

SAMPLE PAGES

FROM

Advanced Airmanship

Book 1

Precision Flying

ADVANCED AIRMANSHIP



BOOK 1 PRECISION FLYING

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INTRODUCTION

An airplane has no eyes. It cannot tell if its pilot is a 30,000 hour airline captain or a new commercial pilot with 200 hours. More importantly, it doesn't care. The airplane only knows that it needs specific actions on its controls to accomplish each maneuver perfectly. The pilot's experience level is irrelevant if the required precise control motions are accomplished.

It is readily acknowledged that pilot skill increases with experience, but the central question is what is really learned during this period and could it be analyzed and taught much earlier? The objective of flight technique analysis is to examine, in great detail, each common maneuver used by professional pilots. The laws of aerodynamics dictate the principles to be applied to each case, regardless of the pilot's experience. If a low time pilot thoroughly understands what actions are required, he can probably control the airplane as well as an experienced pilot who does not possess the same level of understanding. Certainly any pilot will reach a higher skill level earlier if he is taught exactly what the laws of physics require rather than waiting to realize them through "osmosis" after many flight hours.

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It may seem that pilot knowledge of precision flying is less important in today's computerized aircraft. In reality, it is more important. In non-automated airplanes, pilot skill is at its highest due to daily practice. Now, most airline pilots hand fly only the takeoff and landing, letting the Flight Management System and Autopilot fly the majority of the flight. When a systems failure requires manual flying skill, the flight crew is dependent on their past abilities, relying on their professional knowledge to compensate for lack of recent practice.

This book attempts to present the laws of airplane handling in sufficient detail so that any pilot can fly better than the hours in his logbook would predict. In other words, we are going to try to substitute **Knowledge for Experience** in the execution of precision flight maneuvers. Realizing that there is no substitute for experience in many flight related activities, our discussions will be limited to the exacting flight control procedures required of professional pilots, specifically those that are dictated by the laws of physics. We will be examining those cases that have "right" or "best" answers rather than those that can have more than one correct answer.

During these discussions, which are designed to stand alone and can be read in any order, you will probably recognize many controversial areas that pilots have been arguing about for decades. Hopefully, at the conclusion of each section, the related controversies will have been laid to rest. Most of these issues are complex, which accounts for their long life. If the effort is made to understand each issue completely, then total understanding removes the former controversies. Not all aviation questions can be answered while you are walking down the hall.

My interest in this field results from questions and

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observations during the 50 years that I have been a pilot. As a Professor of Aeronautical Science at Embry-Riddle Aeronautical University for 30 years, I have seen young, relatively inexperienced but highly technically educated professional pilots perform admirably as airline and military pilots. Time and again it has been demonstrated to me that after basic flying motor skills have been developed, a pilot's total ability depends upon his cognitive knowledge.

NO MATH - ALMOST!

A few pilots that I have known over the years were interested in the mathematical details of pilot technique. However, most wanted “need to know” information only, provided that the answers were correct. Until the advent of personal computers there was little choice. Mathematics provided the only available method to analyze technical problems.

Comparing mathematical methods with computer techniques is similar to flying in IMC versus VMC. Flying in Instrument Meteorological Conditions with basic instrumentation requires that the instruments be read, their individual meanings interpreted and a complete situational picture generated from abstract pieces. In Visual Meteorological Conditions, the complete final picture is instantly apparent. Like IMC, mathematical analysis involves the derivation of equations, generation and plotting of data and trying to interpret the results. This is a time consuming process whose results are not always believed by those without an extensive scientific background. On the other hand, seeing the results generated by a computer model instantly shows the final relationships in the same way that the total situational picture is seen when flying in VMC. In reality, the computer analysis is not any different from conventional mathematical analysis. In computer modeling, all of the difficult to understand concepts are hidden from view and only the final effects are shown. We

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can then see the clear “bottom line” without being distracted by the complex paths leading to the final conclusion.

THE FLIGHT DEMONSTRATION SIMULATOR

Many of the diagrams in the following chapters are screen pictures or tracings of a computer program called the Flight Demonstration Simulator (FDS). This program has the flight characteristics of a popular two engine heavy jet transport stored within it. During a demonstration, various views can be selected, including a Data Plot View and a Flight Deck View. The program flies the stored airplane and plots flight data graphically while displaying normal flight parameters on a “glass cockpit” instrument panel. Programmed commands allow extremely precise and repeatable flight scenarios to be flown. These computer experiments are not subject to pilot skill.

