THE PILOT'S GUIDE TO

The Airline Cockpit

Second Edition

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The Pilot's Guide to the Airline Cockpit
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The Quick Tour

This chapter takes you on a quick tour of the modern airline cockpit. You will see that the intimidating-looking computers in the cockpit are nothing more than a collection of tools designed to lend a helping hand as you perform the same flight duties that are required when operating any aircraft. These include the familiar chores of: (1) planning a flight route; (2) guiding the aircraft along the planned flight route; (3) making en route modifications to the flight route; (4) flying off the flight route to comply with simple ATC clearances; and (5) sometimes rejoining the flight route when cleared by ATC.

You will see how using cockpit automation changes the way you do your job. The automation is capable of handling some of the dirty work while you and your crewmate assume the role of supervisors who must intelligently manage the automation as it performs its duties.

Planning the Flight Route

Back at the gate, the flight crew works together with a device called a flight management computer to plan a highly tuned flight route that makes optimum use of time and fuel. You and your crewmate must first provide the flight management computer with information about the assigned route, aircraft, and expected conditions. The flight management computer then calculates the details of the route based on your inputs and displays this information to you. The flight crew must then review the route to ensure it meets all requirements.

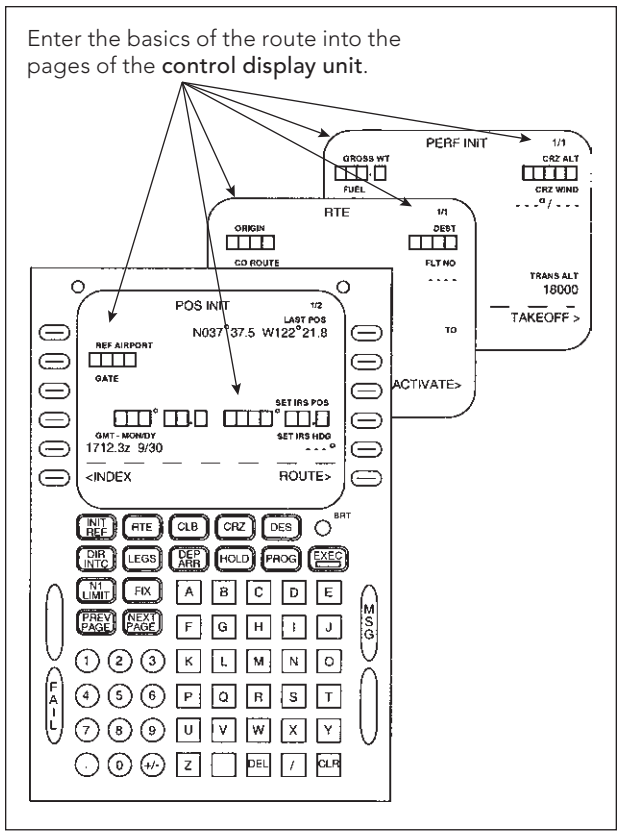
Prior to departure, the flight crew works together with a powerful component of the automated cockpit to plan the ideal flight route. The component is known as the **flight management computer** (FMC). The route created by the combination of you and the flight management computer will do more than simply maneuver the aircraft among the waypoints and airways that make up the assigned route. This route will be highly tuned with respect to both time and fuel. The computed takeoff thrust will be just right for atmospheric conditions. The climb, cruise, and descent speeds chosen will reflect a near-perfect trade-off between time enroute and fuel burned. The FMC will calculate the point at which the aircraft will reach the assigned cruise altitude with remarkable accuracy. Finally, the FMC will choose a top-of-descent point that will allow the aircraft to perform a whispering idle-thrust glide that delivers the aircraft on speed and altitude at the assigned descent crossing restriction.

How does this ideal flight route get built? The flight crew and the FMC work together to accomplish this in three simple steps.

The Flight Crew Enters Information about the Assigned Route, Aircraft, and Expected Atmospheric Conditions

The first step in creating a flight route requires the flight crew to enter a variety of pertinent information that will help the FMC do its part.

