional flight instructor must speak normally and without inhibitions, but he must not allow himself to develop the inability to speak positively and descriptively without excesses of language which can divert the student's ability to receive the instruction intended.

5. Demeanor.—The attitude and movements of the flight instructor can contribute much to establishing his professional image. He should avoid erratic movements and speech, and should avoid capricious changes in mood. The professional image requires development of a calm, thoughtful, and disciplined, but not somber, demeanor.

The instructor must avoid any tendency to frequently countermand his directions to students, to react differently to similar or identical errors at different times, to demand unreasonable performances or progress by the student, or to berate a student unfairly.

A forbidding or imperious demeanor is as much to be avoided as is an air of flippancy. Effective instruction is best fostered by a calm, pleasant, thoughtful demeanor which puts the student at ease, and maintains the instructor's personal image of competence and genuine interest in the student's learning tasks.

G. Self-Improvement

The professional flight instructor must never let himself become complacent or satisfied with his own qualifications and ability. He should be constantly active and alert for ways in which he can improve his qualifications, effectiveness, and the services he provides to his students.

The flight instructor is considered an authority on aeronautical matters, and is the expert to whom many pilots refer questions concerning regulations, requirements, and new operating techniques. He has opportunity and a responsibility to introduce new procedures and techniques through his students, and through other certificated pilots with whom he comes in contact.

There are many means of self-improvement for flight instructors. Properly organized pilot safety symposiums and flight training clinics are valuable sources of refresher training and of opportunities to exchange information with instructors from other areas. Aviation periodicals, government publications, and technical issuances from the aviation industry are sources of valuable information for flight instructors.

For a professional performance as a flight instructor, it is essential that the instructor maintain a current copy of the Federal Aviation Regulations which is pertinent to pilot qualification and certification, current FAA *Flight Test Guides*, and pilot training manuals. A flight instructor who is not completely familiar with current pilot certification and rating requirements cannot do a competent job of flight instruction.

Answers to inquiries, advice, information, and flight instructor check rides are available upon request from Federal Aviation Agency General Aviation District Offices. Inspectors assigned to these district offices are vitally interested in the quality of training which is provided within their districts, and will cooperate in every way with efforts to provide authoritative, competent, and more effective flight instruction.

VIII. FLIGHT TRAINING MANEUVERS AND PROCEDURES

A. *Operational Maneuvers*
   1. Straight and level flight
   2. Normal takeoffs and landings

B. *Coordination Exercises*
   1. Medium turns
   2. Shallow turns
   3. Steep turns
   4. Dutch rolls
   5. Lazy eights
   6. Pylon eights

C. *Planning Maneuvers*
   1. 180° and 360° medium turns
   2. Turns to headings
   3. Climbs and descents to specified altitudes
   4. 720° steep turns
   5. Gliding spirals

D. *Ground Reference Maneuvers*
   1. Following a road or stream
   2. S turns across a road
   3. Turns about a point
   4. Eights around pylons
   5. Rectangular courses
   6. 180° precision landing approaches

E. *Airspeed Control Maneuvers*
   1. Climbs
   2. Descents, with and without power
   3. Slow flight
   4. Airspeed changes in level flight

F. *Maximum Performance Maneuvers*
   1. Maximum rate-of-climb
   2. Maximum angle-of-climb
   3. Short-field takeoffs and landings
   4. Soft-field takeoffs and landings
   5. Chandelles

G. *Emergency or Special Flight Maneuvers*
   1. Stall recognition and recovery
   2. Simulated forced landings
   3. Slips
   4. Crosswind takeoffs and landings
   5. Full stall landings

6. Wheel landings (Tailwheel-type airplanes)
7. Landing on a spot

H. *Flight Operations*

1. Use of radio for communications
2. Cross-country flight planning
3. Pilotage
4. Dead reckoning
5. Use of radio aids for VFR navigation
6. Enroute emergencies

VIII. FLIGHT TRAINING MANEUVERS AND PROCEDURES

The analyses of common pilot training and flight-test maneuvers and procedures, which follow, have been prepared to assist flight instructors in preparing pilot training courses and lesson plans, and for use as a reference in the conduct of pilot instruction.

