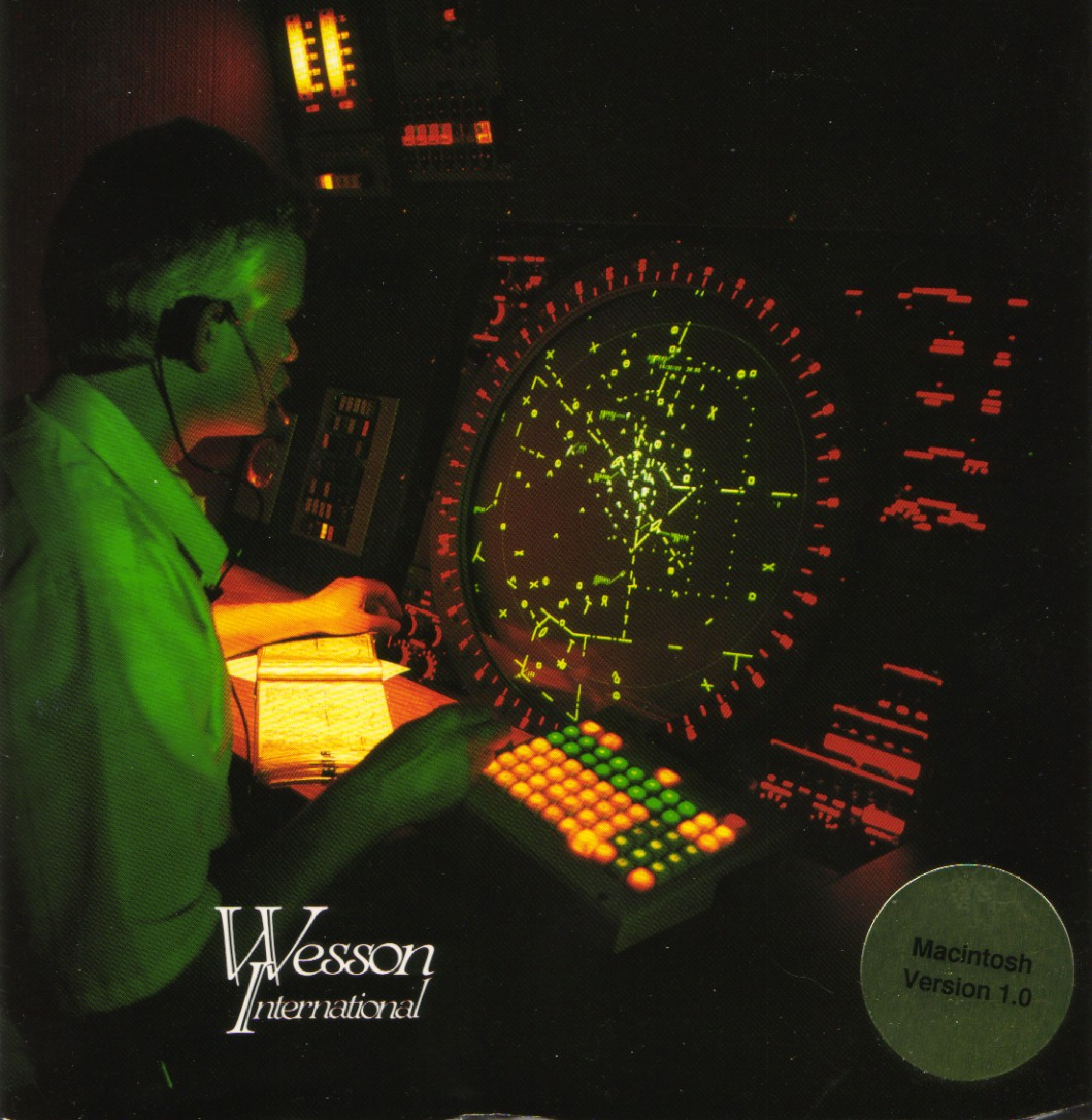
TRACON

Air Traffic Control Simulator



Wesson International

Macintosh Version 1.0

TRACON

Air Traffic Control Simulator

Macintosh Version 1.0

Designed by
Robert B Wesson, Ph.D.

Original Programming by
Dale Young

Macintosh Programming by
Bobby Green & Clark Roberts

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Austin, TX 78746
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Mail to: Wesson International
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Austin, TX 78746

Product: **TRACON - Macintosh Version 1.0**

Name: ____________________
Company: ____________ Position: ________
Address: ____________________
City: __________ State: ____ Zip: ______

Where did you hear about TRACON? __________

How did you acquire this software? __________

What were your very first impressions of this simulation? __________

How was the manual? Did you read it? Are you a pilot or controller?

Any problems that we should know about? __________

Please tell us your overall impressions after a few hours of use. __________

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Contents

Prologue

From the moment he plugged in, Jim Cochran knew he was in trouble.

"...string of pearls now, kiddo," Ronald Sprague, the radar controller whose shift just ended, was saying. "Not much happening on the scope. American 11 on the profile for 25 Left; United 567 and Western 341 right on his tail; gotta get PSA 112 in trail so I've got that Clipper at 200 knots to make the hole. Oh, and there's a Lear over here -- right there, see him? -- who wants to change his destination to Long Beach. All Long Beach has going is a couple of training flights and a few departures scheduled. Got all that?"

"Inbounds?" Jim asked.

"Naw. Nothing much to worry about. Heavier than usual, but shouldn't be too bad."

"What about that Citation that just came off the teletype? How's he gonna fit in?" Jim wondered aloud.

"Time will tell, buddy. I'm outa here." Sprague quickly unplugged, signed out, and sauntered away. The transition had taken less than 30 seconds.

Dammit, thought Jim. Left me with a scope full of targets and no plan again. Ron was a "natural," one of the rare controllers who could somehow "see" the traffic flows in their heads and make the right calls without quite knowing why. Like people who could play a musical instrument "by ear."

Jim, on the other hand, after three years of intensive on-the-job training, was just now full performance qualified for radar duty. Like meticulously playing a piano by reading the notes one by one, he had to think through every call he made.

And now, with the evening rush hour bearing down on him, he had trouble bringing his concentration up to speed. He hadn't gotten much sleep since going home earlier this morning. Working two day shifts, two swings, and one midwatch seven days a week was wearing him down. And chewing out his wife Cindy for leaving the car lights on didn't help much either. Everybody does stuff like that once in a while. He seemed to be demanding perfection in everyone these days.

"Los Angeles Approach, Lear Five Six Hotel. How's that clearance coming?"

"LA, United Five Sixty-seven. Need to start down now if you please."

No time for daydreaming now, he reminded himself. Gotta get those targets lined up.

"Five Six Hotel, stand-by. United Five Sixty-seven, cleared now profile descent runway 24 LAX. What's your speed now?"

"567 is indicating two two zero, sir, and will maintain that during the descent."

"567, roger. 56H, you want to go to...Long Beach, is it?"

"Affirmative. And we need to get started down now, if possible."

"OK, 56H. Descend and maintain five thousand. I'll have a revised clearance in a moment."

"Roger, Approach. Out of twelve to five for Lear 9056H. Thanks."

His hands flying over the keyboard, Jim took less than a second to slew his trackball pointer over the Lear's radar target return and entered the newly-assigned altitude of 5000 feet. A series of interphone conversations and a few glances at his D-man's updates of the flightstrips later, Cochran cleared the Lear to its new destination -- Long Beach airport on the southeastern outskirts of the central Los Angeles area. Getting into the swing of things was becoming easier with each passing day, as the routine of real, and not simulated, radar control was learned and the nuances of procedure became more ingrained.

This TRACON sector, number 2 of the 12 or so in the facility, was where many of the jet routes that fed LAX came together to form a single flow of traffic. It wasn't the hardest sector -- nine was worse. But it was difficult, simply because all those in this area were tough, covering as they did the major East-West thoroughfare connecting Los Angeles International airport with the rest of the country. That reputation, in fact, was what prompted Jim to request this facility in the first place. Along with his co-workers here, he enjoyed Los Angeles TRACON and being regarded as one of the best.

The whole problem of handling this sector's congestion consumed Jim's thoughts. Usually you had four things going for you to manage your airspace: time, altitude, vectors (horizontal seperation) and speed. Time didn't work, at least as long as the airlines kept sending them into LAX at the same time. Sometimes he thought of getting up a party line and asking Pan American, World, Eastern, United, American and Transworld just how they expected all their flights from New York to land at LAX at exactly 8:31pm anyway? Altitude didn't work, at least during these profile descents during which the pilots were flying according to fuel-efficient profiles. Not enough room for vectors, especially with all the small plane traffic near the approach corridors of the TCA. So that left speed, and there wasn't much of that when everyone was descending.

"Los Angeles Approach, World 17's with you, twelve thousand."

"World 17, Los Angeles Approach, roger. Pilot's discretion, descend and maintain three thousand, reduce speed now to 200 knots for spacing."

"Los Angeles Approach, Air Canada Twenty-three."

"Los Angeles Approach, Cessna Three Five Bravo."

"Los Angeles, Western 890 is coming up on ten thousand descending, requesting lower. We're in a broken layer and would like to get out of this turbulence if possible."

"Los Angeles, Air Canada 23 is between layers descending through eight thousand. Just thought you'd like to know."

Getting busy now, as the predicted group started checking into his sector, Jim ticked them off on the strips as they arrived. "Make a plan and make it work," they had drilled into him during the countless hours of training leading to this point. Automatically doing so by looking ahead of the automatic conflict alerter which did straight-line extrapolation of flight paths and warned of imminent conflict situations, Jim noticed that all of the new aircraft would overtake the 200-knot Clipper, which appeared to have slowed down ever further.

"Clipper 15, what speed are you indicating now?"

"Ahhh... Los Angeles, Clipper 15 is coming back up to 200 knots. Guess we let it slip off a little, sorry."

"Roger, give me 250 now."

"Los Angeles, company policy to keep it below 220 on the profile."

"Roger Clipper 15. I say again, make your speed 250 knots. I've got three targets overtaking you."

"250 knots for Clipper 15, roger." The growl was unmistakable.

Early in his apprenticeship, Jim had learned the wild variability of aircraft performance to expect from the different airlines -- even from different captains within one airline -- and had learned to accomodate it. Continental he loved. They would go supersonic for you if they could. So would PSA. Mexicana was also alright, if they understood you. Most of the foreign carriers, in fact were just fine for the routine stuff, but radio-mutilated English took its toll.

"Los Angeles, Delta 1107 is with you at twelve thousand."

"Los Angeles Approach, Baron 8994 Tango with you, level ten thousand."

"Approach, Cessna One Three Three Five Bravo."

"Cessna Three Five Bravo, standby. Delta 1107, Los Angeles, roger. Descend and maintain six thousand; expect lower in ten minutes. Break. Baron 8994T, radar contact, descend and maintain three thousand, turn left heading one seven five."

As the screen filled up, Jim's data man, Mike Samuels, got much busier. He tried to do as much of the data manipulating as possible, freeing Jim to concentrate on planning and making the calls. That the two worked together well was evident in their almost total lack of verbal interchanges. Since Mike knew Jim's patterns of control, he could anticipate and respond to Jim's actions after only the slightest of nonverbal hints. Even the formality with which Jim addressed a pilot mattered -- those Jim felt he could count on would be asked for more complex yet more efficient procedures. The others he handled by the book. That was generally less efficient, but when you didn't know whether they could deal with something non-routine, you didn't try unless it was very light. And it was definitely <u>not</u> light tonight.

"Los Angeles Approach, this is Cessna One Three Three Five Bravo. Please answer. We've got a problem up here."

"Three five Bravo, go ahead." *Who is that guy, anyway? No flightstrip on him.*

"This is Three five Bravo. We're about ten miles south of Palos Verdes at two thousand feet just above the clouds. When we left Catalina for Torrance, it was severe clear, but now it's overcast under us and we're, uh, not real sure what to do...haven't had pilot's license all that long..."

"Three Five Bravo, squawk 0467 and ident, please. Are you instrument-qualified?"

"Three Five Bravo, negative, sir. And we're a bit low on fuel. Maybe twenty minutes left."

"One Three Three Five Bravo, radar contact . Fly heading zero seven zero and stand-by this frequency."

Just what I need, thought Cochran. A newly-minted VFR pilot lost in the marine layer that rolled in every evening about this time! Why don't they ever think ahead? Dammit! I don't need this! Not tonight!

Just then, a computer check for potential separation conflicts happened automatically. It turned up two potentials:

Potential #1:	N8994T	AC23	@ 1719:48
Potential #2:	PSA89	N8994T	@ 1731:37

Noticing that both conflicts involved Beechcraft Baron 8994T, Jim noted the cause -- an unrestricted descent for 8994T which would take it through the projected flight paths of two other aircraft.

Quickly glancing at the flightstrip for 94T, he keyed his mike.

"Beech 8994T, you still intend to cancel IFR when you break out? Pilot reports east of the basin indicate layers at six and ten thousand with tops at 16,000. A few build-ups to 40,000."

"Los Angeles, Baron 94T. Affirmative. We should be out of this stuff in a couple of minutes if that report is correct."

Jim stared at his console for a moment, reflecting that even with this automated assistance there were still many improvements to be made. Take these two conflicts, for example. Although he expected the Baron to break out of the clouds and cancel IFR at any time now, and long before the predicted conflicts should actually occur, he couldn't tell the machine that. The computer interface simply couldn't handle "fuzzy" information of this sort. It would not even let him override the conflict alert. He circumvented the problem by declaring N8994T a VFR target, so that the conflict recognizer would ignore it for now, and turned his attention back to the lost Cessna.

The Cessna 152's pilot was clearly not qualified to be up in this muck, yet he was clearly making a supreme effort to keep calm. Taking him back into Torrance was out of the question -- the peninsula was completely shrouded in clouds. Long Beach, maybe? Weather over there was holding -- the fog hadn't reached that far inland yet. With radar vectors and a little luck, he could vector the Cessna over the lowlands there and line him up with the Long Beach active before it, too, got socked in by the converging temperature and dew point.

Coordinating with LGB tower, Jim started to vector the Cessna pilot east to Long Beach when the whooping siren of the conflict alerter went off. His screen blinked urgently:

******SEPARATION CONFLICT ALERT!******
N8994T and AC23: Less than 1 mile.

"What the hell..." he wondered aloud. Then he saw it. In fooling his conflict predictor by improperly marking 8994T as VFR, he had disabled the series of routine conflict checks which would have preceded this last-ditch alarm. 94T had apparently not broken out of the cloud layer by the time it reached the 6000 foot altitude of the descending Air Canada DC-10 after all. If he didn't do something right now, the two rapidly merging targets would become one. His stomach tightening, Jim hoped both pilots had quick reflexes.