Like every other computer, the flight management computer has a keyboard and monitor that allow the flight crew to view information contained in the computer and to input information into it. The **control display unit** (CDU) serves as the keyboard and monitor for the FMC. Shown in Figure 1.1, the CDU displays information about the route on the **CDU screen.** Since the FMC contains far more information



1.1. The control display unit (CDU).

than could fit on one small screen, information stored in the FMC appears on a collection of **CDU pages.** Each CDU page displays information related to one particular aspect of the flight route. Only one CDU page can appear on the CDU screen at a time. The alphanumeric buttons allow the crew to enter information the FMC needs to perform its part in building the flight route.

The CDU pages shown in Figure 1.1 allow you to enter information such as the initial position of the aircraft, the origin and destination airports, the gross weight of the aircraft, and the planned cruising altitude.

Using the CDU keypad to enter this information into each of the CDU pages is the first step in the flight crew's part in building the flight route.

The FMC Uses the Crew Entries to Calculate the Flight Route

After you and your crewmate have entered the basic information about the route and aircraft, the FMC constructs a detailed flight route. The FMC draws on two extensive databases to accomplish this step. A **navigation database** electronically stores the same navigational information contained in your aeronautical charts. A **performance database** details the performance characteristics of the aircraft and engines. It tells the FMC how the aircraft will perform in a variety of configurations and atmospheric conditions.

Using the information you have entered, the FMC performs all of the calculations that you had to perform in the past using your hand-held flight computer. In addition to figuring the tracks, distances, times, and fuel remaining at each waypoint, the FMC also calculates the most fuel-efficient speeds to fly and the ideal point at which to start your descent as you approach your destination airport.

The flight plan created by you and the FMC can take you all the way from your departure runway to the missed-approach point at your destination airport.