Each maneuver or procedure is covered in terms of (1) the purpose for which it is used in pilot training and flight testing; (2) the elements which are involved in its performance; (3) the other maneuvers or procedures with which it is associated, either as a prerequisite or as a logical progression; and (4) the common significant errors in performance which should be detected by the flight instructor.

The flight instructor should refer to the FAA *Flight Training Manual* or the appropriate *Flight Test Guide* for information on the correct or preferred performance of these flight maneuvers and procedures.

The flight maneuvers and procedures which are covered in this chapter have been arranged in accordance with the primary purpose for which they are introduced in pilot training. Although a maneuver may be shown under one classification, it may also be useful and important for instruction in one or more other areas of pilot performance. For example, *S Turns Across a Road* are listed as "ground reference maneuvers," but they are also valuable for the development of planning and as an exercise in coordination.

A. Operational Maneuvers

"Operational Maneuvers" are basic maneuvers which are necessary to each normal flight. They are included in the training syllabus because their performance is necessary for the instruction and performance of all other flight maneuvers and procedures. Technically they are not training maneuvers because they are objectives in themselves.

1. Straight and Level Flight

Purpose

Straight and level flight is the most effective way to direct an airplane from one point to another. It is the starting and finishing maneuver of all normal flight.

Elements

a. Coordinated use of flight controls
b. Use of visual and instrument heading and attitude references
c. Maintenance of altitude
d. Use of trim and power settings

Associated maneuvers

Straight and level flight is basic to all flight maneuvers.

Common errors

a. Failure to maintain attitude, heading, or altitude
b. Improper control coordination
c. Failure to use available references

2. Normal Takeoffs and Landings

Purpose

A normal takeoff and a landing are the beginning and ending of each routine flight.

Elements

a. Airspeed control
b. Control of heading, ground and flight
c. Planning
d. Coordination

Associated maneuvers

a. Flight at minimum controllable airspeed
b. Stalls
c. Rectangular courses
d. Climbs and descents

Common errors

a. Deficient airspeed control
b. Poor planning
c. Failure to control heading on the ground
d. Failure to direct vision properly

B. Coordination Exercises

Coordination exercises are flight maneuvers which are used in pilot training. They are used primarily to develop habitually correct coordination of flight control usage. Turns, introduced originally as coordination exercises, are actually operational in nature, as they are an integral part of most flight maneuvers.

1. Medium Turns

Purpose

Medium turns, because of their relative simplicity, are the starting point for instruction in maneuvering an airplane. As training exercises, they provide excellent practice in the basic coordination of forces applied to the various flight controls.

Elements

a. Control of bank attitude by visual and instrument references
b. Coordination of forces on flight controls
c. Maintenance of constant altitude

Associated maneuvers

a. Control familiarization
b. Straight and level flight
c. All subsequent maneuvers which involve changes in heading

Common errors

a. Poor coordination of control forces
b. Poor timing
c. Faulty attitude control
d. Failure to maintain altitude and airspeed

2. Shallow Turns

Purpose

Shallow turns are used as advanced coordination exercises. Precise shallow turns are difficult because of the inherent stability of most modern airplanes.

Elements

a. Control of banked attitude
b. Coordination of forces on flight controls
c. Maintenance of a constant altitude

Associated maneuvers

a. Straight and level flight
b. Medium turns
c. Lazy eights

Common errors

a. Slipping or skidding
b. Variations in bank angle
c. Failure to maintain constant altitude and airspeed

3. Steep Turns

Purpose

Steep turns are advanced coordination maneuvers which require precise coordination, good timing, and careful airspeed control. The higher control forces involved, the overbanking tendency of most airplanes, and the fact that most small airplanes are operating near their performance limit combine to make any inept control usage, or errors in technique, immediately apparent.