"Air Canada 23, maintain six thousand feet <u>now</u>."

"Los Angeles Approach, this is 8994T. We're still in and out of clouds at six thousand. Guess we'll stick with you a little... JEEEZUS!..." Click.

"Baron 94T, Los Angeles Center, descend immediately, maintain 5000.

"November 8994T, Los Angeles Approach. How do you hear?

"November 8994T, Los Angeles."

As N8994T's reported altitude wound down at a rate greater than 5000 feet per minute and its tracked heading shifted rapidly, the automated conflict predictor ticked off its projections after Jim automatically but belatedly retagged N8994T as IFR:

Conflict #1: N8994T N300HJ @ 1722:03
Conflict #2: MX67 N8994T @ 1722:27
Conflict #3: N8994T N300HJ @ 1722:28
Conflict #4: N8994T WO14 @ 1725:56

He stared unbelieving at the altitude readout. 5600, 4500, 3300. He had never seen changes so rapid. 2800, 2300, 1900, 1800, 1900... Wait! Was it holding? Yes! The last two updates had been 1900 feet.

"Er...uh, this is 94T. We just...some jumbo or somethin'...uh, stand-by, Approach." Jim could hear the confusion in the background while the Baron's mike was keyed.

"November 8994T, Los Angeles. Say your status. You all right?"

"Uh...guess so...what? no, wait...no, go on back and sit down -- I'm talking to them now... sorry, Approach. That was a close one. Guess we hit that guy's vortex?"

"Affirmative, 94T. You just passed close behind a DC-10. When feasible, resume your descent and report any changes in your status. And please call this facility after your arrival on the landline, er, telephone."

Jim began small shivers just as he finished briefing the relief man his area supervisor had immediately provided. He broke into uncontrollable whole-body shaking just before he stumbled through the men's room door and threw up.

He had blown it. He had almost killed 500 people. And he had just sat there and watched while it all crumbled in front of him.

Before, they had been *targets*. Little blips on his scope, nothing more than callsigns and destinations, really. You learned how to move them, arrange them in neat patterns that fit all the rules, and hand them off. Sort of like a grown-up video game.

He never thought of them as, well, you know, *people*. Nobody did that. But those "targets" would taunt him in his dreams for nights to come, and he wondered if he would come back to work tomorrow or ever. This was no game -- this was his deadly reality!

1 Welcome to TRACON!

TRACON is the most complete simulation ever of a Terminal Radar Approach Control facility. Using TRACON, you will enter a world of almost unimaginable authority and responsibility, a world where the lives of thousands of passengers depend on your skill and ability to "look-ahead" in time and anticipate aircraft flight paths in four dimensions.

You have probably listened in on air traffic control conversations using a scanner, at the movies or through your headset while sitting bored at 35,000 feet. Much of what was said might have been unintelligible to you, yet the verbal exchanges communicated precise command and control information between pilot and controller. With TRACON, you can enter into this mysterious world and learn what those verbal conventions mean. You can actually experience the problems and solutions that air traffic controllers must deal with every minute they are on duty.

TRACON's world is the airspace surrounding a major airport and its satellite airports near one of five major metropolitan cities: Los Angeles, San Francisco, Chicago, Miami or Boston. A sweeping radar beam continuously scans the skies, pin-pointing each aircraft target and reporting its altitude with each scan. Airports, airways, VOR radio beacons, intersection fixes and ILS instrument landing systems are all depicted faithfully from actual government airspace charts. Significant ground markings such as coastlines are also shown.

Using this radarscope and the automated flightstrip display plus the communications channel shown along the bottom of your screen, you must handle all the aircraft in your sector, keeping them on-course, vectoring them into and out of the airports there, and handing them off to the adjacent facility controllers.

This job is complicated by pilot errors -- sometimes they don't hear you the first time and ask for your commands to be repeated, sometimes they do hear you but still do not comply! -- and weather. Missed approaches are common in bad weather, so even though you think you have finally finished with some turkey, he may pop up announcing a missed approach, which in turn throws all your other careful sequencing off, and generally turns a "good day" into a nightmare.

You control these factors, though, and can gradually progress through the ranks from controller trainee to seasoned veteran. Helping you in this process is an audio cassette tape which tracks a sample scenario precisely, allowing you to comprehend the total audio/visual ATC environment. Also included are demonstration scenarios in which prerecorded instructions are played back for you to watch. And always the *Communications* section translates each menu command to the official controller/pilot vocabulary, using the proper commands and responses that real air traffic controllers and pilots use every day to keep the skies as safe as they are.

You Don't Do Manuals

Yes, we know. You just fire up the program and muddle through from there.

If you have some controller or IFR pilot experience you can probably get away with that here. But the real job of a TRACON controller typically takes many years of training -- you are not going to master it in a couple of minutes. We have painstakingly composed this manual to take you step-by-step into this incredibly rich and complex world, and you will be wasting your time if you do not at least scan its high points first.

Besides, there is an on-disk demo at the end of this chapter and a fun audio tape demonstration at the end of the next chapter. So just sit back and enjoy reading, watching and listening to this fascinating world. You'll get your chance sooner than you think.

Coming Attractions

If you are not an instrument pilot or controller, you should absolutely read through the second chapter which introduces you to this complex arena. And even if you have substantial knowledge of air traffic control, you should probably skim this chapter and look over the elements of this environment -- which are simulated here and which are not. Chapter 2 ends with instructions about running the audio tape demo.

After this brief introduction to the world of ATC, TRACON's basic display setup and controls are described. By the time you have read through Chapters Three and Four, you will begin to feel comfortable with the environment of TRACON; without this "sense" of TRACON's world, you will probably be powerless to prevent the inevitable mid-air collision.

Chapter Five is optional but useful for achieving high performance using TRACON. This chapter distills information from various air traffic control procedures and describes how to best utilize the resources available to you: altitude, speed and heading. You might call it a "Hints" chapter. It also points out the errors that can occur and what you should do to prevent them.

After the chapters come maps and charts of each of the control sectors included with the program.

Manual Conventions

In this manual, we will consistently use **boldface** to indicate menu options, **Command (Cmd)** - key functions and Mouse commands.

First references to Air Traffic Control terminology will be listed in *italics*.

About The Designer and Programmers

TRACON was designed primarily by Robert B. Wesson, Ph.D. Dr. Wesson's thesis involved applying artificial intelligence techniques to the problems of air traffic control. In 1977, he created a program running on a mainframe (which had little more power than today's '386-based microcomputers!) which not only simulated an Air Route Traffic Control Center's sector, but also solved separation problems in that environment and issued appropriate ATC commands to the aircraft in the sector. This program was judged by professional controllers at Houston Center to perform better than human ATC personnel handling the same traffic in the same sector. TRACON derives from the simulation component of that program.

During the late '70's at the Rand Corporation "think tank" in Santa Monica, California, Dr. Wesson led a research team which produced and evaluated scenarios for the evolution of the present-day en route ATC system to a modern computer-mediated control environment called AERA. This work helped guide the FAA's multi-billion dollar airspace and airway modernization program currently underway, and the Prologue is an excerpt from one of the many publications Dr. Wesson wrote at that time. Dr. Wesson moved back to Austin, TX in 1981 and is currently president of Zen Software, Wesson International, Wesson Developments, and a partner in Wesson Dental Systems.

TRACON was originally programmed in Microsoft C by Dale Young. Many of its most advanced, realistic features were suggested and tested by George Booth, a Program Manager at the FAA's Advanced Concepts Division in Washington, D.C. and by a number of local professional controllers at the Austin TRACON, an ARTS II facility.

Conversion of TRACON from DOS to the Macintosh format was handled jointly by Bobby Green and Clark Roberts, programmers at Wesson International.

System Requirements

The Macintosh version of TRACON requires a Macintosh Plus (128k ROM) or larger, with floppy-disk or hard drives, and a compatible mouse. TRACON is not copy-protected and may be installed on a hard-drive for better performance.

Package Contents

When you open this product, you should find enclosed its three basic elements:

* This manual, which you really should look over before using the program;

* One 3.5" program diskette; and

* An audio cassette tape which has a recording of an air traffic control scenario recorded on it.

There are no hidden files or copy-protection.

Installing and Running TRACON

As with any new microcomputer product, you should first make a backup of the distribution diskette and then install the program and all its data files onto your system. Your Macintosh manual describes how to make copies of standard Macintosh disks.

Before even installing TRACON, you should read the file **README** from the distribution disk, if one is present. Like all microcomputer products, TRACON undergoes constant revision, and some things may have changed since this manual was printed, including the installation procedure. The **README** file documents these changes.

To see **README**, simply double-click on the file icon.

If you are at all familiar with Macintosh, then you already know that installing TRACON is really very simple.

Floppy-Disk Systems

After backing up the distribution disk, you should make a working copy of the program and its associated data and voice files. If you want to run TRACON from the same disk you use when you turn your computer on, you should copy all TRACON files onto a bootable diskette. See your Macintosh manual for more information about making a bootable diskette and copying files to it.

To run TRACON from a single working disk, simply insert this floppy disk into your disk drive and double-click on the TRACON icon.

Hard Disk Systems

Installing TRACON onto your hard disk is even easier. Just:

1. Insert the TRACON program disk into floppy drive A:.

2. Double-click on the TRACON disk icon to open.

3. Click on the TRACON folder and drag it to your Hard Disk window.

TRACON will automatically install on your Hard Disk.

To run TRACON from your hard disk, do the following:

1. Open TRACON by double-clicking on the TRACON folder.

2. Double-click on the TRACON icon.

To run a TRACON demonstration from your Hard Disk, choose "Demo.SIM" from the open dialog Box (**File Open**).

Exiting TRACON

You can shut down TRACON at any time and return to **System/Finder** selecting **Quit** from the **File** menu, or via **Cmd-Q**.

> **Command (Cmd)**-keys are two-key commands initiated from the keyboard, and may be used interchangeably with menu commands. You will find that in many cases this is a much faster way to issue rapid-fire commands. To execute a command using a **Command**-key, hold down **Cmd** on your keyboard and press the desired key.

Quick-Start Demonstration

Now for the fun part. Let's run a simple demonstration of TRACON's capabilties. It will take about 15 minutes, and you don't have to do anything but sit back and watch! This demonstration is a good way to become familiar with many of the program functions documented in the rest of this manual.

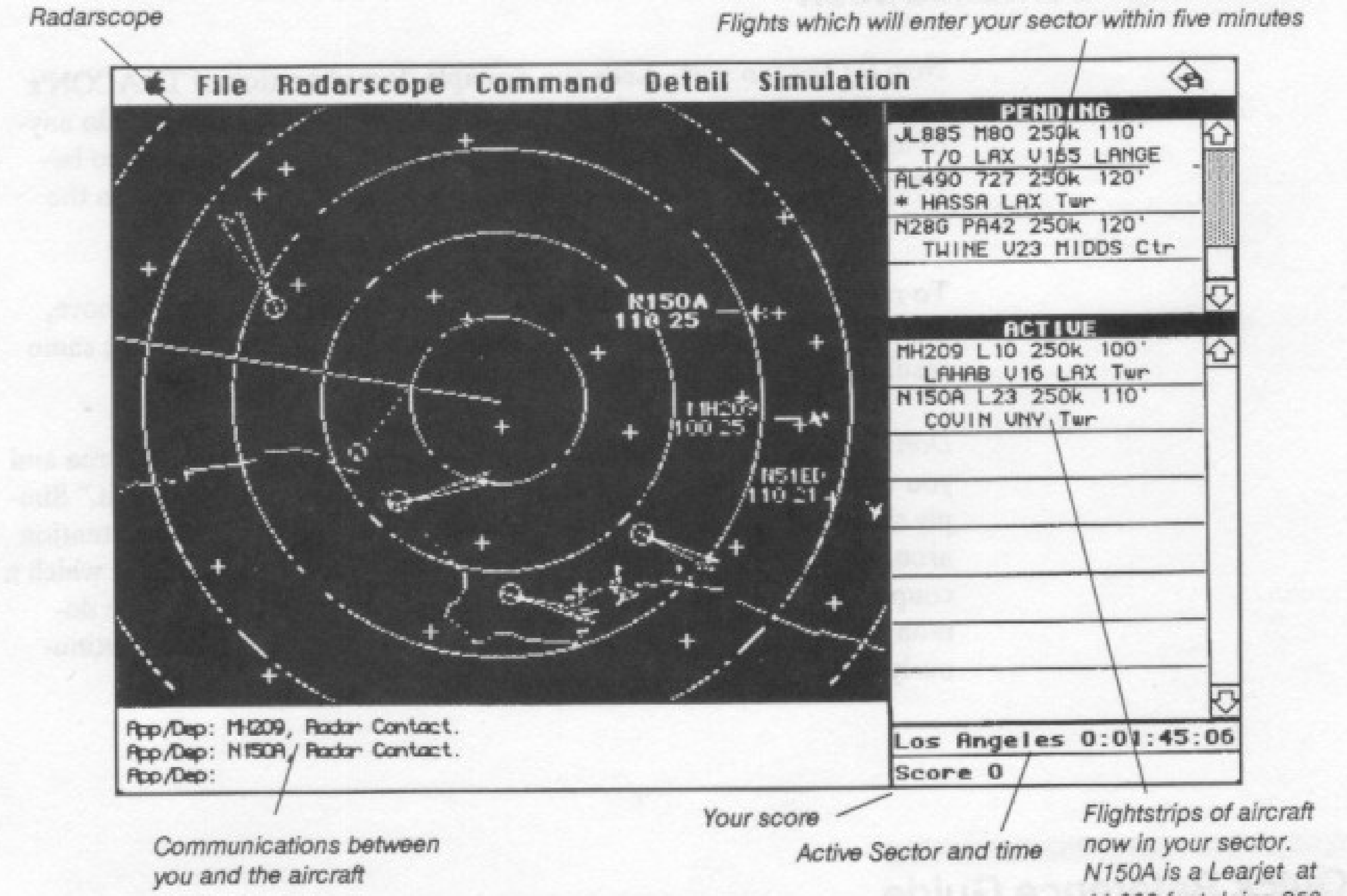
To run the demonstration, simply start TRACON as described above, pull down the **File** menu and choose **Open**. (**Cmd-O** acheives the same results.) Select **DEMO.SIM** from the file list.