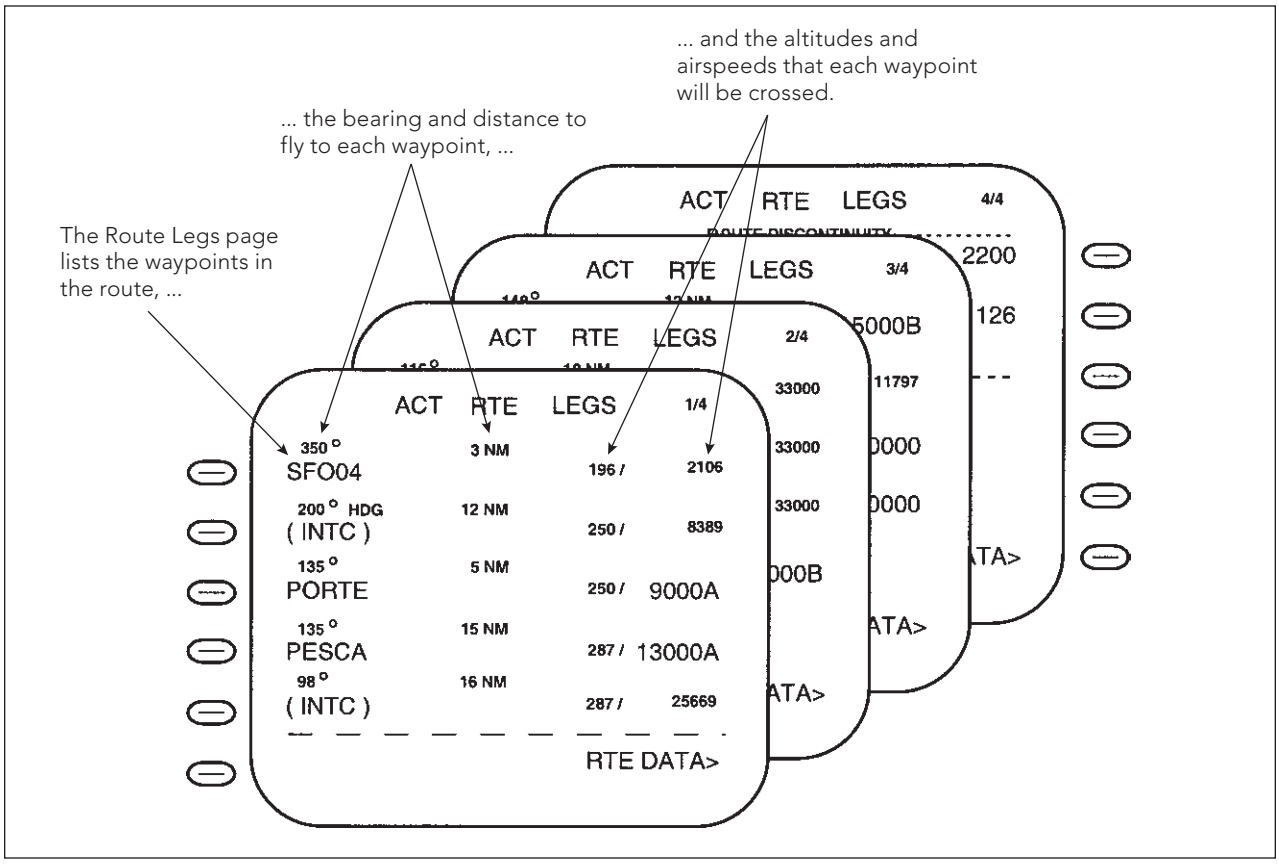
The Crew Reviews the Flight Route

Once the FMC has done its job, the crew must review the finished product. Why is it so important for you and your crewmate to check the flight route? You will soon learn that cockpit automation offers you the capability to automatically guide the aircraft along the route. With that in mind, it's a good idea to make sure the FMC's plan is the right one!

How do you review the route that the FMC has devised? Two displays help you and your crewmate check the flight route that is now programmed into the FMC.

A variety of CDU pages list the many details of the planned route. For example, the **Route Legs page,** shown in Figure 1.2, lists the succession of waypoints that make up the route, along with the altitude and airspeed at which the aircraft is expected to cross each waypoint.

Another cockpit display called the **electronic horizontal situation indicator** (EHSI), shown in Figure 1.3, provides the "big picture" presented in a graphical format. The waypoint symbols and lines sketch the lat-



1.2. The Route Legs page.

eral track of the aircraft along the programmed route. The T/C and T/D symbols show the points at which the aircraft is predicted to reach the assigned cruising altitude and the planned top-of-descent point.

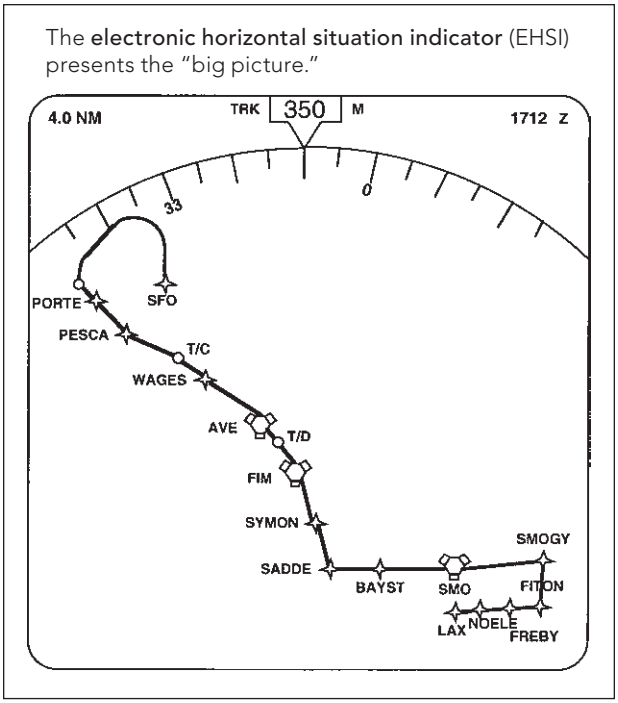
Following the Flight Route

The airline cockpit also supports the flight crew in accurately guiding the aircraft along the flight route that has been planned. Guidance is provided not only along the lateral portion of the route but also along the vertical trajectory as well. In one mode of operation, the pilot flying must manipulate the control yoke and thrust levers in response to roll, pitch, and power commands that are generated by the automation. In another mode of operation, the control yoke and thrust levers are automatically manipulated while other computers track the progress of the airplane through the air.

Now that the flight route has been built, the next step is to fly it. As you will see, the automation found in the airline cockpit not only helps you plan a flight route, it also helps you follow it.