Elements

a. Coordination, with emphasis on rudder usage
b. Control of banked attitude
c. Maintenance of altitude and airspeed
d. Orientation

Associated maneuvers

a. Medium turns
b. Lazy eights
c. Accelerated stalls
d. Chandelles

Common errors

a. Insufficient control usage
b. Poor coordination
c. Poor timing on entries and recoveries
d. Failure to maintain altitude and airspeed
e. Dissimilar right and left turns, especially in airplanes with side-by-side seating
f. Poor pilot posture—tendency to lean against bank

4. Dutch Rolls

Purpose

The practice of dutch rolls is a coordination exercise in that it requires the conscious application of forces on all the flight controls. Dutch rolls may be very elementary with shallow banks, or be developed by introducing a controlled amount of turn even as far as lazy eights.

Elements

a. Coordinated control application
b. Timing
c. Control of airspeed, altitude, and heading

Associated maneuvers

a. Turns
b. Control function and usage
c. Lazy eights

Common errors

a. Faulty coordination
b. Insufficient control usage
c. Poor timing
d. Failure to maintain altitude and heading

5. Lazy Eights

Purpose

The lazy eight is an advanced coordination maneuver which involves constantly changing control forces, aircraft attitude, airspeed, and heading. It is valuable for evaluating a pilot's control usage, and his planing and timing. The lazy eight is not appropriate for beginners.

Elements

a. Coordination
b. Timing
c. Planning
d. Airspeed and altitude control

Associated maneuvers

a. Dutch rolls
b. Chandelles
c. Turns

Common errors

a. Faulty coordination
b. Poor timing
c. Unsymmetrical pattern
d. Failure to maintain altitude
e. Insufficient control application at slow speeds

6. Pylon Eights

Purpose

Pylon eights are used to develop and evaluate the pilot's coordination when his attention is demanded by precise maneuvering. The maneuver consists of maintaining the apparent position of points on the ground in the desired relation to the lateral axis of the airplane; the objective is the technique used to accomplish this.

Elements

a. Coordination
b. Planning
c. Altitude control

Associated maneuvers

a. Turns
b. Lazy eights
c. Ground reference maneuvers

Common errors

a. Faulty coordination
b. Failure to establish and maintain pivotal altitude

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c. Poor planning
d. Poor selection of pylons
e. Attempt to hold pylons aft or forward of lateral axis

C. Planning Maneuvers

Planning maneuvers are used in flight training to teach the student to maneuver an airplane to specified headings and altitudes. They are his first practical application of the turns, climbs, and descents he has learned in his first lessons. They are preliminaries to instruction in maneuvering by reference to ground objects and compensating for the effects of the wind.

1. 180° and 360° Medium Turns

Purpose

Precision turns are the student's first application of the medium turns he has learned. The recovery points used are established by major ground references, such as mountain ridges or rivers, and by reference to the directional gyro.

Elements

a. Orientation
b. Anticipation of recovery headings
c. Coordination
d. Maintenance of altitude

Associated maneuvers

a. Turns
b. Turns to headings
c. Ground reference maneuvers

Common errors

a. Poor planning
b. Disorientation
c. Poor timing
d. Poor coordination
e. Failure to maintain altitude

2. Turns to Headings

Purpose

Turns to headings prepare the student pilot for establishing flight on any desired course. Heading references to be used are of both major terrain features and of headings indicated by the compass or directional gyro.

Elements

a. Orientation
b. Coordination
c. Maintenance of altitude

Associated maneuvers

a. 180° and 360° medium turns
b. Ground reference maneuvers
c. Use of instrument references

Common errors

a. Disorientation
b. Poor timing of recovery actions
c. Poor coordination
d. Failure to maintain altitude

3. Climbs and Descents to Specified Altitudes

Purpose

This prepares the student to attain efficiently and accurately the desired altitudes for cruising, traffic pattern entry, or for other special operations.