Don't touch anything. Instead, watch the lower righthand screen area and you will see a small "Post-it"-like notepad which is "talking to you." Simply sit back and watch this notepad area, which will direct your attention around the screen and generally run through a simple scenario in which a couple of arrivals and departures are handled correctly. This little demonstration should give you a flavor of TRACON. It repeats continuously until you stop it.

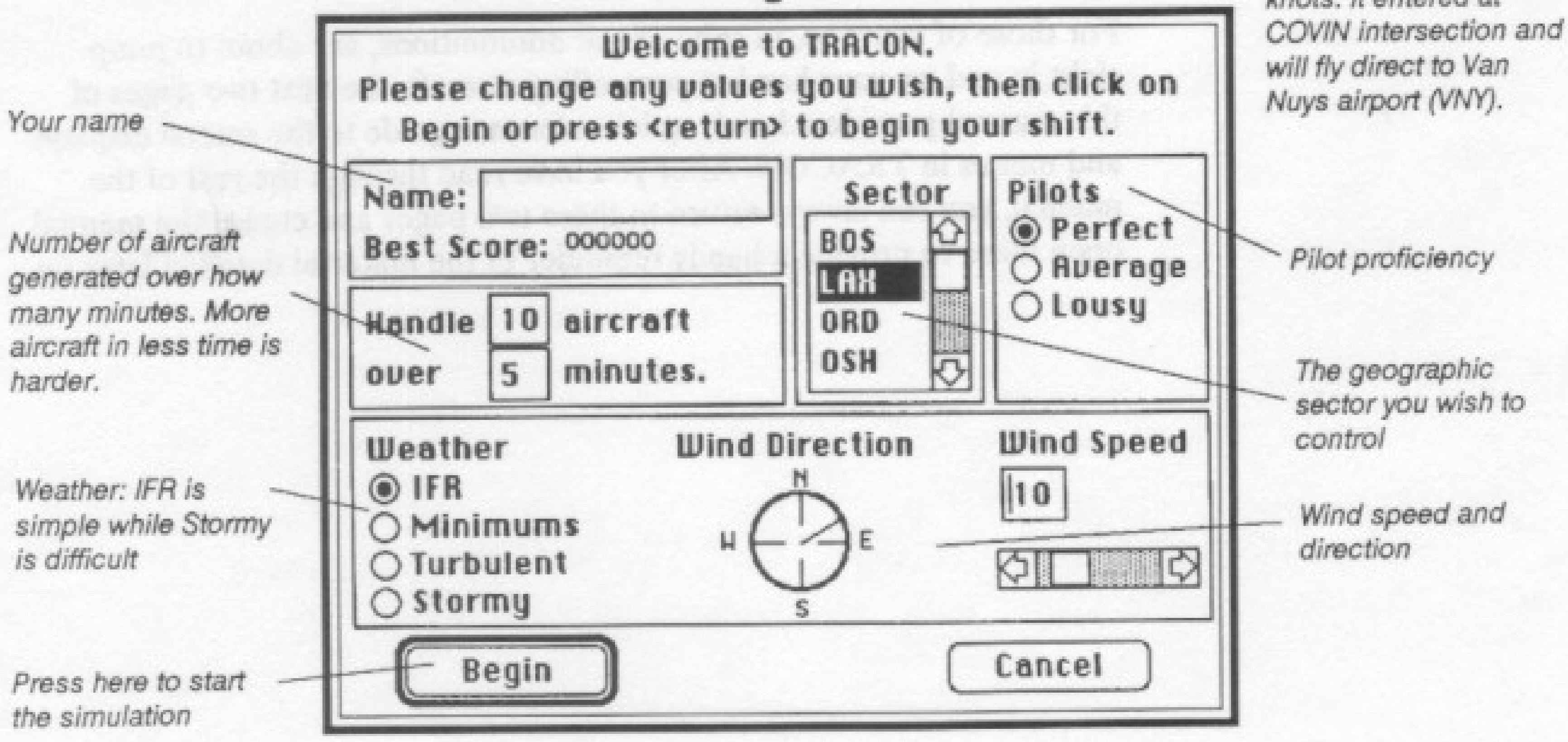
Quick Reference Guide

For those of you who, in spite of our admonitions, are about to jump right in and try your hand at controlling aircraft, the next two pages of this manual provide a handy quick reference guide to the screen displays and menus in TRACON. After you have read through the rest of the manual, you can always return to these two pages and crease the manual open there to provide a handy reminder of the material detailed later on.

Quick Reference: Screen Display



New Dialog Box



Quick Reference: Menus

File

New	⌘N
Open	⌘O
Save	⌘S
Quit	⌘Q

Select **New** for a new simulation, **Open** to view and select previously-saved simulations; **Save** to preserve this simulation; or **Quit** to end.

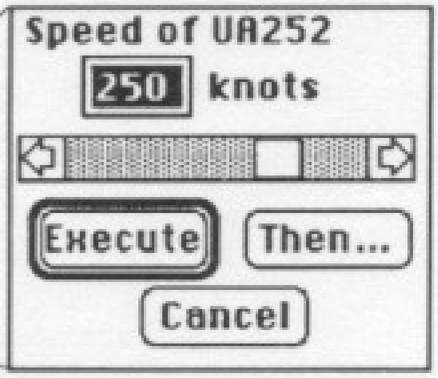
Detail

Aircraft	⌘I
Airports	⌘A
FlightPlan	⌘F

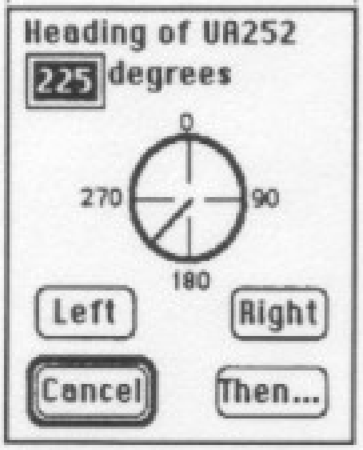
Select **Aircraft** for information on the selected aircraft; **Airport** for information on any airport in your sector; or **Flight Plan** to view the flight plan of the selected aircraft.

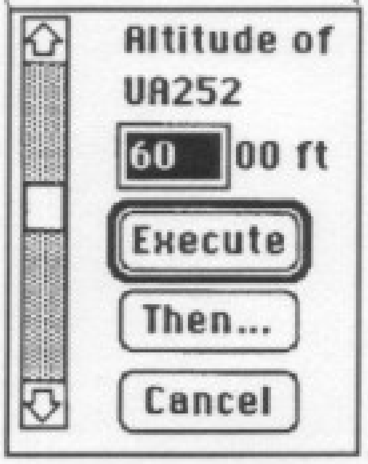
Command

Speed...	⌘E
Climb/descend	⌘C
Turn...	⌘T
Direct to...	⌘D
Hold at...	⌘H
Say Heading	⌘G
Resume	⌘R
Handoff	⌘K



The **Command** menu is used to actually issue commands to the aircraft under your control. **Speed**, **Turn** and **Climb/descend** commands are initiated via these dialog boxes. **Direct to** and **Hold at** require you to indicate a fix. **Say Heading** prompts the appropriate response from the selected aircraft. **Resume** directs an aircraft to continue its original flight plan, while **Handoff** clears the aircraft for an instrument approach into its destination airport or turns it over to a Center Controller.

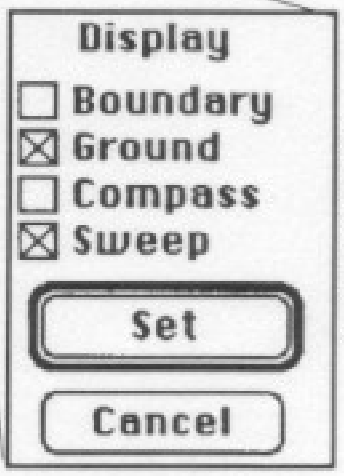




RadarScope

Airways	⌘W
Map Names	⌘M
Display...	
Zoom in	⌘+
Zoom out	⌘–

Select **Airways** to view all airways in your sector, or **Map Names** to see the locations of airports and fixes. Select **Display** for the options in the dialog box at right. **Zoom In** and **Zoom Out** allow you to magnify portions of your radarscope.



Options from the **Display** dialog box cause the listed information to be displayed continuously on your scope.

Simulation

✓Talking	
✓Noise	
Step Time	⌘Z
Pause	⌘P

Select from the Simulation menu to toggle audio on or off, to speed up the simulation in steps, or to pause the action (which is cheating!).

2 Air Traffic Control

A Short History of Air Traffic Control

You have undoubtedly heard the expression "flying by the seat of his pants." This characterizes the way early airplanes and their pilots took to the air. They flew by looking ahead at the physical horizon and navigated by looking over the side at landmarks. Seat of the pants flying has a severe drawback, of course, because clouds frequently obscure both the horizon and the ground.

The increasing requirement for reliability in the burdgeoning mail and passenger flying services led to the development of *instrument* flying, in which control of the aircraft is achieved using inboard artificial horizons and other instruments coupled with the use of radio navigational beacons along standardized routes of flight. As more and more aircraft began using these routes, however, some method of cordinated control became necessary and the government-based air traffic control service was born.

During these early days, air traffic control was performed using time as the basis for control. Each aircraft was given precise take-off and fix-crossing times. Aircraft flying the same routes were tracked using plastic indicators moved manually across large horizontal maps in the ATC control rooms. These indicators were called "shrimp boats" and continue to be the worst-case backup mechanisms available in many control rooms even today.

The use of ground-based radar to provide more precise position information for this tracking function is really only a few decades old. As frequently happens with government, this concept was a response to a critical catalytic event. In 1956, two airliners, both flying under existing instrument flight rules of the day, crashed over the Grand Canyon. One was climbing and the other descending. Congress mandated that "something has to be done about this!" and so radar-based ATC was created.

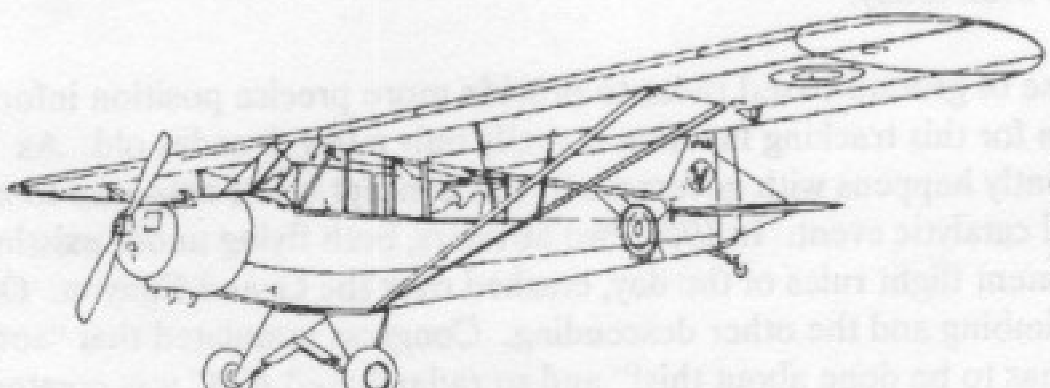
With radar control, ground-based centralized controllers can monitor an aircraft's flight and execute their basic safety mandate: *maintain separation between aircraft*. In TRACON, as in real life, that separation requirement is three miles horizontally or one thousand feet vertically. This constraint will form one of your primary goals in TRACON.

ATC controllers naturally do many other things in the course of their job. Although every airport equipped with an *instrument landing system* (ILS) has a published approach procedure, most pilots never actually fly it. Instead, the air traffic control authority issues guidance commands to position the inbound aircraft at a point from which an abbreviated approach can be successfully completed. In TRACON, as in real life, you will be required to perform these activities as well.

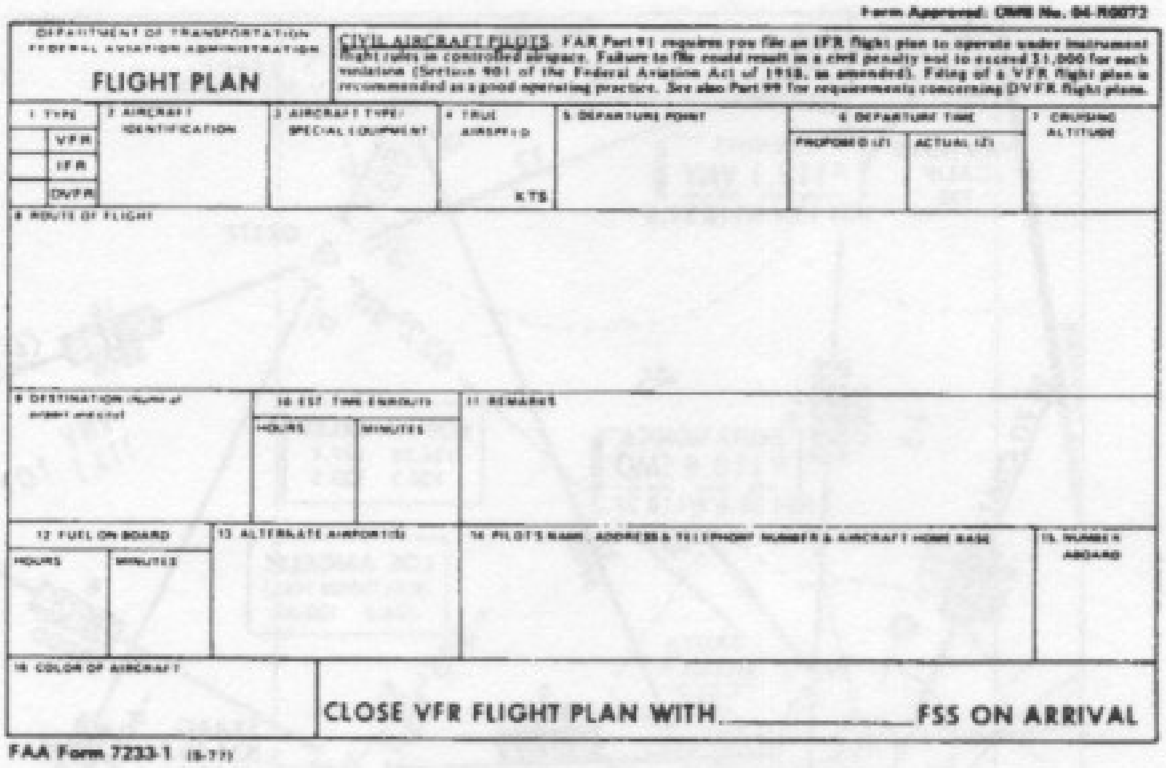
A Complex System of Interlocking Parts

Air traffic control is not a uniform system -- it is comprised of a multitude of overlapping rules, control facilities, and personnel. This section introduces you to that system as a whole, and discusses the part that TRACON simulates.