The FDS begins plotting data at preset initial conditions. Beginning with these conditions, all following flight parameters are determined by pitch and bank attitude, power and configuration. Examples of the Data Plot View and Flight Deck View are shown on the next page. Since all computer demonstrations are in full color, they show concepts more clearly than their black and white copies used in this book. Therefore, you will be referred to particular demonstrations at appropriate points in the text of each chapter.

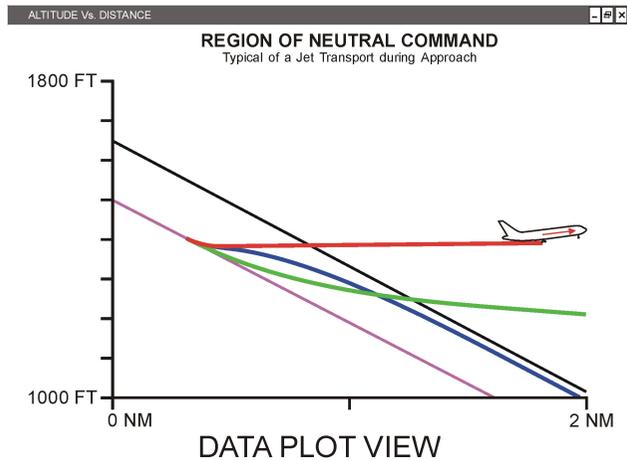
Download information for the Flight Demonstration Simulator and other programs referenced in following sections of this book is shown on page VII.

ORGANIZATION AND SUGGESTED USE

How should you use this book? All chapters are designed

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THE FLIGHT DEMONSTRATION SIMULATOR



FLIGHT DECK VIEW

The Flight Demonstration Simulator allows viewing of the Data Plot View or the Flight Deck View at anytime during a demonstration. Simulation demonstrations are easily accessed from the included CD with a few mouse clicks.

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to be self-contained and can be read in any order. However, knowledge of a few basic aerodynamic facts are required to understand the material in any chapter. Luckily, these areas are usually well understood by most professional pilots.

Explanations are true to the physics and aerodynamics involved, generally without mathematical details.

Some areas in the following chapters may differ from your initial pilot training. An educational principle, the Law of Primacy, states it is more difficult to accept changes to established beliefs than to learn from the beginning. Please keep in mind that most issues in this book are securely based on solid principles of physics that are not subject to opinion. In addition, nothing is contrary to established major airline procedures. Significant portions of the chapters that follow are devoted to understanding why these procedures are used.

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SUPPORT AND CONTACT INFORMATION

The following programs are available on the included CD:

- FLIGHT DEMONSTRATION SIMULATOR BOOK 1
- TURN DATA COMPUTER
- TRACK DATA COMPUTER
- GLIDE SLOPE WIND EFFECT COMPUTER

They can be run directly from the CD or copied to your hard drive. When copying to the hard drive, be sure that *all* the files on the CD are transferred to the same folder.