Elements

a. Planning
b. Airspeed control
c. Timing of level-off
d. Coordination

Associated maneuvers

a. Climbs and descents
b. Slow flight
c. Straight and level flight
d. Takeoffs and landings

Common errors

a. Failure to anticipate recovery from climb or descent
b. Poor airspeed control
c. Poor power control
d. Failure to hold headings

4. 720° Steep Turns

Purpose

Proficiency in 720° steep turns requires accurate orientation and precise

planning in a flight situation which is very demanding of the attention of a student pilot.

Elements

a. Orientation and planning
b. Coordination
c. Airspeed and altitude control

Associated maneuvers

a. Steep turns
b. 180° and 360° medium turns
c. Chandelles
d. Lazy eights
e. Accelerated stalls

Common errors

a. Faulty coordination
b. Disorientation
c. Poor timing of recoveries
d. Failure to maintain constant altitude and airspeed
e. Dissimilar right and left turns

5. Gliding Spirals

Purpose

Gliding spirals require advanced planing by including considerations of heading, airspeed control, rate of descent, and recovery on assigned headings and altitudes. This maneuver has a practical application to high altitude forced landings.

Elements

a. Orientation and planning
b. Airspeed control
c. Coordination
d. Timing

Associated maneuvers

a. Descents without power
b. Medium turns to headings
c. Descents to specified altitudes
d. Simulated forced landings

Common errors

a. Faulty planning
b. Varying angles of bank
c. Poor airspeed control
d. Poor coordination
e. Disorientation
f. Poor timing on recovery

D. Ground Reference Maneuvers

These are training maneuvers used to teach students to maneuver an airplane over a track established by reference to points and lines on the ground. Proficiency in ground reference maneuvers is important to a competent observance of airport traffic patterns and the execution of landing approaches.

1. Following a Road or Stream

Purpose

This is the student's first introduction to maneuvering an airplane by reference to the ground. Following a crooked road or meandering stream provides practice in right and left turns without exceeding the student's capability.

Elements

a. Straight flight and turns
b. Planning
c. Altitude and airspeed control
d. Coordination
e. Countering effect of wind

Associated maneuvers

a. Straight and level flight
b. Turns
c. All other ground reference maneuvers

Common errors

a. Poor coordination
b. Failure to maintain constant altitude
c. Disorientation
d. Faulty choice of bank angle

2. S Turns Across a Road

Purpose

S turns across a road, or across some other straight line on the ground, introduces planning as well as maneuvering by ground references, and for correction of wind effect from various angles.

Elements

a. Maneuvering by ground references
b. Planning
c. Compensation for wind effect
d. Coordination
e. Altitude control

Associated maneuvers

a. Medium turns to headings
b. Other ground reference maneuvers

Common errors

a. Disorientation
b. Poor planning
c. Faulty coordination
d. Failure to maintain altitude and airspeed
e. Inadequate compensation for wind effect

3. Turns About a Point

Purpose

Turns about a point are used to train the student in maneuvering around a point on the ground while compensating for the effect of wind from all angles.

Elements

a. Planning
b. Varying bank to control the radius of a turn
c. Coordination
d. Control of airspeed and altitude

Associated maneuvers

a. Turns
b. 720° steep turns
c. All other ground-reference maneuvers

Common errors

a. Failure to maintain a constant radius
b. Poor altitude control
c. Poor coordination

4. Eights Around Pylons

Purpose

The performance of eights around pylons adds increased complexity and more advanced planning to the performance of turns about a point.