Aircraft in this country may fly under two sets of rules and regulations: *visual flight rules* (VFR) or *instrument flight rules* (IFR). The majority of "Sunday-pilot" flights occur VFR out of uncontrolled fields, where "see-and-be-seen" constitutes the primary traffic control mechanism. But whenever the weather turns cloudy, and always in congested airspace around major commercial airports, aircraft must file flightplans and be guided by ground-based controllers.



Aircraft like this Piper Cub usually fly VFR, but you will occasionally encounter an IFR one.



Form Approved: OMB No. 04-R0072

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

FLIGHT PLAN

CIVIL AIRCRAFT PILOTS. FAR Part 91 requires you file an IFR flight plan to operate under instrument flight rules in controlled airspace. Failure to file could result in a civil penalty not to exceed $1,000 for each violation (Section 901 of the Federal Aviation Act of 1958, as amended). Filing of a VFR flight plan is recommended as a good operating practice. See also Part 99 for requirements concerning DVFR flight plans.

1. TYPE: VFR / IFR / DVFR
2. AIRCRAFT IDENTIFICATION
3. AIRCRAFT TYPE/ SPECIAL EQUIPMENT
4. TRUE AIRSPEED — KTS
5. DEPARTURE POINT
6. DEPARTURE TIME — PROPOSED (Z) / ACTUAL (Z)
7. CRUISING ALTITUDE
8. ROUTE OF FLIGHT
9. DESTINATION (Name of airport and city)
10. EST. TIME ENROUTE — HOURS / MINUTES
11. REMARKS
12. FUEL ON BOARD — HOURS / MINUTES
13. ALTERNATE AIRPORT(S)
14. PILOT'S NAME, ADDRESS & TELEPHONE NUMBER & AIRCRAFT HOME BASE
15. NUMBER ABOARD
16. COLOR OF AIRCRAFT

CLOSE VFR FLIGHT PLAN WITH ____________ FSS ON ARRIVAL

FAA Form 7233-1 (8-77)

Flightplan Form

In order that these controllers have sufficient information to anticipate the movements of these IFR aircraft, pilots file a *flightplan* before actually taking off. This is filed through a Flight Service Station and entered into a networked nationwide computer system and fed as required to the various control authorities which will oversee the flight.

A flightplan consists of (at least) an aircraft's type (so the controller will have some idea of its performance capabilities), its true airspeed, the altitude it wishes to cruise at, its destination, and its intended route of flight to reach that destination. (Much other information may also be required, depending on the area to be traversed, but for our purposes this is enough.)

Various navigational beacons called *fixes* have been established over the years, along with *Victor* (low-altitude) and *Jet* (high-altitude) airways which form a complex spiderweb connecting these beacons. Aircraft flying IFR carry radio transmitters and receivers which allow them to track along these airways and maintain continuous communication with the ground at all times. In the absence of a specific instruction from a ground controller, each IFR pilot must maneuver his aircraft according to the flightplan he filed before taking off.

Los Angeles Area Instrument Flight Chart showing Airways, Fixes, and Instrument Approaches

Once an aircraft is airborne, it is continuously monitored by ground-based controllers during each phase of its flight. There are different controllers for each phase of flight.

Before taxiing from the gate, the pilot must call *Clearance Delivery* to get his actual flightplan instructions. Depending on traffic, weather, and delays, the route of flight he is given may or may not be what he requested.

Once he accepts the clearance, he calls *Ground Control* for taxi instructions from the gate to the active runway. Ground Control "owns" all the airport real estate except the active runway(s).

Once positioned in line at the active runway, the *Tower* clears him for takeoff, and after a takeoff roll he lifts off. Once his transponder (a radio beacon device which uniquely identifies him to the radar site) can be seen on the controller's scope, the tower hands him off to the local TRACON (Terminal Radar Approach CONtrol), which houses both *Departure* and *Approach* Controls for the surrounding airspace. His transponder reports his altitude as he climbs out, and the TRACON's computer system matches the transponder return with the aircraft's identifier and displays it all onscreen. As you would expect, this program simulates the environment of a TRACON facility.

After climbing to his requested cruising altitude, Departure control (that will be you!) hands off to the first of a series of Enroute or *Center* Controllers who monitor the more-or-less level flight's progress from an Air Route Traffic Control Center (ARTCC) until it reaches the vicinity of its destination.

For the descent to the airport, the flight is handed off to Approach Control (that's you, again), who issues turn and descent commands to line up the aircraft with the instrument approach into its destination. This process is generally called *vectoring* the aircraft, and usually results in maneuvering the aircraft until it is positioned at the correct altitude a few miles outside of the *Final Approach Fix* (FAF) for the destination airport.

The aircraft is then handed off to the destination tower, who clears it to land and finally turns it over the the local ground controller who has responsibility until it is safely parked on the airport ramp.

Handoffs

Since there are so many sectors in the ATC system, coordination between and among them is critical. Who has control of an aircraft at a particular point in time must always be unique and known to everyone involved with the aircraft. Transitions of control from one sector or facility to another are called *hand-offs*. In TRACON, since you control no airports directly (their respective Tower controllers do that) and are surrounded by the Center's en route airspace, you will use a handoff procedure for every aircraft you handle.

Inbound aircraft entering your sector will be at their cruising altitude (or level at some intermediate altitude, having been sent there by the Center controller already). Their target on the scope will immediately begin blinking, indicating that the Center controller wishes to hand them off to you. These aircraft may not proceed into your sector until you accept them -- that is one of the tenets of the absolute control regime of ATC. If you do not or cannot accept an aircraft, the Center controller has no choice but to hold the aircraft in his airspace until you can accept it. Once you accept the handoff, the aircraft can proceed normally under your control.

Similarly, departing aircraft are not released for takeoff by their tower until you say so. They hold on the ground (easier and more efficient than holding in the air, but burning precious fuel anyway). If the hold becomes protracted, they will start to complain about fuel use, but you have absolute discretion about when to let them depart.

As overflights or departures reach the edge of your airspace, they must be handed off to the adjacent Center controller. Likewise, after you have lined up an arrival so he will arrive at the FAF at the proper altitude and heading, you hand him off to the Tower, who takes him the rest of the way in. If he misses the approach because of pilot error or bad weather, the Tower will hand him off to you again once he has attained sufficient altitude to be seen on your radarscope.

Types of Flights

In TRACON, as in real life, you will deal with three basic types of flights:

1. *Overflights* are the easiest to handle. These aircraft enter your sector at one of its edges at a cruising altitude and wish to exit your sector at another edge straight and level at the same cruising altitude. If there were no other traffic, you would have to do nothing other than accept the handoff from one Center controller and then hand him off to another Center controller. Of course, life is rarely like that, and you might have to change his altitude or vector him around conflicting traffic in your sector. The key constraint in TRACON is that an overflight must be back at his original altitude when he exits the sector, or you will get an error generated for not adhering to the flightplan that Center expects.

2. *Departures* are still relatively easy. Once you release an aircraft for departure, the tower clears it for takeoff and presumably it starts rolling. You do not immediately see it on your scope -- the aircraft must have some altitude before its transponder can be seen by your radar system. That takes time -- usually a minute or two. Then, if you do nothing, the aircraft will merely turn to intercept its outbound course and proceed to climb to its cruising altitude (or the top of your sector control, whichever is higher). Just before it reaches the edge of your sector, you must hand the aircraft off to the Center controller.

Problems arise when an aircraft's requested departure time conflicts with others at the same airport (ever noticed how many airlines schedule 8:13 departures?), when it would conflict with an approach in progress, or when its normal climb-out would conflict with another overflight or climb-out from a nearby field. In this case, you would probably choose to either hold the aircraft or, more probably, release it for takeoff and then vector it or the conflicting one around each other.

3. *Arrivals* are the stickiest, mainly because they take so much of your attention. After accepting the handoff from Center, you must vector the arriving aircraft and also descend it so that it arrives at the destination airport's final approach fix at the correct altitude and heading from

which to begin the approach. This usually involves intense concentration and great skill, since you must anticipate when to turn and descend the aircraft and alter the times you give these commands depending on the specific aircraft type, Handling arrivals with finesse requires the most experience of all in TRACON.

Control Terminology

Each control environment has its own specific vocabulary. Most users will be familiar with the phrase "Cleared to land" -- tower terminology which means the subject aircraft will be the next arrival at the target runway and is guaranteed that the runway will be vacant when he arrives. TRACON has a similar set of phrases that, used properly, guarantee that the target aircraft will perform to your expectations during flight.

Overall, an aircraft's flightplan governs its general operations and route of flight, and its performance capabilities govern the speed with which it accomplishes those operations. The flightplan specifies when it expects to takeoff, what altitude it desires to cruise at, how fast it cruises, the exact route of flight, and the destination airport. In the event of communications failure, in fact, the flightplan (as last modified by a control authority) and standard rules of interpretation are used by both pilot and controller as the sole guidance for the rest of its flight. Pilots file requested flightplans, and then Clearance Delivery, who has been working in conjunction with the other control authorities, either approves it and clears the aircraft "as filed" or modifies it and issues a modified actual flightplan.

Performance capabilities of an aircraft determine much of its behavior. Except for the rule that aircraft may not fly faster than 250 knots below 10,000 feet, an airplane will generally proceed as fast as its normal cruise capabilities allow. Similarly, while small general aviation aircraft might be straining to climb at 500 feet per minute to their cruising altitude, a LearJet might rocket up at over 6000 feet per minute. IFR aircraft generally turn at three degrees per second, so heading changes are easily anticipated.

So overall, then, most of what an aircraft will do once he takes off is predetermined or outside of your control. You really only have three basic tools that you can use to separate aircraft:

1. ***Altitude***. "Descend and maintain three thousand feet...Roger, out of ten thousand for three thousand." You have probably heard such interchanges many times when you listened in on ATC frequencies.

Keeping planes apart with altitude seems simple, for it is, after all, a big sky up there. And indeed it is in "en route" airspace, where the traffic is generally boring holes through the sky flying straight and level. In fact, ARTCCs have evolved rules whereby aircraft travelling at certain headings or airways must travel at specified altitudes.

In the TRACON environment, however, things are not quite so simple, because your aircraft will be continuously descending to land or ascending to their cruising altitudes. Thus, while altitude is always useful in separating aircraft, you will find using it more difficult than you might think in the transitory environment of TRACON.

Sample vocabulary:

Controller: "November 3275 Tango, climb and maintain eight thousand feet."
Response: "Roger, Swift 75 Tango is out of five thousand for eight thousand feet."

Controller: "American 34 Heavy, descend and maintain three thousand feet."
Response: "Roger, American 34 Heavy is out of ten thousand for three thousand feet."

2. ***Heading***. If two planes are on a collision course, you can always turn one or both of them away. The process of issuing turn or heading commands to an aircraft is called "vectoring" in controller jargon. As a controller, you can command that an aircraft fly any particular compass heading from 001 through 360 degrees. Headings are specified as magnetic compass courses to fly, so magnetic variation (up to 17 degrees from true North on the West coast) affects the courses you specify. You should recall from your geography studies that 090 means East, 180 means South, 270 means West, and 360 (or 000) means North. You can also make fine relative heading changes by asking aircraft to "turn five degrees left."

Again, because of the rapidly-changing nature of the TRACON environment, and because it is poor form to keep an aircraft on a heading significantly away from its destination, this tool is less useful than you might think. Your use of heading in TRACON will mainly focus on lining up aircraft for their final approaches, just as your most frequent use of altitude might be meeting the FAF altitude requirement (more on that later).

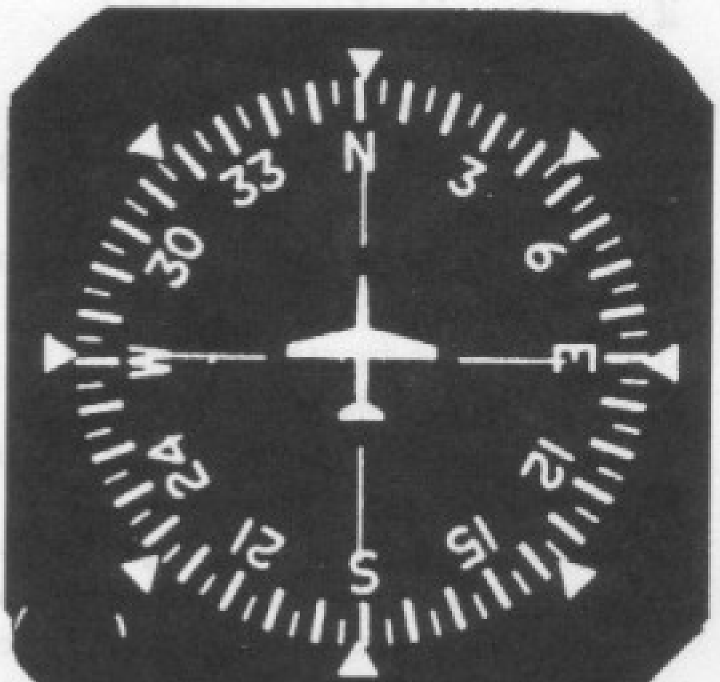
Sample vocabulary:

Controller: "Bonanza 345 Delta Zulu, turn right heading one zero zero degrees."
Response: "Roger, Delta Zulu, right turn to one zero zero."

Controller: "Delta Eleven Eighty-eight, turn left about twenty degrees to intercept final approach course."
Response: "Roger, Delta One One Eight Eight turning left twenty degrees."