If assistance is required, please email:
support@cchpublishing.com

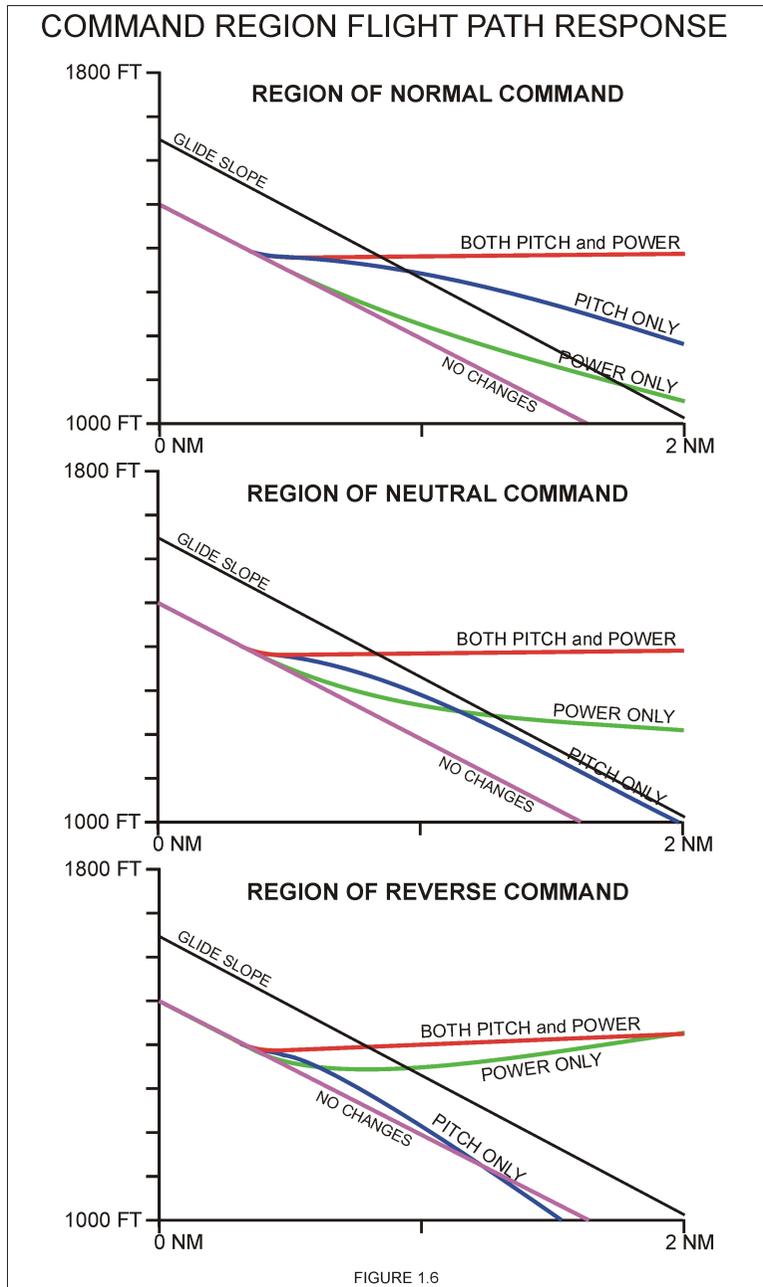
All programs have been tested on Windows XP and earlier versions. Performance on later versions is unknown.

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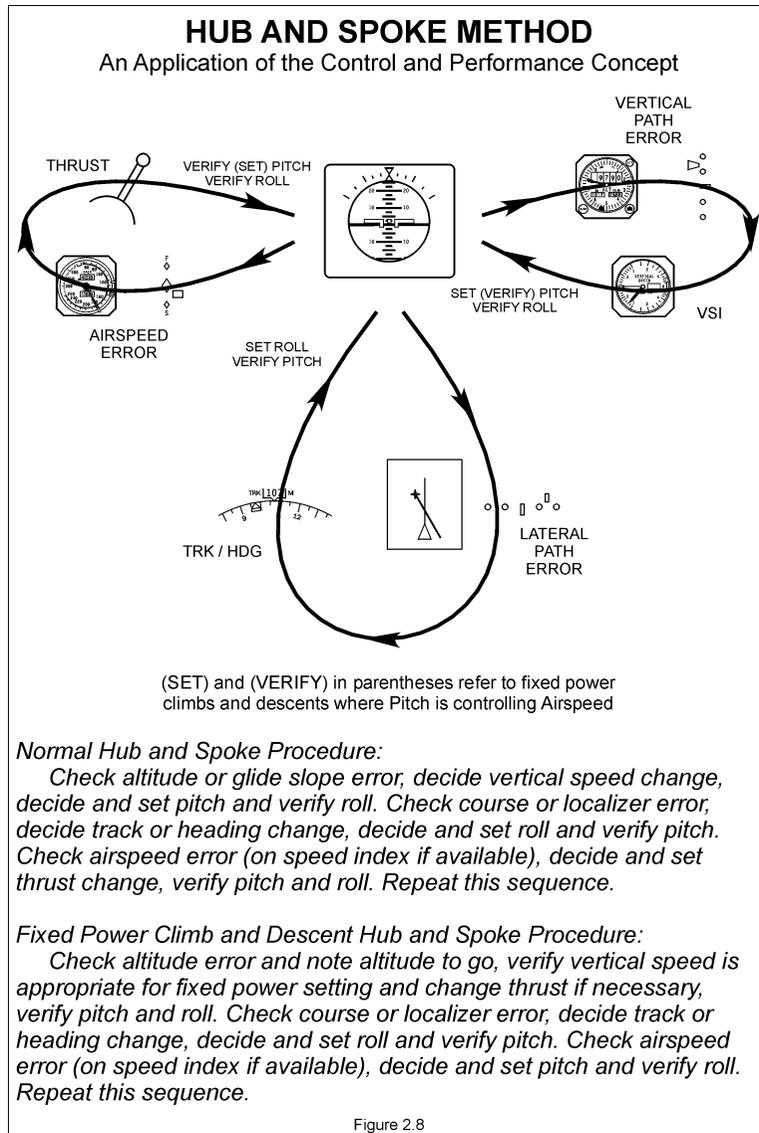
About the Author