Elements

a. Planning
b. Varying bank to control radius of turns
c. Coordination
d. Altitude and airspeed control

Associated maneuvers

a. Turns about a point
b. Turns
c. Turns to headings
d. Pylon eights
e. All other ground-reference maneuvers

Common errors

a. Failure to maintain a constant radius
b. Poor planning
c. Poor altitude control
d. Poor coordination

5. Rectangular Courses

Purpose

The rectangular course is introduced in preparation for flying a proper airport traffic pattern during takeoff and landing instruction. It combines compensation for wind drift from various angles during straight flight and turns, in preparation for actual landing approaches.

Elements

a. Planning
b. Compensating for wind effect
c. Coordination
d. Airspeed and altitude control

Associated maneuvers

a. Straight and level flight
b. Turns to headings
c. Airport traffic patterns
d. Approaches and departures
e. All other ground-reference maneuvers

Common errors

a. Failure to maintain desired track
b. Failure to stop turns on necessary headings

c. Poor altitude control
d. Poor coordination
e. Disorientation

6. 180° Precision Landing Approaches

Purpose

180° precision approaches have a practical application to forced landings, and are also used in flight training to develop planning, airspeed control, and the ability to make consistent accuracy landings without power.

Elements

a. Planning
b. Airspeed control
c. Coordination
d. Correction for wind effect

Associated maneuvers

a. Simulated forced landings
b. Descents without power
c. Slow flight
d. Landings
e. All other ground reference maneuvers

Common errors

a. Failure to maintain desired track
b. Poor airspeed control
c. Poor coordination
d. Faulty judgment of altitude and distance
e. Ineffective compensation for wind effect

E. Airspeed Control Maneuvers

The airspeed control maneuvers are flight maneuvers which are used in flight training to teach the ability to achieve and maintain the proper airspeed for various flight operations. Although several of them have direct practical operation, as training maneuvers they all are based on the accurate control of airspeed.

1. Climbs

Purpose

Climbs are used to fly to a desired altitude above the ground for various flight operations. As a training maneuver, the practice of climbs is an exercise in the establishment and maintenance of an appropriate airspeed.

Elements

a. Airspeed control
b. Power control
c. Maintenance and control of headings
d. Planning
e. Coordination

Associated maneuvers

a. Slow flight
b. Straight and level flight
c. Medium turns
d. Turns to headings
e. Maximum performance maneuvers

Common errors

a. Failure to maintain appropriate airspeed
b. Failure to control headings accurately
c. Inadequate planning
d. Poor coordination

2. Descents, With and Without Power

Purpose

Descents have a practical application to flight maneuvers and landings. As training maneuvers, descents without power are used to teach airspeed control, timing of leveloff, and coordination. Descents with power also teach planning and power control.

Elements

a. Airspeed control
b. Planning
c. Power control
d. Coordination

Associated maneuvers

a. Slow flight
b. Climbs
c. Straight and level flight
d. Turns
e. Gliding spirals
f. Landing approaches

Common errors

a. Failure to maintain appropriate airspeed
b. Poor planning
c. Failure to maintain desired headings
d. Poor coordination
e. Inaccurate power control

3. Slow Flight

Purpose

The use of slow flight as a training maneuver may include the maintenance of any airspeed slower than cruising speed, including climb speeds, descent speeds, traffic pattern and approach speeds, and minimum controllable speeds. The accurate management of airspeed is essential to safety and to efficient airplane performance.

Elements

a. Determination of appropriate speeds
b. Maintenance of desired speeds
c. Evaluation of control responsiveness
d. Stall recognition
e. Control of heading, attitude, and altitude
f. Coordination

Associated maneuvers

a. Takeoffs and landings
b. Climbs and descents
c. Stall recognition and recovery
d. Maximum performance operations

Common errors

a. Failure to maintain proper airspeed
b. Inadequate heading and altitude control
c. Inadvertent stalls
d. Poor coordination
e. Inadequate power control

4. Airspeed Changes in Level Flight

Purpose

This is an exercise in airspeed control which prepares the student to attain any specified airspeed without loss of heading or altitude.