3. *Speed.* A good controller is able to line up his approaching traffic on the extended centerline of the runway, tightly spaced, and the view from the tower, especially at night, has produced the descriptive jargon for this feat as a "string of pearls." To accomplish this, a controller must carefully adjust each inbound's speed so that the aircraft follows the one in front of it just so. Yet, since airspeed indicators and winds aloft change with altitude, an indicated 200 knots at 10,000 feet might be substantially different than the same speed near the ground. So speed adjustments must be made continuously and regularly. They are also the

most imprecise of all the adjustments available to you, for while the human eye can read the reported altitude off the radarscope directly, and can note direction of travel with some certainty, speed of target motion across the scope is particularly difficult to discern.



Directional Gyro with Magnetic Headings Shown

Sample vocabulary:

Controller: "Eastern Two Nine Two, please make your speed now one seven zero knots."
Response: "Roger, Eastern Two Ninety-Two is coming back to One hundred Seventy."

Controller: "Piper Twenty-three, can you keep your speed at one fifty on final?"
Response: "Roger, Seneca Twenty-three, one fifty all the way in."

This, then, is your charter as a TRACON controller: Keep 'em apart, but keep 'em on course and on time.

Let's Listen In...

This next demonstration requires any sort of cassette tape recorder. Get one out and put it near your computer. We are going to watch "over the shoulder" of a controller as he performs the above-described tasks in the TRACON environment. Standard terminology is used, but if you read the preceding material and watch the scope carefully, you should be able to easily follow what is going on.

You will need to synchronize the audio tape with the computer. This procedure is quite simple:

1. Set up your cassette recorder where you can hear it near your com-

puter and insert the TRACON cassette. You will not have to operate the recorder once you turn it on during this session, so you may position it across the room or use the cassette deck of a large stereo system.

2. Insert your TRACON working diskette or open the TRACON folder if you are working from a hard disk.

3. Start up TRACON by double-clicking on the TRACON icon. Select the file **TAPE.SIM** from the **Open** dialog box.

4. Press the **Play** button on your recorder and return to your computer.

5. Following the dictated instructions on the tape, press the **Return** key when you hear a beep tone on the tape. TRACON will synchronize itself with the tape player. Everything is automatic from this point on.

6. Now, sit back, listen to the tape, and watch the scope. The controller on the tape should voice all the commands that TRACON is issuing at about the same time as they appear onscreen. If that is not happening, please rewind the tape and start over on this procedure. After the demonstration ends, stop your tape player and rewind the cassette tape. TRACON will stop itself automatically.

3 The Simulator

TRACON provides a simulation of the complex real world of air traffic control. There are many aspects to this world, some you may adjust and many you cannot.

For instance, in real life traffic ebbs and flows according to time of day, geographic sector and a host of other variables. In TRACON, you may choose a particular sector to control and set the number of simulated aircraft which will be generated for that sector. The program's built-in rules determine the appropriate traffic mix for each sector. In Los Angeles, for instance, most traffic arrives and departs to the eastern hemisphere of the sector, since the Pacific Ocean lies to the West.

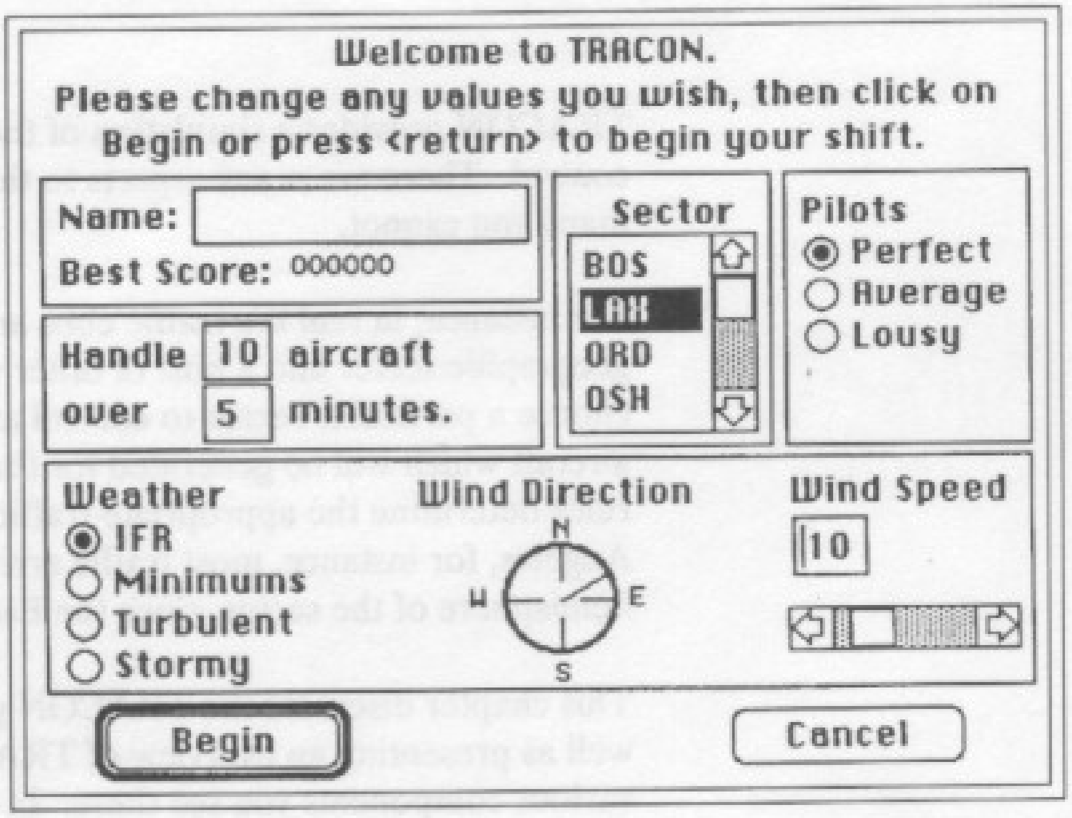
This chapter discusses the TRACON parameters that you may adjust, as well as presenting an overview of TRACON's display screen and the various components you see there. In order to better comprehend it, you might activate TRACON by clicking on the icon. This first section points out the features of TRACON's entry screen.

Starting a New Simulation from Scratch

You have probably noticed that you can enter your name on the **New** dialog box, as well as change the number of aircraft generated and the time span over which they enter your sector. You can also change the sector itself, as well as weather and pilot capabilities.

TRACON comes to you configured for an "average" beginning user. Ten aircraft are generated over a twenty-minute period in the Los Angeles sector (the example sector used throughout this manual), resulting in about four aircraft onscreen at once and a total scenario run time of about forty minutes to an hour. This results in scenarios which, although still difficult to handle without any practice, are nonetheless not too slow and boring.

You should be able to reasonably handle these beginner scenarios without too much trouble before attempting to change anything about the simulation.



You interact with this and all other TRACON dialog boxes using mouse clicks which follow conventions typically used in Macintosh software. Each value within the box can be highlighted and changed in turn. Initially, the first value (*Name*) is highlighted. When you have finished entering a new value, click on the next value in the box. If you make a mistake, just click on the value to highlight it again and retype the value.

If you prefer to use the keyboard, simply use the standard keyboard commands: **Tab, Backspace, Arrows, Spacebar, Shift-Tab** and **Return.** When you tab out of multiple-choice value areas, a check mark indicates your final selected choice. When the dialog box finally has everything set up just the way you want it, click on **Execute** or press **Return** to "accept" it and begin the simulation.

Remember: Pressing Esc will exit TRACON back to the top level menu.

The New dialog box contains the following adjustable values:

Name

Enter your name (first, last, or both). If more than one of person will be training, make sure that each user enters his/her name the same way each time.

Best Score

The highest score for each user will be stored and recalled after the name is entered. You cannot edit this dialog box value.

Control Sector

The filename of the sector you want to control. Sectors files included in this package are:

`LAX.SEC`	Los Angeles
`SFO.SEC`	San Francisco
`ORD.SEC`	Chicago
`MIA.SEC`	Miami
`BOS.SEC`	Boston.

Disks of many other sectors around the country are available from Wesson International.

___ aircraft over ___ min.

Fewer aircraft and/or more minutes will simplify; more aircraft over a shorter time will make the simulation more difficult. The maximum value for each of these fields is 99.

Weather

When you select this item, you may either choose the value with the mouse or type it in.

* *IFR*. The weather is keeping all the puddle-jumpers at home, but traffic is moving normally. Wind defaults to 10 knots. All approaches will terminate in a landing.

* *Minimums*. Occasionally an approach will be missed and an aircraft will popup as though taking off when you think you've finished with him (with the message "<*aircraft*>, Missed approach" in the Communications box). Initial miss instructions will be to continue on final approach heading, climb to FAF altitude, and contact Approach Control. Wind defaults to 20 knots.

* *Turbulent* and *Stormy*. Approaches are mighty difficult and lots of misses occur. Winds default to 30 and 40 knots, respectively.

Pilots

Select as above. *Perfect* pilots never make mistakes (hah!). *Average* pilots might ignore some commands, misinterpret others, execute a command intended for another aircraft, forget to turn at fixes, and do many other things that make life "interesting" for the controller in reality. *Lousy* pilots make it miserable. The most perfect sequencing of approaches can be totally destroyed by one turkey who misses the approach and has to come around again for resequencing, or a pilot who just doesn't understand or hear what you want him to do.

If pilot skill other than *Perfect* is selected, be prepared for the following sorts of pilot errors:

* Pilot does not reply to a command. Normally, every command you give will be at least "roger'ed" by the pilot. A short unobtrusive beep accompanies this reply, simulating the aural feedback of a normal radio transmission. If you do not receive this confirmation that the pilot heard and understood your command, then you must assume that he did not hear it and will not execute the last command unless you issue it again.

* "Please say last command again." He missed the command and needs it repeated in full. He continues his previous actions until you repeat the command. There are many variations of this action, including, "Sorry, approach. Had my head in a map. Please say again..." etc.

* Pilot misinterprets a command. For instance, when given a left turn he might turn right instead, or a turn to heading 080 might be implemented as a climb to 8000 feet. Problems like this are insidious. He might echo the command as he understood it, but then again he might not! It's up to you to spot his mistake and correct it for him!

* The wrong pilot might start executing a command not intended for him. Really tricky to detect, but it happens, especially when callsigns are similar (e.g., N12898 and N21989)!

* An aircraft overshoots a flightplanned turn or doesn't hold where required. For instance, assume an aircraft is tracking an airway heading 100 degrees. The airway veers right to 125 degrees, but the aircraft continues straight ahead after the turning point. Or, when climbing to 6000 feet, the aircraft continues its climb past that assigned altitude. Again, it's up to you to notice this sort of error and gently correct it without damaging the pilot's ego.

* A pilot strays from some assigned value. Told to climb and maintain 10000 feet, he gets there, levels off, then gradually over time descends down through 9000. Or, limited to 160 knots, he lets his speed creep up to 250 knots.

You should expect that pilots of the simpler aircraft will make more mistakes more often than those of the more complex, just as in real life. Airline pilots have probably flown their routes hundreds of times, but a doctor tooling around in his Bonanza probably doesn't get much actual IFR time and is likely to be less familiar with procedures in the area.

Wind

On the wind compass rose, arrow indicates the wind direction (where it's blowing from). Note that each weather pattern has a default wind speed. You may set wind speed by clicking on the scroll bar or by simply typing in a number. To set wind direction, simply click on the desired compass setting.

The Screen

In real life, a controller's work area is cluttered with computer-generated icons and hatch marks on his scope, printed strips of paper all over his console, taped-up communications frequencies and notes to himself, and of course, the radar targets of the aircraft in his sector. Your screen is considerably simpler, although your basic control task can be just as complex as his.

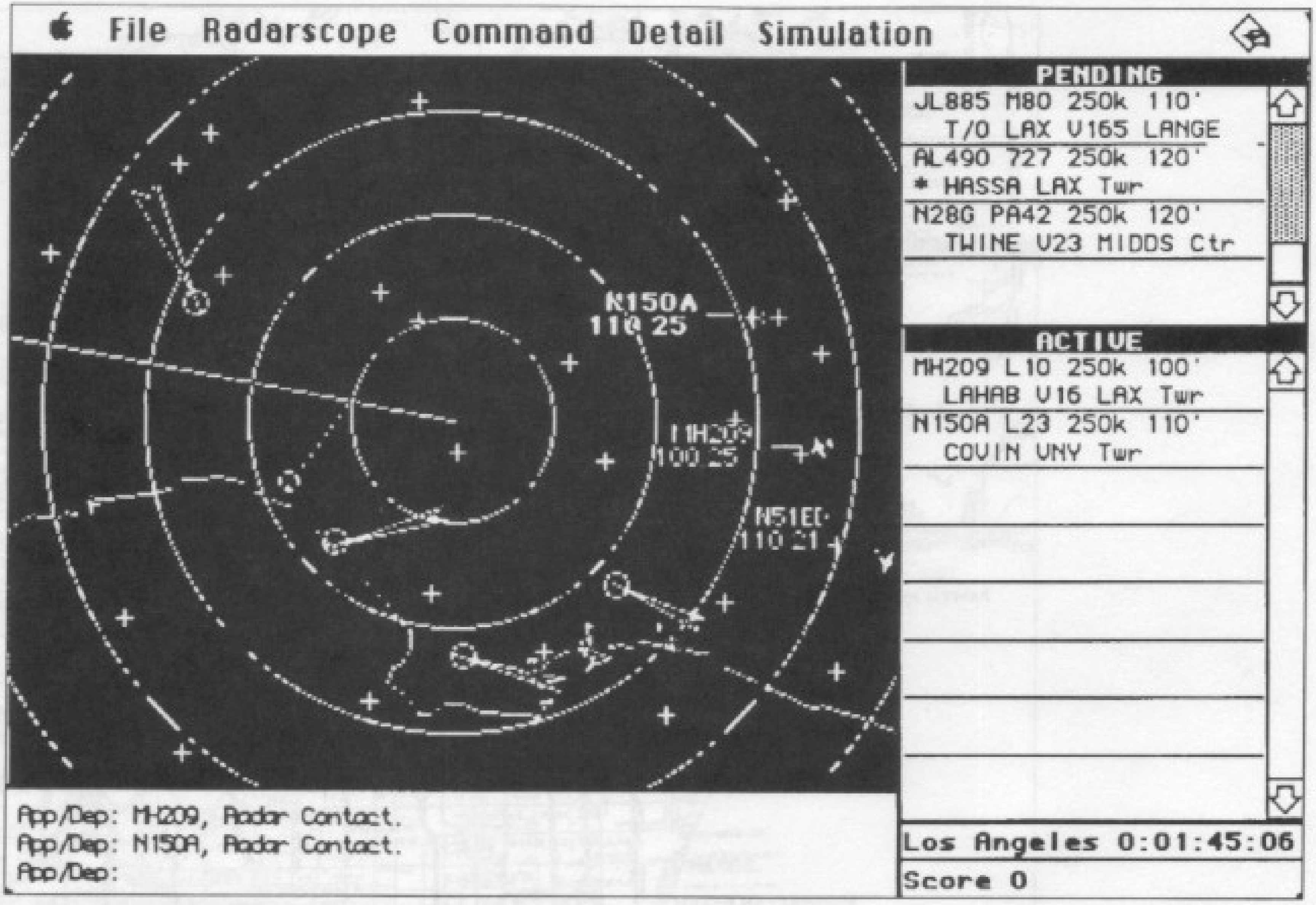
For all examples in this manual, we will use the Los Angeles sector (LAX.SEC). Please refer to the map on the facing page and the flying chart previously shown for the examples in this section.