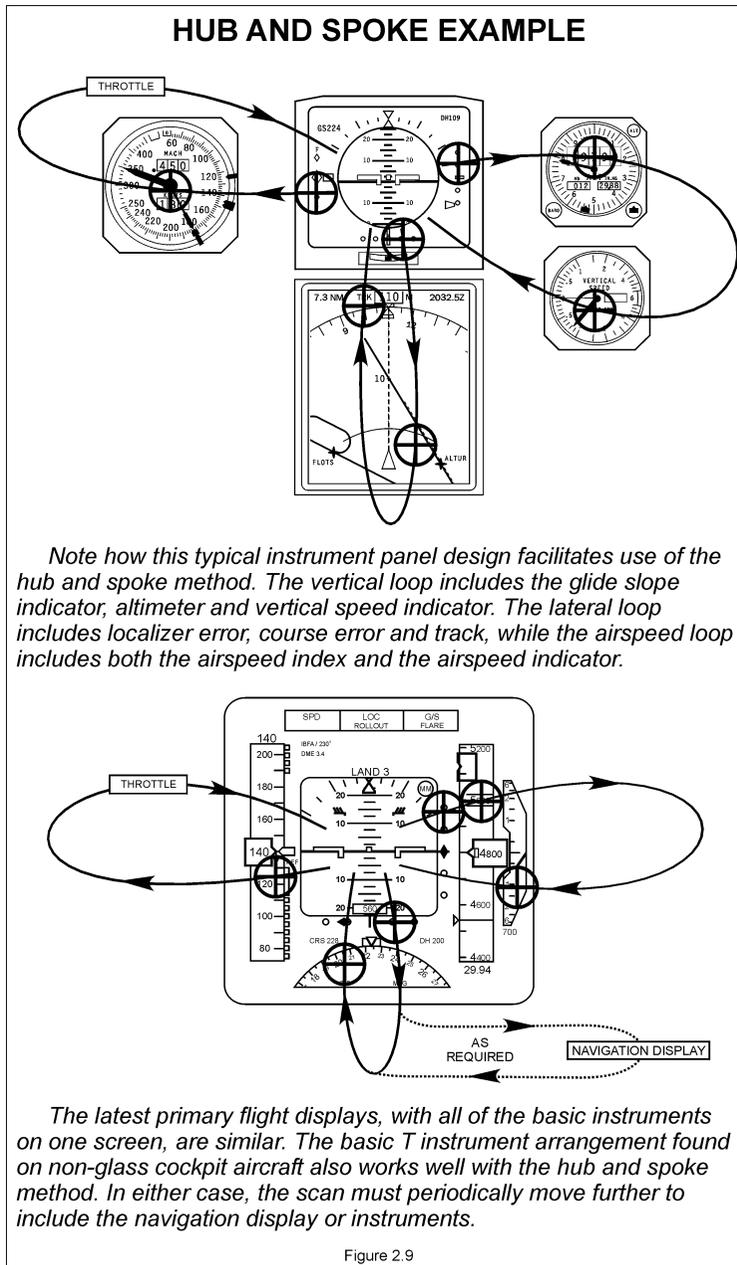
Professor Les Kumpula (Emeritus) specialized in the optimization of pilot technique through aerodynamic analysis during 30 years on the Aeronautical Science faculty at Embry-Riddle Aeronautical University in Daytona Beach Florida. He holds a Masters Degree in Aerospace Engineering from the University of Minnesota and is a former Corporate Pilot and Chief Flight Instructor. His FAA certificates include an Airline Transport Pilot Certificate with type ratings in the Boeing 757/767 and Airbus A320.