The Crew Engages Two Powerful Guidance Functions: LNAV and VNAV

Aside from the flight management computer that helps you plan a flight route, most modern airliners contain an **autoflight system** that assists the flight crew in guiding the airplane along the route stored in the flight management computer. The autoflight system offers powerful **guidance functions** that help guide the airplane along the programmed route. The **lateral navigation** (LNAV) guidance function automatically manages the roll of the aircraft to guide the aircraft between the waypoints listed on the Route Legs page shown in Figure 1.2. LNAV does not manage the speed or vertical trajectory of the aircraft. To



1.3. The electronic horizontal situation indicator (EHSI).

handle that job, the crew can engage a second guidance function called **vertical navigation** (VNAV). VNAV automatically manages pitch and thrust to help ensure that the aircraft crosses each waypoint at the speed and altitude shown on the Route Legs page. You can engage the LNAV and VNAV functions just after takeoff and use them all the way to the missed-approach point at the destination airport.

LNAV and VNAV can be engaged by pressing the LNAV and VNAV buttons on the **mode control panel** (MCP) shown in Figure 1.4.

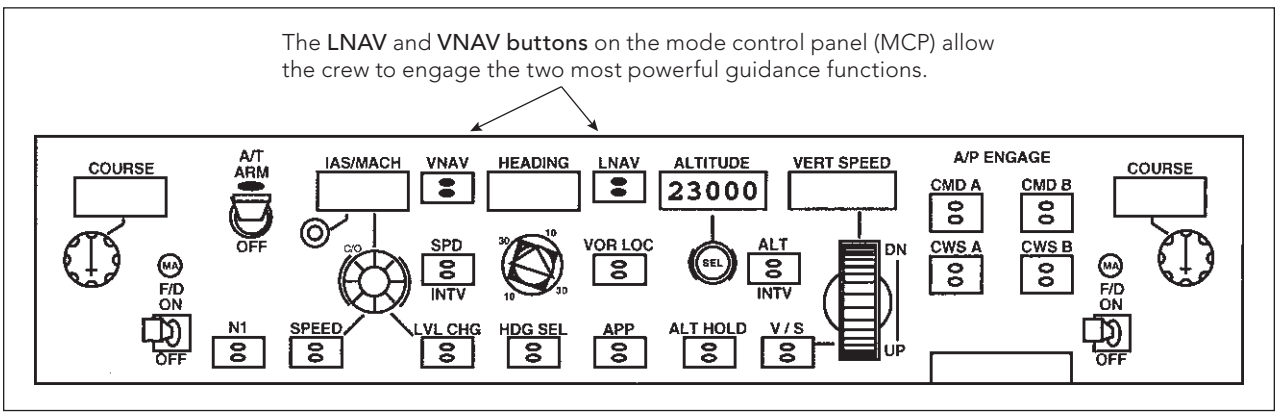
Guidance functions such as LNAV and VNAV can be used in two basic ways. In one mode of operation, the pitch and roll commands that are necessary to guide the aircraft along the programmed route are presented to the crew using a set of command bars that appear on each pilot's **electronic attitude director indicator** (EADI). Together, these command bars are referred to as the **flight director** and resemble the glide slope and localizer needles you have seen in smaller aircraft. An EADI with flight directors is shown in Figure 1.5.

Commands presented on the **engine indicators** show the pilot flying how to manipulate the thrust levers. The arrows that appear beside the needles on the N1 gauges shown in Figure 1.6 are called **cursors** or **bugs** and show the crew the thrust settings that the FMC has calculated.

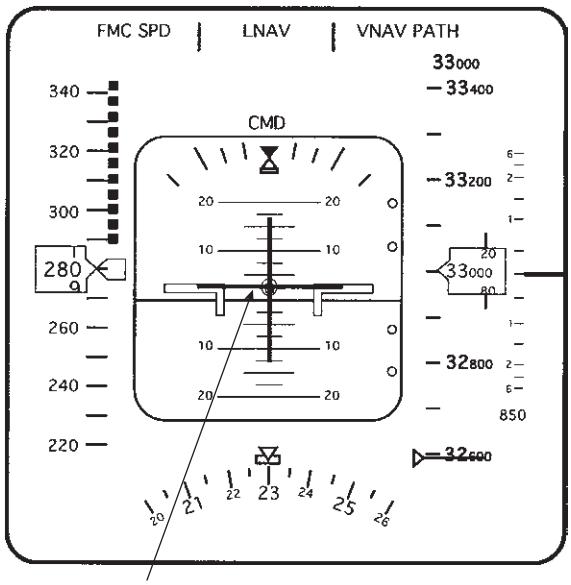
In this mode of operation, the flight crew is able to receive guidance information from the autoflight system, yet remain in close contact with the controls of the aircraft.