Your computer screen is divided into four basic areas for this simulation -- the main *Radarscope* itself, which represents these charts electronically, the *Pending* flightstrips, which tell you what aircraft are coming at you; flightstrips of *Active* aircraft, and the *Communications* area where your interactions with the active aircraft and other control personnel are echoed.

Radarscope

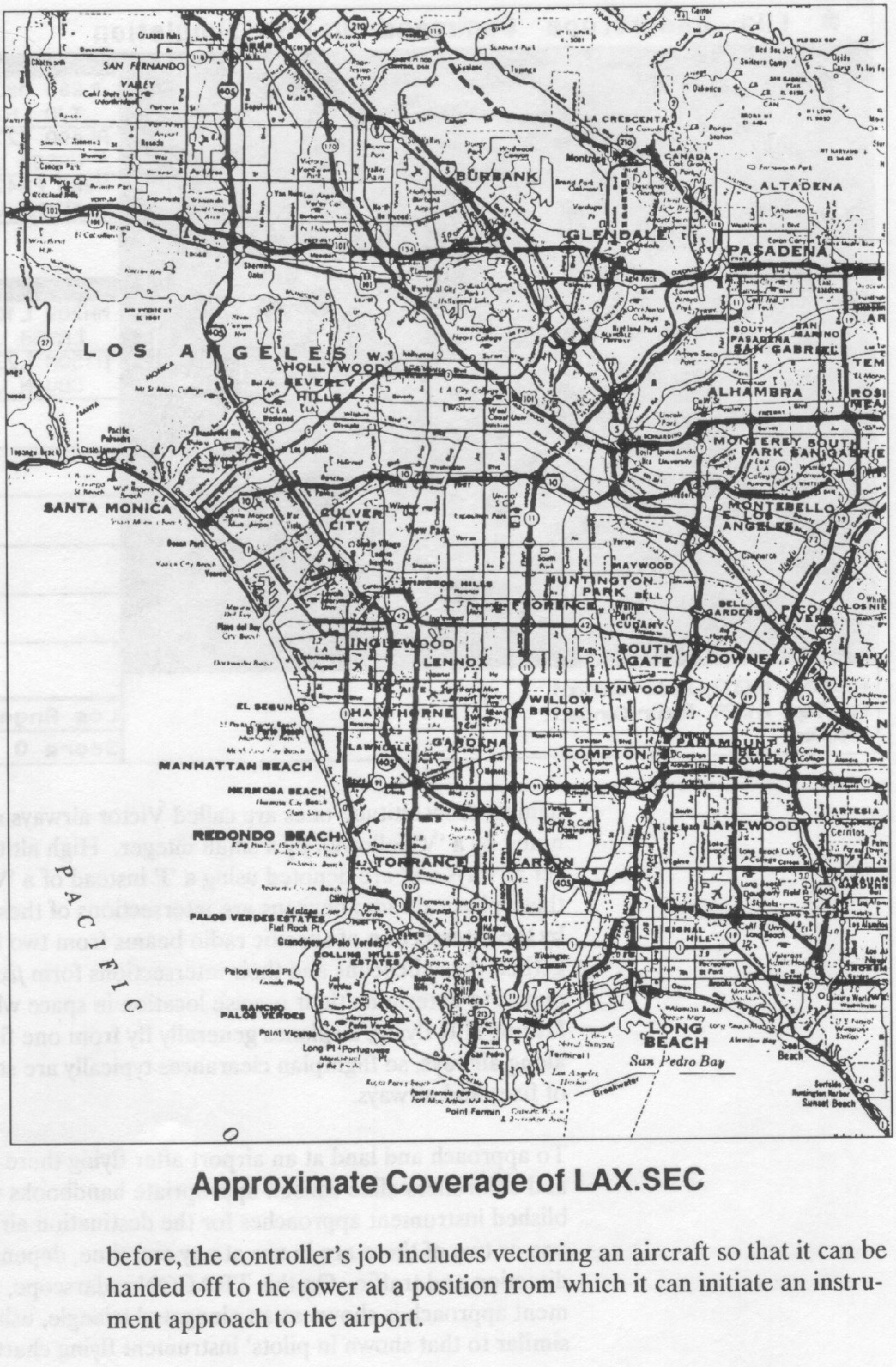
Naturally, the largest area of your screen consists of the radarscope. It is black with green lines and icons just like in real life. Imagine it as a "God's eye" view of your sector, with airports marked as circles (their ILS instrument approaches shown as funnels to FAF points, non-precision approaches shown as lines), intersections and radio beacons shown as plus signs. You should pay careful attention to the representation of these elements on the radarscope -- after some practice, you will begin to memorize the locations of the airports, important fixes, and even airways connecting them. (Selecting **Map Names (Cmd-M)** from the Radarscope menu during a simulation will display the entire map complete with the name of every fix and airport, while **Airways (Cmd-W)** will display the airway map complete with connecting lines between fixes. This display will revert to normal after one radar sweep.)

Since an instrument flight does not proceed by reference to ground landmarks, it must use some electronic method of locating its position. Radio beacons have been established for this purpose, and most planes fly from one beacon to the next. Like highways on the ground, these established routes of flight are called *airways* and have been given unique



names. Low altitude ones are called Victor airways and usually are denoted by a 'V' followed by a small integer. High altitude ones are called Jet airways and are denoted using a 'J' instead of a 'V'. Scattered among these physical radio beacons are intersections of these airways, created by the intersection of specific radio beams from two beacons. Taken together, these beacons and their intersections form *fixes* which allow planes to determine their precise location in space while flying in clouds. During IFR flying, airplanes generally fly from one fix to another, usually along airways, so flightplan clearances typically are stated as a sequence of fixes and airways.

To approach and land at an airport after flying there in the clouds, pilots and controllers alike consult appropriate handbooks which list the published instrument approaches for the destination airport. Usually only one or two of these are in use at any one time, depending on the wind direction and traffic. On this TRACON radarscope, the active instrument approach is shown as an elongated triangle, using a nomenclature similar to that shown in pilots' instrument flying charts. As mentioned



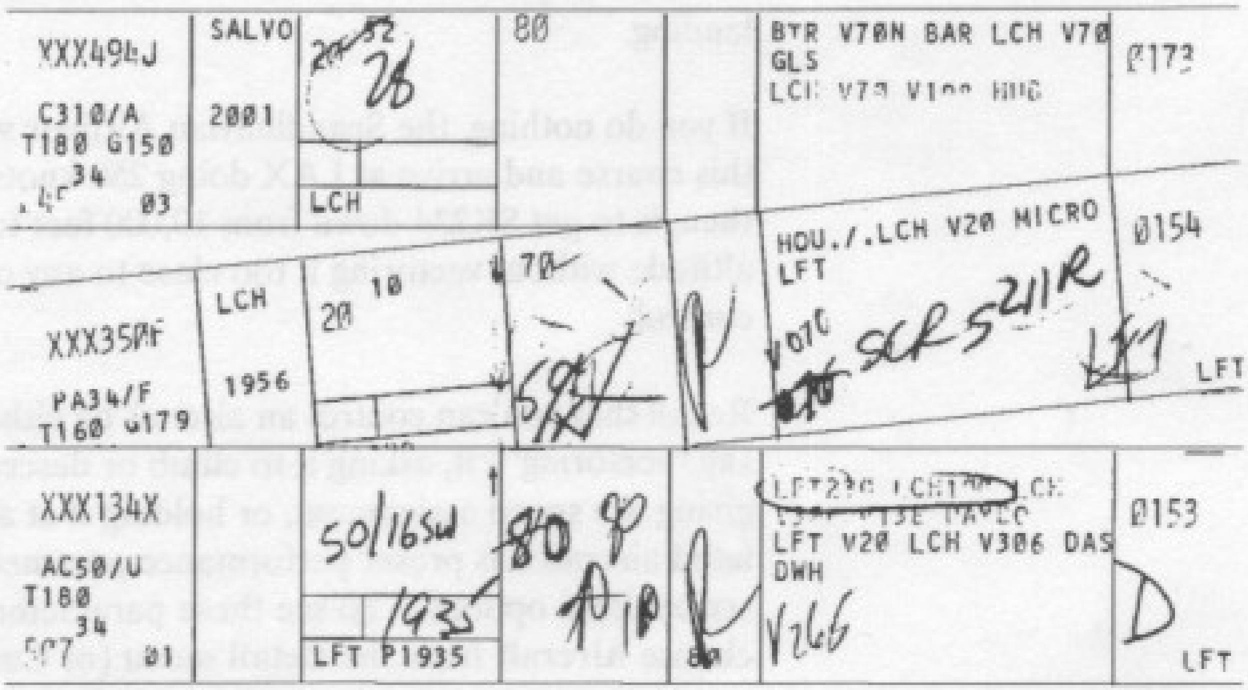
Approximate Coverage of LAX.SEC

before, the controller's job includes vectoring an aircraft so that it can be handed off to the tower at a position from which it can initiate an instrument approach to the airport.

On the scope aircraft will appear and move around. Each aircraft is shown via a small aircraft icon oriented in the direction of travel. Information about that aircraft is shown next to it, offset by a leader line to one of the eight major compass directions (N, NE, E, SE, S, SW, W, or NW). The information shown is its ID number, current altitude (in hundreds of feet), and its current speed.

Pending Flightstrips

About five minutes before an aircraft will be handed off to you from the Center or wishes to takeoff from one of the airports in your airspace, a flightstrip will be posted on the *Pending* stack (located on the top right-hand side of your display, light blue on color displays). A flightstrip gives you information about the aircraft's type, current position (including location, altitude, and speed), and requested flightplan (or route).



Notice how the controller has written notes to himself on the real flightstrips above. These remind him of commands he has already given to the aircraft, or of commands yet to be given that he must keep in his head.

Real Paper Flightstrips

A flightstrip looks like this in TRACON:

```
SK234 707 250k 100'
MIDDS V165 SLI DOWNE LAX Twr
```

This particular aircraft, Scandinavian Airlines flight number 234, is a 707 flying at 250 knots (all aircraft, even jets, are required to fly at or below 250 knots at or below 10,000 feet), level at 10,000 feet. Your control sector only extends upward to around 12,000 feet -- above that, the Center handles it, so that a nonstop flight from San Diego to San Francisco level at 25,000 feet would never appear on your scope.

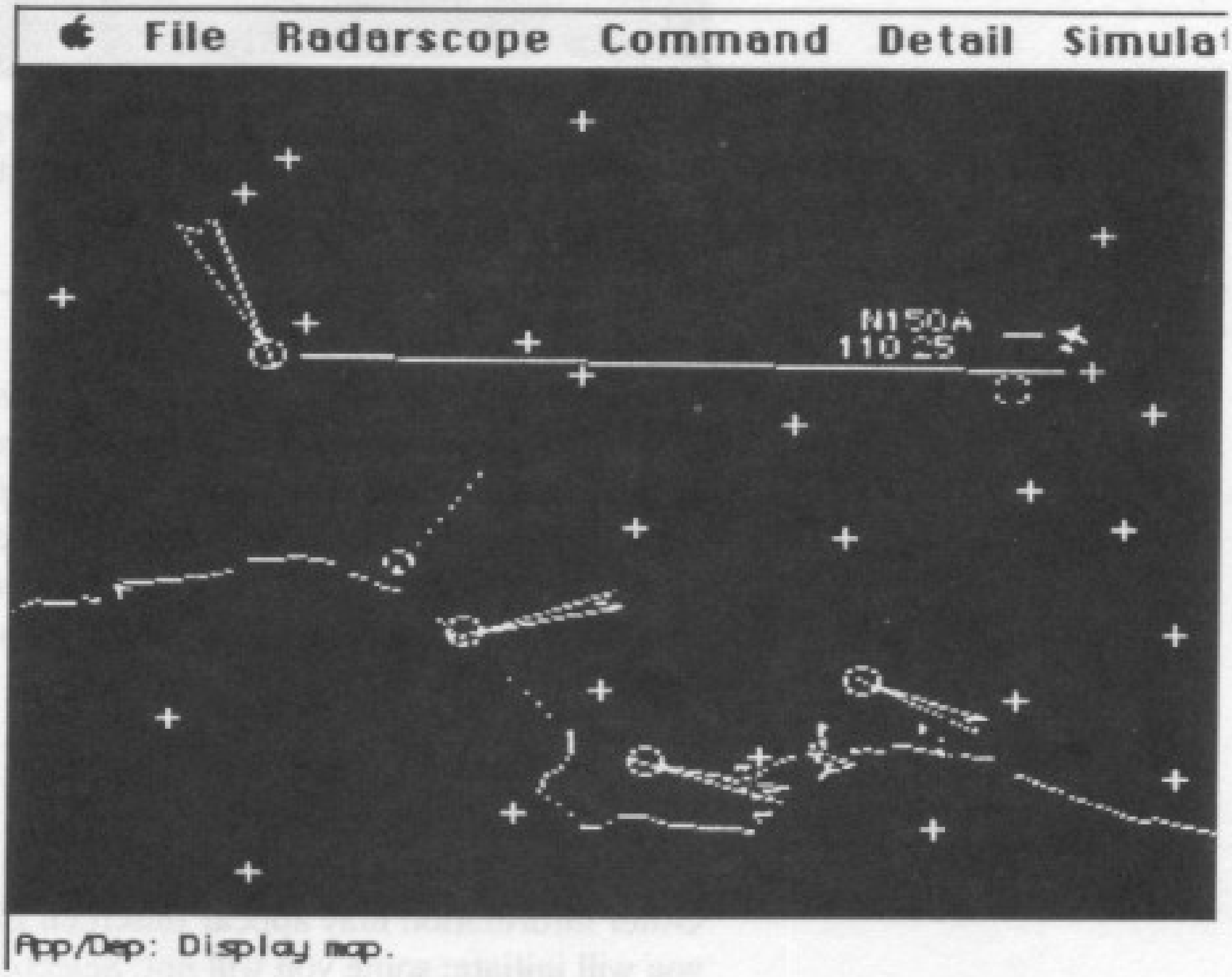
This airliner is coming in from MIDDS intersection (one of the fixes that instrument pilots use to locate themselves using radio navigation when flying in the clouds); will travel via Victor airway number 165 to the Seal Beach radio beacon, then direct to DOWNE intersection, then direct to the LAX airport where the tower there will assume final control for landing.