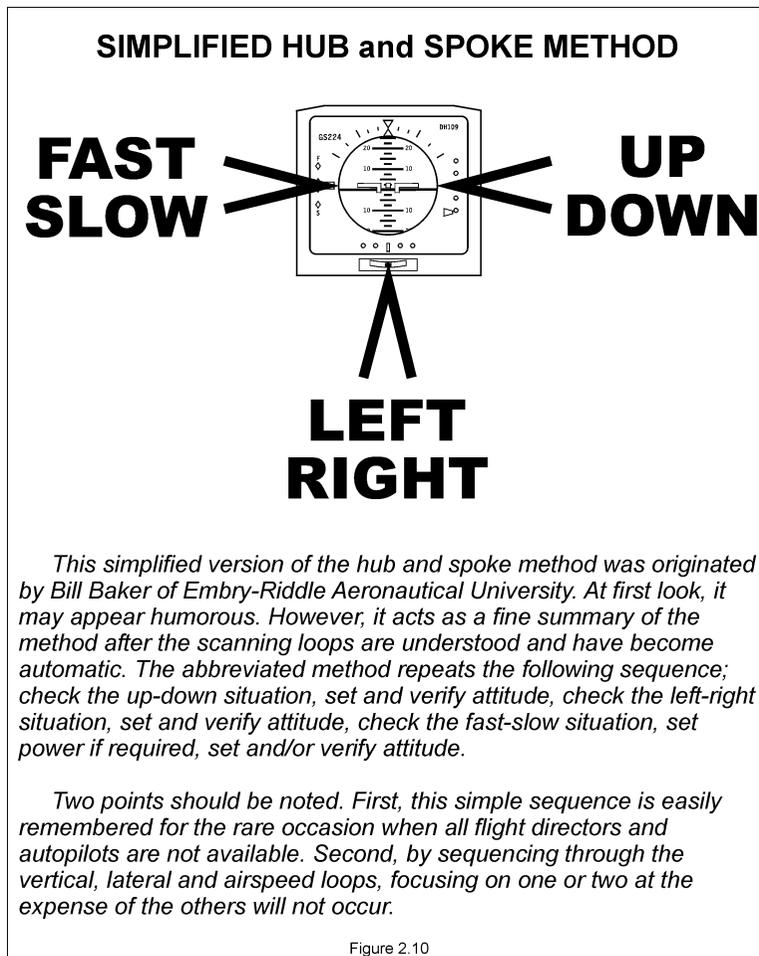
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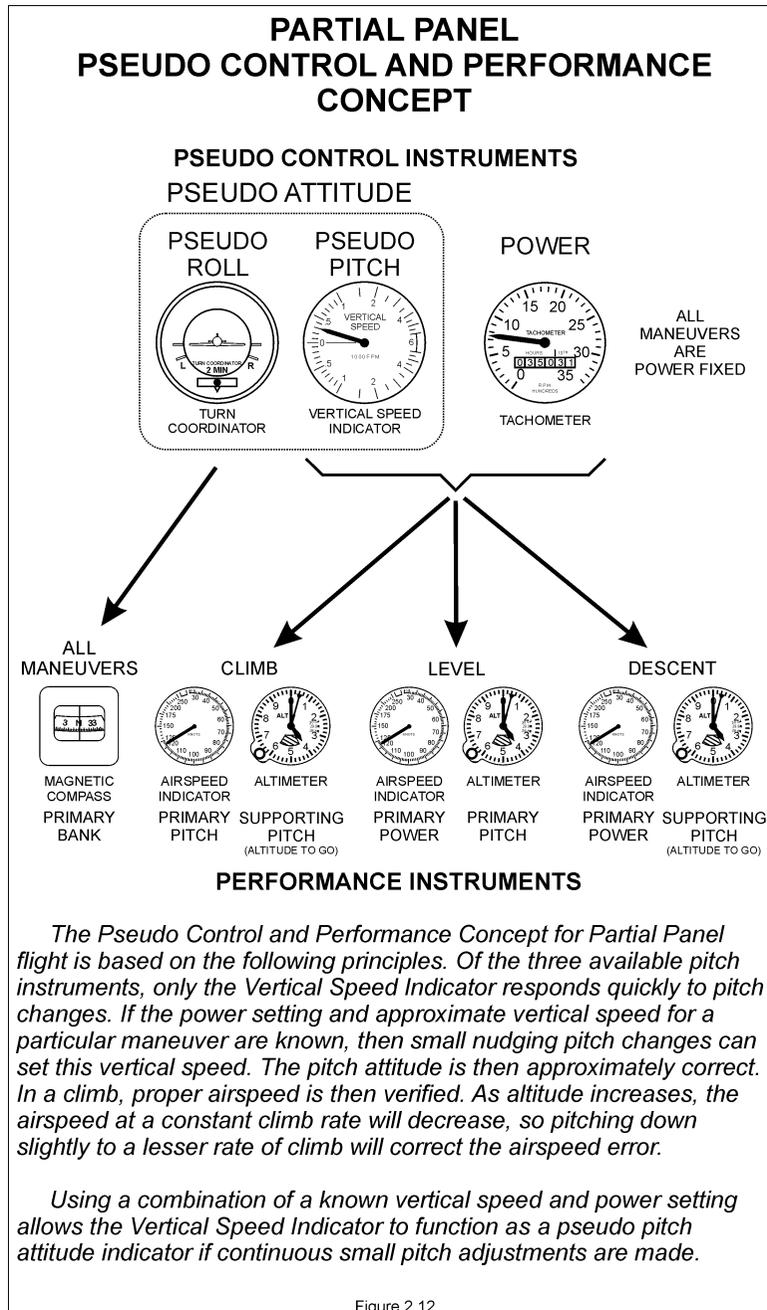