Elements

a. Maintenance of heading and laterally level attitude
b. Attainment and maintenance of specified airspeed
c. Coordination of power and angle of attack
d. Recognition of effects of airspeed and power on control responses

Associated maneuvers

a. Straight and level flight
b. Slow flight
c. Takeoffs and landings
d. Airport traffic patterns

Common errors

a. Failure to maintain altitude or heading
b. Undershooting or overshooting assigned speed
c. Poor power coordination
d. Poor coordination of flight controls

F. Maximum Performance Maneuvers

The maximum performance maneuvers are primarily operational in nature, but they are used effectively in pilot training to prepare the student for obtaining the best performance from any airplane he flies. A full understanding of the principles involved in the performance of these maneuvers in any airplane will enable the student to apply them effectively in the operation of other airplane types.

1. Maximum Rate-of-Climb

Purpose

To teach the student the significance and use of the maximum rate-of-climb airspeed.

Elements

a. Airspeed control
b. Maintenance of heading
c. Use of trim
d. Coordination

Associated maneuvers

a. Climbs
b. Slow flight
c. Takeoffs

Common errors

a. Failure to maintain required airspeed
b. Poor use of trim
c. Failure to control heading
d. Poor coordination, usually holding one wing low

2. Maximum Angle-of-Climb

Purpose

To teach the student the significance and effective use of the maximum angle-of-climb airspeed.

Elements

a. Airspeed control
b. Maintenance of heading
c. Use of trim
d. Coordination

Associated maneuvers

a. Climbs
b. Slow flight
c. Takeoffs
d. Emergency go-arounds

Common errors

a. Failure to maintain required airspeed
b. Poor use of trim
c. Failure to control heading
d. Poor coordination, usually with a wing low

3. Short-Field Takeoffs and Landings

Purpose

To teach the student the most effective technique for takeoff from a short field, with a firm surface, which is surrounded by obstructions, and for landing in such a field.

Elements

a. Airspeed control
b. Maintenance of heading
c. Flap usage
d. Power management
e. Use of trim

Associated maneuvers

a. Slow flight
b. Takeoffs and landings
c. Power approaches
d. Maximum angle-of-climb airspeed

Common errors

a. Poor planning
b. Poor airspeed control
c. Failure to control heading
d. Poor power control

4. Soft-Field Takeoffs and Landings

Purpose

To teach the student the most effective technique for takeoff from a rough, soft, or snow-covered surface, and for landing on such a surface.

Elements

a. Airspeed control
b. Planning
c. Flap usage
d. Maintenance of heading
e. Power management

Associated maneuvers

a. Slow flight
b. Takeoffs and landings
c. Power approaches
d. Full-stall landings

Common errors

a. Poor planning
b. Poor airspeed control
c. Failure to maintain heading
d. Poor power management
e. Poor coordination

5. Chandelles

Purpose

The chandelle is an advanced training maneuver which incorporates the elements of speed control, orientation, planning, and coordination to a high degree. It is listed as a maxi-

mum performance maneuver because its performance involves the conversion of airspeed to the maximum possible gain in altitude during a 180° turn.

Elements

a. Airspeed control
b. Timing
c. Coordination
d. Orientation
e. Heading control
f. Altitude gain

Associated maneuvers

a. Steep turns
b. Turns to headings
c. Stall recognition and recovery
e. Climbs
f. Lazy eights

Common errors

a. Poor timing
b. Poor coordination
c. Poor airspeed control
d. Inadvertent stalls
e. Failure to recover on desired heading
f. Inadequate altitude gain

G. Emergency or Special Flight Maneuvers

Emergency and special flight maneuvers have direct application to safety, either to piloting as a whole, or under specific circumstances. They are taught and are practiced to prepare the student for avoiding or extricating himself from hazardous situations.