If you do nothing, the Scandinavian Airliner will proceed blithely along this course and arrive at LAX doing 250 knots at 10,000 feet. You job, then, is to get SK234 down from 10,000 feet to LAX's 1900 foot FAF altitude without vectoring it too close to any other aircraft under your control.

Recall that you can control an aircraft by either turning (real controllers say "vectoring") it, asking it to climb or descend to a particular altitude, giving it a speed assignment, or holding it at a specified fix. Each simulated aircraft has preset performance parameters which limit and circumscribe these options. To see these parameters, select the aircraft, the choose **Aircraft** from the **Detail** menu (or **Cmd-I**).

For instance, aircraft make "standard rate" turns so that their headings will always change at about three degrees per second. A jet will thus use up far more airspace than a piston single during a turn, for example. Each aircraft stalls out below a certain speed and cannot exceed other maximum cruising speeds, and each climbs and descends at various rates typical for its type (generally between 500 feet per minute and 3000 feet per minute). Using the performance envelope for each type of aircraft, TRACON's simulated aircraft will move through space in a manner consistent with, but not exactly equal to, the performance parameters shown for its type. In other words, an aircraft that whose normal cruise speed is 150 knots might enter your airspace actually doing 142 knots, for example.

An aircraft is posted to this stack five minutes before becoming active, giving you the opportunity to look over its intentions before having to do anything about them. To select an aircraft in the *Pending* stack and display its intended flight path visually onscreen, select **Flight Plan** from the **Detail Menu** (or **Cmd-F**). You cannot otherwise control these aircraft.



Active

The flightstrips of all active aircraft are shown in this (light green) area of the screen below the *Pending* stack. Each aircraft occupies two lines and you may use the screen commands to select aircraft here, scroll their flight plan lines, scroll the entire *Active* stack up and down, and otherwise view all the active aircraft. Note that the first line of each flightstrip remains constant, with the speed and altitude shown being the requested altitude of that aircraft rather than the actual values.

Communications

Since the Macintosh does not come with a voice recognizer, just below the radar scope is the written *Communications* area. Consisting of three lines, it echoes all communications between you, the active aircraft, and the adjacent controllers, as well as other commands you have entered and the simulation's responses to those commands.

You will soon notice that interactions between yourself and the pilots are relatively standardized. Whenever you accept a handoff from Center, the communications box echoes your "*<aircraft id>*, radar contact" transmission. When you issue a descent and the target aircraft hears it, he responds with "*<aircraft id>*, out of *<current-altitude>* for *<newly-assigned-altitude>*" This phraseology has been adapted from current procedures.

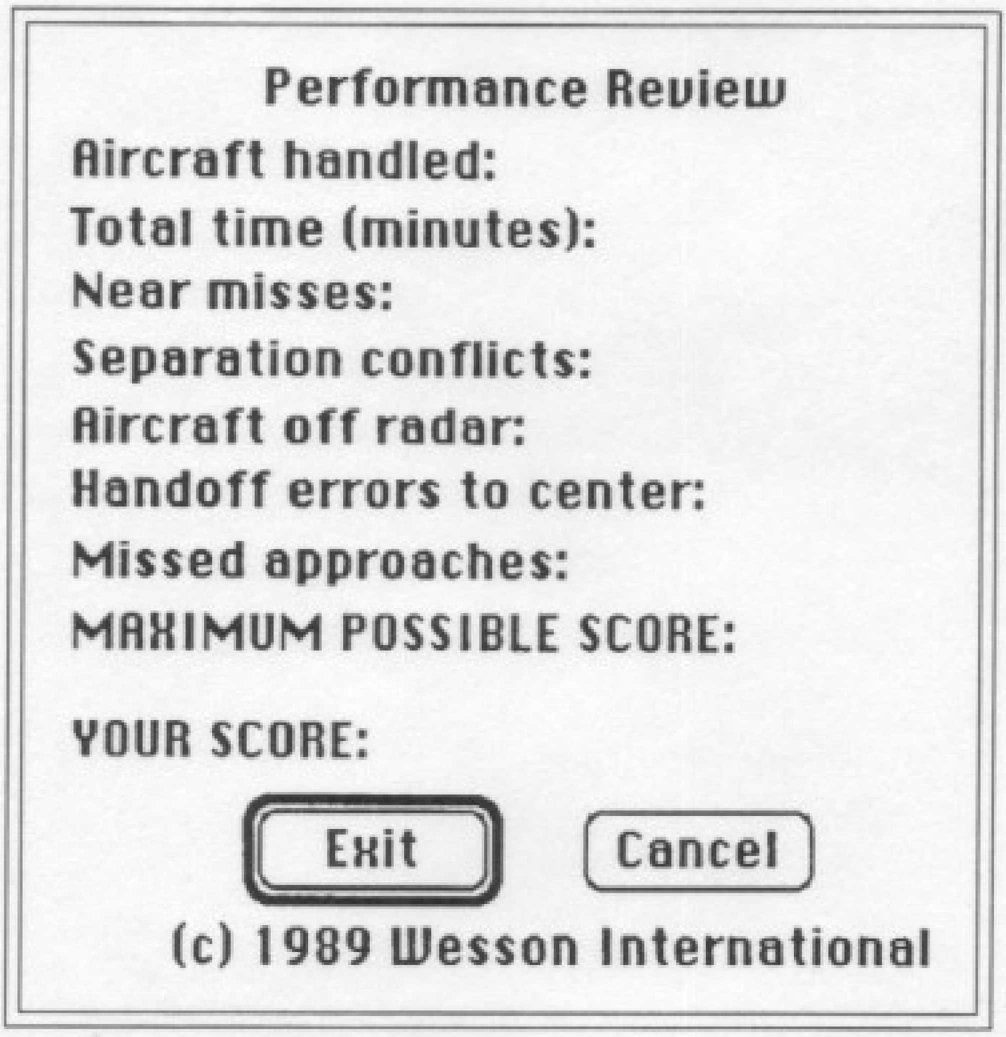
Transient Screen Items

Other information may appear onscreen from time to time. Some of it you will initiate; some you will not. Selecting **Map Names (Cmd-M)** from the **Radarscope** Menu, as mentioned above, will show the complete map with all fixes and airport names, while **Airways (Cmd-W)** will display airways. These are the sorts of things that you can make happen onscreen.

Other boxes are automatically popped up by TRACON. You will learn to dislike these boxes, for they usually report an error condition that detracts from your score measurably. These error conditions are described more fully in Chapter Five.

Exit Dialog Box

Selecting **Quit** from **File (Cmd-Q)** will popup the **Exit** dialog box which displays your final score (broken down by error types) and offers you the option to **Exit** the program or **Continue** (if there are still active aircraft to be handled).



4 Controlling Aircraft

This chapter discusses how to issue commands in the simulator. There are usually several alternative methods available to issue a command.

Command Syntax

As you have probably noticed by now, the general format of an aircraft command as stated verbally is:

<aircraft id> followed by
<command> followed by an optional
<parameter>

For example, to climb a N123DV to 6000 feet, a controller would say:

N123DV,	*<aircraft id>*
Climb and maintain	*<command>*
6000 feet	*<parameter>*

Or to clear the same aircraft directly to the Torrance airport, he would say:

N123DV	*<aircraft id>*
Cleared direct to	*<command>*
Torrance airport.	*<parameter>*

Some commands have no parameter slot:

N123DV	*<aircraft id>*
Resume normal navigation	*<command>*

So the general syntax for an air traffic control command is:

1. The aircraft you want to maneuver;
2. What you want that aircraft to do (turn, climb, etc.); and

3. The value you want the aircraft to achieve when it finishes the command (heading to turn to, altitude to climb to, etc.)

Every command must begin when only the *App/Dep:* prompt is showing on the last line of the *Communications* section; if something else is showing after that prompt, you are midway through some other command and should cancel it before continuing.

Selecting Aircraft

The first part of each command requires that you "select an aircraft," which can be done in two ways.

1. Position your mouse cursor over the aircraft icon or the aircraft's flightstrip and click to select it.

With the keyboard:

2. Type in enough of the aircraft ID to uniquely identify it. This involves the end of the aircraft identifier, not the beginning -- "N3953T" would normally be called "Cherokee Five Three Tango" on the radio and abbreviated here using its trailing "53T", not the leading "39" as you might otherwise expect. Terminate with any whitespace character (**space**, **Return**, **comma**, etc.); or

To reselect a just-previously-selected aircraft, simply reselect by clicking on either the aircraft's icon or flightstrip, or press **Return**. This is especially useful for issuing a rapid-fire sequence of commands to the same aircraft.

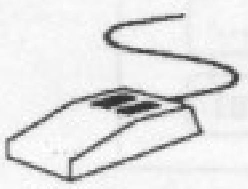
To cancel a selected aircraft, either click on a blank portion of the Radarscope or press **Return** again.

An aircraft is selected when you see its full ID echoed just after the *App/Dep:* prompt, and the next command you issue will affect that aircraft as though you had keyed your microphone and said, "Southwest Two Three Four, please ..."

If an aircraft signals that it is awaiting takeoff, double-click on its flightstrip or icon, or type in its ID and press **Return** twice. This will immediately clear it for takeoff and you should see it on your screen within a minute or two once it gains some altitude. Unless you intervene, it will automatically turn on course and climb to its flightplanned altitude. Use this same procedure to accept inbound handoffs.

Menu Commands

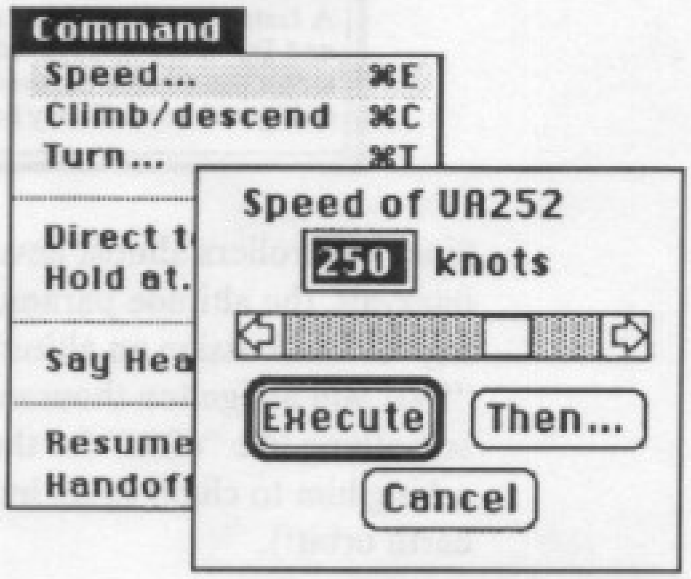
As previously mentioned, you select an aircraft using the mouse to click on either its icon or flightstrip. This simulates your pressing the microphone button and stating the aircraft's call sign.



Menu commands may be initiated by pulling down each menu with the mouse or via **Cmd**-key. The results are identical.

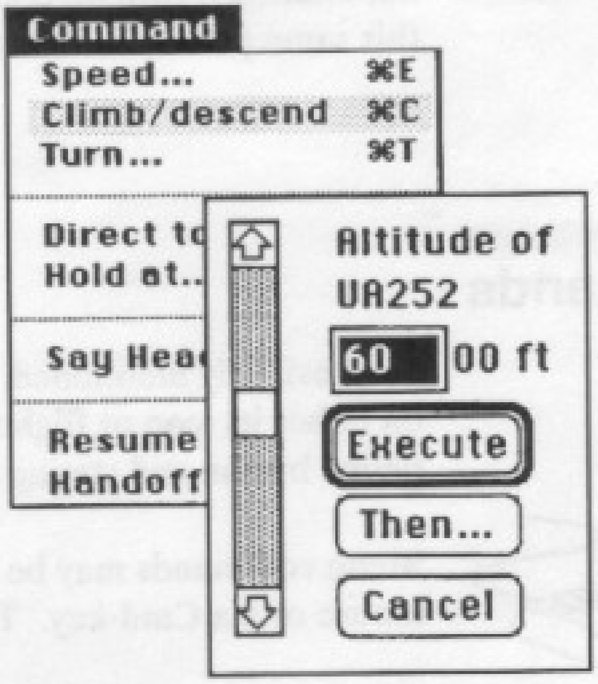
When you select an aircraft, by clicking on either its icon or flightstrip, the following options are available on the **Command** menu:

Speed ... Cmd-E



To bring up this dialog box, select **Speed (Cmd-E)**. Click on and drag the scroll bar to slow down or speed up an aircraft. Your assignment must be within the performance capabilities of the target aircraft or its pilot will complain. For instance, asking a Boeing 727 to slow down to 100 knots will just not work, since that aircraft stalls at around 120 knots. And asking a Cherokee to speed up to 250 knots is similarly futile.

Climb/descend ... Cmd-C

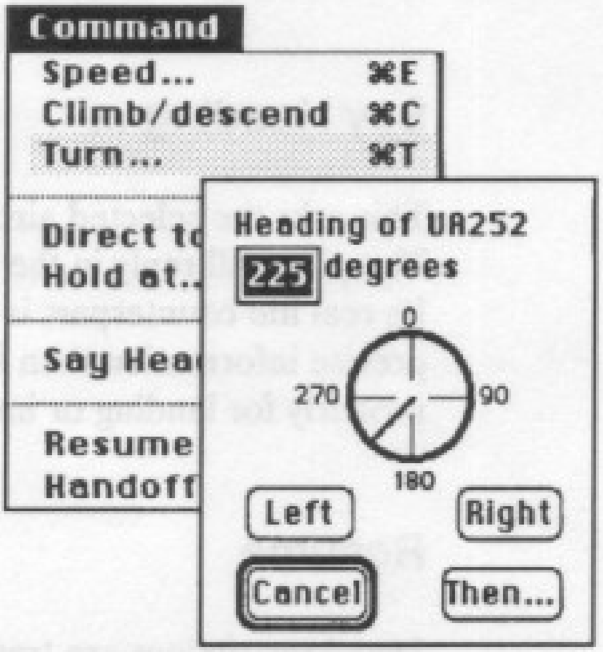


Choose **Climb/descend... (Cmd-C)** to bring up the dialog box. The selected aircraft's identification will appear in the upper portion. Click on and drag the scroll bar up or down until the desired altitude appears in the window, then click on **Execute**.