In another mode of operation, an autoflight system component called an **autopilot** automatically manipulates the control yoke, while another autoflight system component called an **autothrottle** automatically manipulates the thrust levers. Together, these components work the controls of the airplane as if it were being flown by an invisible pilot.

If the flight management computer stores the sequence of waypoints that make up the flight route

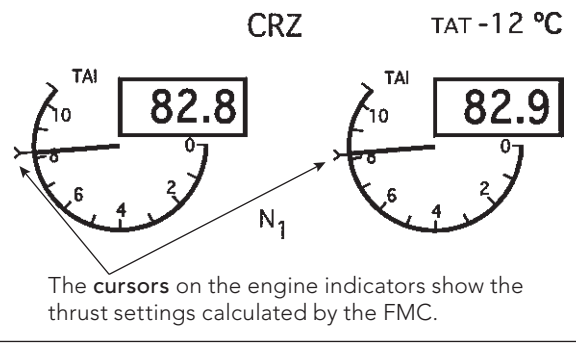


1.4. The mode control panel (MCP).



The **flight director** shows the pitch and roll commands generated by the FMC.

1.5. The electronic attitude director indicator (EADI) and flight director.



The **cursors** on the engine indicators show the thrust settings calculated by the FMC.

1.6. Engine indicators.

and the autoflight system guides the airplane between the waypoints, how does the airplane keep track of where it is? Every modern airliner contains a collection of technologies that keeps all of the cockpit automation systems informed about the present position of the airplane at all times. Conventional **radio navigation receivers** use VOR stations to track position. **Inertial reference systems** sense the airplane's movements in space. **Global positioning system receivers** use satellites to determine the aircraft's position. Working together, these systems provide an answer to the important question: Where are we?

The Crew Closely Monitors the Progress of the Aircraft

Although the cockpit automation systems we have discussed can do many things that save you time and effort, like any other computer system, they don't always work the way you want them to. For this reason the flight crew remains in a leadership role in the cockpit. You and your crewmate are at all times responsible for evaluating your situation, deciding how best to fly the aircraft, and closely supervising and monitoring the automation. For the flight crew who is now placed in a supervisory role, cockpit automation provides plentiful information about what it's doing and what it plans to do next.

The **Route Legs page,** shown in Figure 1.7, lists the waypoints in the planned route along with the planned speed, altitude, and distance remaining to each waypoint. Of particular importance is the first waypoint in the list, known as the **active waypoint.** The active waypoint is the one that the automation is always working to achieve when LNAV and VNAV are engaged.

The **Progress page,** shown in Figure 1.8, displays the planned time of arrival and fuel remaining at each waypoint along with the actual time and fuel remaining for the waypoint you have just passed.

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The Airline Cockpit

This book introduces you to the fundamentals of today's airline cockpit before you enter training at an airline company. Whether it is a turboprop, a regional jet, a Boeing, or an Airbus, most every airliner in operation today contains a flight management system, an autopilot, and other glass-cockpit systems. These systems represent a gap between the skills you learn during your general aviation experience and the skills you will be expected to have when you begin your airline flying career. This book will give you a head start on bridging that gap and acquiring those necessary skills.

Unlike the typical "systems" manual, *The Pilot's Guide to the Airline Cockpit* places you in the left seat and takes you step-by-step through a challenging line flight. It teaches about the airline cockpit in terms of what you already know as a commercial multiengine instrument pilot. You will learn how to use the flight management system and autopilot to plan and follow an assigned route. You will learn to deal with realistic enroute scenarios such as vectors, intercepts, holds, diversions, late descents, and many others. Along the way, you will learn how to decide which automation features to use and when, the limits of the automation's capabilities, how to monitor the progress of your flight, and remain in-the-loop while the automation performs its work.

This book is essential reading for anyone who has aspirations to fly for an airline—it is the ideal companion as you transition from general aviation to regional jets, and then to larger transport-category airplanes.

"Feeling comfortable the first time you are in front of an FMC is great! Detailed explanations and illustrations walk you through advanced systems. [This book is] a must for the future airline pilot."

—Rafael Cardenas,
Captain, Canadair Regional Jet

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