1. Stall Recognition and Recovery

Purpose

Stall recognition and recovery is emphasized in pilot training to teach students to avoid stalls, and to cope with such stalls as do occur. Proper control usage for flight near stalling speed is also essential for normal takeoffs and landings.

Elements

a. Evaluation of control responsiveness at slow speeds
b. Coordination
c. Timing
d. Control of headings

Associated maneuvers

a. Takeoffs and landings
b. Slow flight
c. Steep turns
d. Maximum performance maneuvers

Common errors

a. Inadequate or late stall recognition
b. Poor coordination
c. Poor heading control
d. Poor timing
e. Excessive airspeed and altitude loss on recovery

2. Simulated Forced Landings

Purpose

Simulated forced landings are introduced in flight training to prepare the student for emergency landings in the event of power failures or other emergencies. If the student is not pushed beyond his capabilities, the practice of simulated forced landings is also an excellent confidence builder for an apprehensive student.

Elements

a. Planning
b. Airspeed control
c. Coordination

Associated maneuvers

a. Descents without power
b. Gliding spirals
c. Precision approaches
d. Slips
e. Short- or soft-field landings

Common errors

a. Indecision
b. Poor airspeed control
c. Poor planning
d. Poor coordination
e. Poor choice of field

3. Slips

Purpose

Slips are introduced in pilot training to prepare the student to correct minor

errors in judgment on landing approaches in airplanes without effective flaps, and for use in the performance of crosswind landings.

Elements

a. Coordination (appropriate control application)
b. Airspeed control
c. Heading control

Associated maneuvers

a. Descents without power
b. Crosswind landings
c. Precision approaches
d. Short-field landings
e. Simulated forced landings

Common errors

a. Poor coordination
b. Poor airspeed control
c. Poor heading control
d. Skidding on recovery
e. Poor timing

4. Crosswind Takeoffs and Landings

Purpose

Crosswind landings are taught because most takeoffs and landings are subject to some crosswind. Crosswind landings are the greatest single cause of flight accidents in airplanes.

Elements

a. Coordination
b. Alining heading with track over the ground
c. Airspeed control
d. Use of flaps and brakes

Associated maneuvers

a. Slips
b. Descents, with and without power
c. Takeoffs and landings
d. Slow flight
e. Precision approaches

Common errors

a. Poor timing
b. Failure to compensate for drift
c. Poor airspeed control
d. Poor directional control on the ground roll
e. Poor coordination

5. Full Stall Landings

Purpose

Full stall landings provide the slowest possible landing speed for short or soft field landings. Their instruction is especially appropriate to airplanes with tricycle gears, because full stall landings are routine in tailwheel-type airplanes.

Elements

a. Airspeed control
b. Timing
c. Heading control
d. Stall recognition

Associated maneuvers

a. Slow Flight
b. Stall recognition and recovery
c. Landings
d. Soft-field landings

Common errors

a. Poor airspeed control
b. Poor timing
c. Poor heading control

6. Wheel Landings (Tailwheel-type airplanes)

Purpose

Wheel landings are taught in tailwheel-type airplanes to prepare the student for landings in gusty conditions which make full stall landings inadvisable.

Elements

a. Airspeed control
b. Timing
c. Directional control

Associated maneuvers

a. Normal landings
b. Precision approaches
c. Descents, with and without power
d. Power approaches
e. Slow flight

Common errors

a. Poor airspeed control
b. Faulty timing
c. Inadequate directional control
d. Poor coordination

7. Landing on a Spot

Purpose

Landing on a spot is introduced in pilot training to prepare the student to land an airplane precisely where he desires, using any combination of power, flaps, and slips he chooses.