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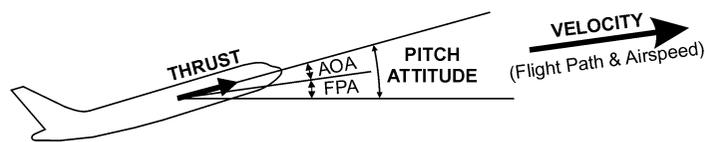






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**PITCH ATTITUDE and POWER
DETERMINE
FLIGHT PATH and AIRSPEED**



Configuration, Weight, Pressure Altitude and Temperature are specified.

Assume Flight Path and Airspeed are specified. For the flight path direction to remain constant, the forces perpendicular to the flight path must be balanced. Only one value of lift will balance the perpendicular forces for the specified conditions. This lift can be obtained at only one angle of attack since the airspeed is specified. Since Pitch Attitude = Flight Path Angle + Body Angle of Attack, there is only one pitch attitude that will maintain a constant flight path direction at a given airspeed, weight and configuration. Airspeed in this discussion is indicated airspeed corrected for pitot static system error and compressibility, i.e. Equivalent Airspeed (EAS). Body angle of attack is the angle between the flight path and the longitudinal axis.

Drag can now be calculated since angle of attack, EAS and configuration are known. Likewise, the parallel component of weight can also be computed from weight and flight path angle. Required thrust can then be determined from drag and the parallel component of weight. The power setting can be determined from thrust, pressure altitude and temperature. Note that any relevant power setting information can be determined from pressure altitude, temperature and equivalent airspeed, including density altitude, mach number and true airspeed.

The above discussion illustrates the final result:

For a given Configuration, Weight, Pressure Altitude and Temperature, There is only one Pitch Attitude and Power Setting combination that will produce a particular stabilized Flight Path Direction and Airspeed.

This somewhat complicated discussion is only needed to prove the above fact of flight. Only the final result above is required operational knowledge since pitch attitudes and power settings are determined experimentally in flight.

FIGURE 3.2