Elements

a. Airspeed control
b. Stall recognition
c. Power control
d. Use of flaps and slips
e. Timing

Associated maneuvers

a. Short field landings
b. Precision approaches
c. Slow flight
d. Stall recognition and recovery
e. Full stall landings

Common errors

a. Poor airspeed control
b. Violent maneuvering
c. Poor power control
d. Poor timing

H. Flight Operations

The flight operations which follow are included in the pilot training syllabus to prepare a student to use an airplane effectively and safely. While they are not exactly flight maneuvers, they do constitute, more or less, complex operations which the pilot must perform during flight. Ignorance, or an inept performance, of any of them will eventually result in a hazardous flight situation.

1. Use of Radio for Communications

Purpose

The matter-of-course two-way radio communication with control towers, flight service stations, and airport "unicom" stations, is essential to safe, efficient, flight operations in today's air traffic.

Elements

a. Operation and tuning of aircraft receivers and transmitters
b. Use of correct call procedures and phraseologies

Associated maneuvers

All local and cross-country flight operations

Common errors

a. Improper frequency selection
b. Failure to identify aircraft and position
c. Obscure or improper phraseology

2. Cross-Country Flight Planning

Purpose

Adequate preparation is essential to the success and safety of each cross-country flight. Since airplanes today are used primarily for travel, it is important for all pilots to be qualified in all phases of cross-country flight operations.

Elements

a. Obtaining necessary data
b. Providing appropriate equipment
c. Plotting route, intermediate stops, and alternates
d. Preparation of flight log

Associated maneuvers

All operational flight maneuvers

Common errors

a. Failure to procure important information
b. Failure to provide necessary charts, computers, etc.
c. Inadequate or faulty course plotting
d. Impractical flight log

3. Pilotage

Purpose

Pilotage prepares a student to use charts and terrain features for

navigation. It is a basic form of navigation which is used in conjunction with all other forms of VFR navigation, and is used in finding destination airports on all VFR cross-country flights.

Elements

a. Chart interpretation
b. Recognition of terrain features
c. Fixing a course by reference to prominent landmarks

Associated maneuvers

All operational flight maneuvers

Common errors

a. Misinterpretation of chart symbols
b. Disorientation, especially right from left
c. Failure to consider general pattern of landmarks
d. Failure to fix check points on course ahead of flight
e. Poor selection of checkpoints

4. Dead Reckoning

Purpose

Training in the use of dead reckoning prepares the student to navigate with the aid of computations based on compass headings, wind reports, airspeed, and flight time. Such computations are basic to all contact and instrument aerial navigation.

Elements

a. Procurement of necessary data
b. Resolution of necessary correction factors
c. Time, speed, and distance computations
d. Flying a desired heading and altitude

Associated maneuvers

All operational flight maneuvers

Common errors

a. Use of inadequate or faulty data
b. Computation errors
c. Failure to maintain heading or altitude

5. Use of Radio Aids for VFR Navigation

Purpose

The use of radio aids to navigation, both VFR and IFR, is now universal in general aviation. A thorough knowledge of the use of radio aids, in conjunction with pilotage and dead reckoning, is necessary for effective, safe cross-country flying.

Elements

a. Tuning and operating navigational radio receivers
b. Interpretation of radio navigation signals
c. Use of radio signals for tracking
d. Use of radio signals for position fixes

Associated maneuvers

All operational flight maneuvers

Common errors

a. Faulty station identification
b. Misinterpretation of navigational signals
c. Faulty plotting and resolution of fixes

6. En Route Emergencies

Purpose

Training in enroute emergencies is included in the pilot training syllabus to prepare the student to recognize and cope with typical emergency situations encountered on cross-country flights, such as, deteriorating weather, equipment malfunctions, and disorientation.

Elements

a. Recognition of emergency
b. Attempts to correct malfunctions
c. Adoption of alternate procedures

d. Diversion of flight
e. Lost procedures

Associated maneuvers

a. Simulated forced landings
b. Emergency and special flight maneuvers
c. Other operational flight maneuvers

Common errors

a. Failure to analyze situation correctly
b. Precipitous action
c. Overlooking of a most effective alternate action
d. Failure to act in time

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