> A faster way to execute a **Climb/descend** command uses the **Up** and **Down arrow** keys. Identify the aircraft, select the command, strike the desired **arrow** key, and type in a number. The command string will immediately be shown in the communications box.

Since controllers almost never assign altitudes in other than hundred foot intervals, the altitude parameter is displayed in hundreds of feet. Entering "19" will assign an altitude of nineteen hundred feet, while entering "100" will assign ten thousand feet. A pilot will complain if you enter something like "6000" for the altitude assignment, since you are really asking him to climb to six hundred thousand feet (which would be in low earth orbit!).

Turn ... Cmd-T



Select **Turn... (Cmd-T)** to bring up the dialog box. Vector the selected aircraft by entering the number of degrees, or by clicking on the desired heading and selecting **Left** or **Right** to activate.

> Use the **Left/Right arrow** keys in the same manner as **Climb/descend** to issue turn commands rapid-fire: identify the aircraft, press left or right arrow, then type in the assigned heading

Direct to ... Cmd-D

Choosing **Direct to.. (Cmd-D)** clears an aircraft directly to a fix. After the radarscope displays all of the fix names, simply click on the desired destination. The aircraft will proceed directly to that fix.

Hold at ... Cmd-H

Similar to **Direct to..**, you may command an aircraft to proceed directly to a fix and hold there until you release it by choosing **Hold at.. (Cmd-H)** from **Command**. Then click on the desired fix on your radarscope. Aircraft cannot really just stop in space like helicopters can. Holding an aircraft requires that aircraft to fly in a circular pattern based upon the fix location until you tell it to "resume normal navigation" or clear it directly to another fix. This maneuver is aviation's equivalent of "just a moment," but deducts points since the aircraft is burning fuel while waiting in place. Pilots hate holding more than almost anything you can do to them!

Say Heading ... Cmd-G

This asks the selected aircraft to state its current heading and airspeed. The pilot will reply in the Communications box below the radarscope. Its real life counterpart is frequently used when a controller needs more precise information than he can deduce from his display to space aircraft properly for landing or intercept the glide slope.

Resume Cmd-R

Speed restrictions are tremendously useful, but you should remove them as soon as possible, since pilots hate them and your score will therefore suffer. Choose **Resume (Cmd-R)** to insure the instruction "Resume normal navigation." This gives the aircraft authority to proceed directly to the next fix in its flightplan and from there along its previously-planned route of flight. It basically means "Cancel any restrictions I have placed on you and continue normally along your flightplan." The assigned altitude remains unchanged, however.

Handoff Cmd-X

To handoff an aircraft to the appropriate tower or center controller, choose **Handoff (Cmd-X)**. When you clear an aircraft for an approach, it will turn and intercept the approach course for its destination airport. You still have control of the aircraft until it reaches the FAF, whereupon it will switch over to the tower frequency and you will be unable to contact the aircraft (unless it misses the approach and the tower hands it back to you for another try).

If the aircraft reaches the FAF without being at the required final approach altitude for the airport or is more than 30 degrees off the final approach heading, the aircraft will automatically execute a missed approach and fly outbound on the approach heading at its last assigned altitude. You must then bring the aircraft around again for another try, losing points in the process for inefficient fuel use and loss of time.

Similarly, if you attempt to handoff an aircraft to the center before it is within five miles of the handoff fix, the center controller will tell you that because it cannot yet see the aircraft on its radarscope it is unable to accept the handoff. If the aircraft is not at its requested altitude when it reaches the handoff fix, an error will still occur but the handoff will be accepted and the center controller will try to sort out the mess you created for him.

Stacking Commands

Every dialog box under the **Command** menu includes a **Then..** option. This option is used to link or stack commands in complete strings. The just-issued command appears after *App/Dep:* in the Communications box, with "Then.." showing on the next line. TRACON is now waiting for you to enter the next command in the string. This will continue for a maximum of five commands, or until you have completed the string. You may cancel a string of commands at any time by clicking on any blank portion of the screen.

For instance, a nice SOP (standard operating procedure) for taking inbounds from the Southeast into LAX is:

<aircraft id>,	Cleared direct to DOWNE;
then	Turn left heading 245;
then	Speed 180 knots.

An aircraft executing this stacked command will turn immediately and head straight for DOWNE intersection. Upon reaching DOWNE, it will <u>then</u> turn left heading 245 degrees (which will intercept the final approach course for LAX nicely). When the turn is completed, it will <u>then</u> begin slowing down to 180 knots.

Stacked commands are executed in sequence, with each subcommand beginning immediately <u>after</u> the previous subcommand completely finishes. This means that an aircraft must reach a cleared-to fix or the newly-assigned altitude, speed, or heading <u>before</u> the next subcommand will be executed.

If, during execution of a stacked command, you issue a real time command to the same aircraft, the type of the commands determine the resulting actions. Speed, altitude and heading commands are regarded as separate types. A newly-issued command of one type will erase all stacked subcommands of the same type, but not those of different types. Thus, using the above example, if the flight is heading for DOWNE and you issue the real time command,

"*<aircraft id>*, Turn right heading 340"

then the stacked commands to head for DOWNE and then turn left to 245 will be ignored. The speed command in the list will continue in effect, however, and will become the active command from the stacked command list, so *<aircraft id>* will begin slowing to 180 knots immediately. If an aircraft is executing a stacked command to proceed directly to a fix then descend to a new altitude, and you clear it to another altitude before it reaches that fix, then the stacked conditional descent will be ignored.

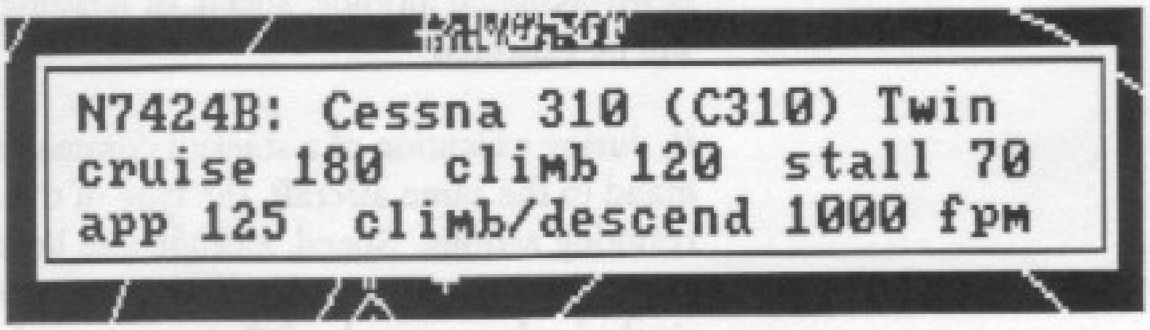
Selecting **Cancel** will cancel all stacked commands for an aircraft, of course, and force it to resume normal speed and navigation.
Note that communication stops during your construction of stacked commands, just as it does when your microphone button is depressed in real life. If you take too long in constructing such a command, you might end it and have several take-off requests and other backed-up communications quickly scroll by.

The best way to understand stacked commands is to practice using them in "don't-care" simulations.

Information Requests

Other commands are available to get more information about an aircraft and its intentions. With the mouse, pull down the **Detail** Menu and select the desired command (**Aircraft**, **Airport** or **Flight Plan**):

Aircraft **Cmd-I**



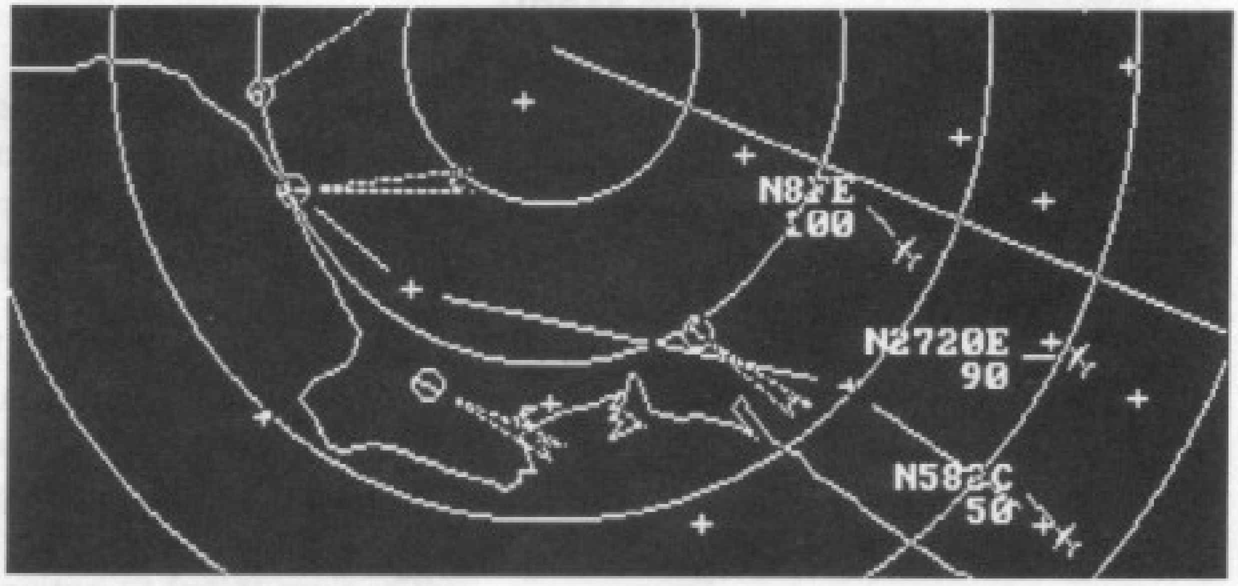
Display information about performance parameters for this aircraft, including its full name and type, climb, cruise, and approach speeds, climb rate in feet per minute, etc. The information will be displayed in a small popup white box and will disappear with the next radar update.

Airport Cmd-A

This command provides information about the airports in your sector. Type in the ID of the airport that you want information about, then select **Airports**. This command is especially useful when you forget the FAF altitude for an airport!

Flightplan Cmd-F

The flight path for the selected aircraft will appear on the radar scope, and will disappear with the next radar update. This command is incredibly useful to see just where an aircraft will go once it becomes active, or where the rest of its nominal flightplan would take it. Expert TRACON controllers use it frequently.



Notice the flight path shown for N582C (in the Southwest corner) to LAX.

/ (slash)

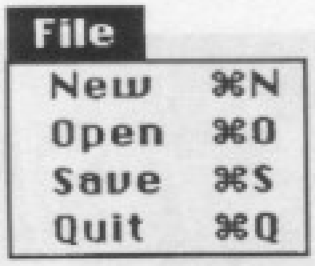
You may move an aircraft's leader line and information block to any of four quadrants using / (slash)-**arrow** or keypad **number** key. Or, you can move an aircraft's leader line to any quadrant simply by clicking and holding the mouse button on the aircraft, dragging from the center of the aircraft icon in the direction you want the leader line to point and then releasing. It takes far longer to say it than to do it.

Flightstrip Commands

Flightstrip commands do not require an aircraft to be selected, but are used to manipulate the flightstrips in general. Selecting a flightstrip is the same thing as selecting an aircraft, and once you have done so you may issue commands in the same way. Use the scroll bars to view all Pending or Active flightstrips, then select the one you want to work with.

Simulation Commands

Finally, various other commands can be initiated through either Mouse commands or **Command**-key combinations. Remember that you issue them by clicking on the desired command or by holding down the **Command** key and depressing the regular key simultaneously.



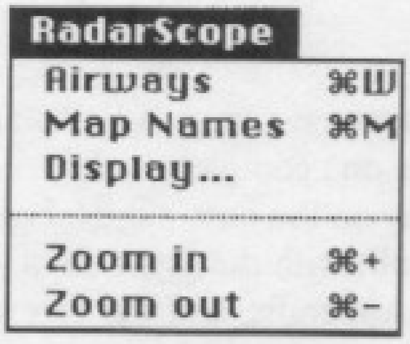
File Menu

New Select **New (Cmd-N)** to popup the **New** dialog box. Here you may type in your name, set new or accept default parameters and begin a new simulation. Click on **Begin** to start the simulation.

Open Selecting **Open (Cmd-O)** brings up a standard Macintosh dialog box of previously saved .SIM files. Use the scroll bar to view all of the current files, then select the one you want and click **Open**.

Save The **Save (Cmd-S)** option saves all the aircraft flightplans for the current simulation to a file of your choice. To execute the same simulation more than once, just select **Open**, and choose the desired simulation (*.SIM) file from the list. For consistency, the filename you enter should have a .SIM extension.

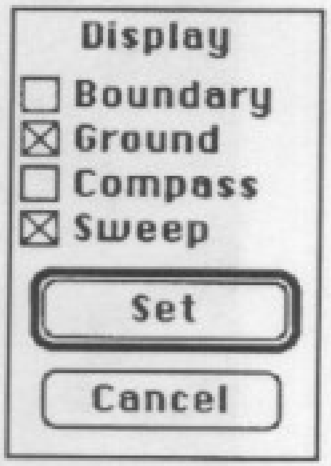
Quit — **Quit (Cmd-Q)** stops the simulation and returns you to the main screen.



Radarscope Menu

Airways — To display the actual airways onscreen, choose **Airways**, or use **Cmd-W**. Connecting lines between fixes and airway names will be shown on the screen. After one radar sweep, the display automatically reverts to normal.

Display — Using either the mouse or **Cmd-D**, this menu option provides you with four ways to change the view of the radarscope screen:



Boundary - You may display the boundaries of your sector by choosing this option from the **Display** dialog box. Fixes along the boundary determine where aircraft will enter and exit your control, so displaying this boundary will give you a good visual indication of entry/exit points.

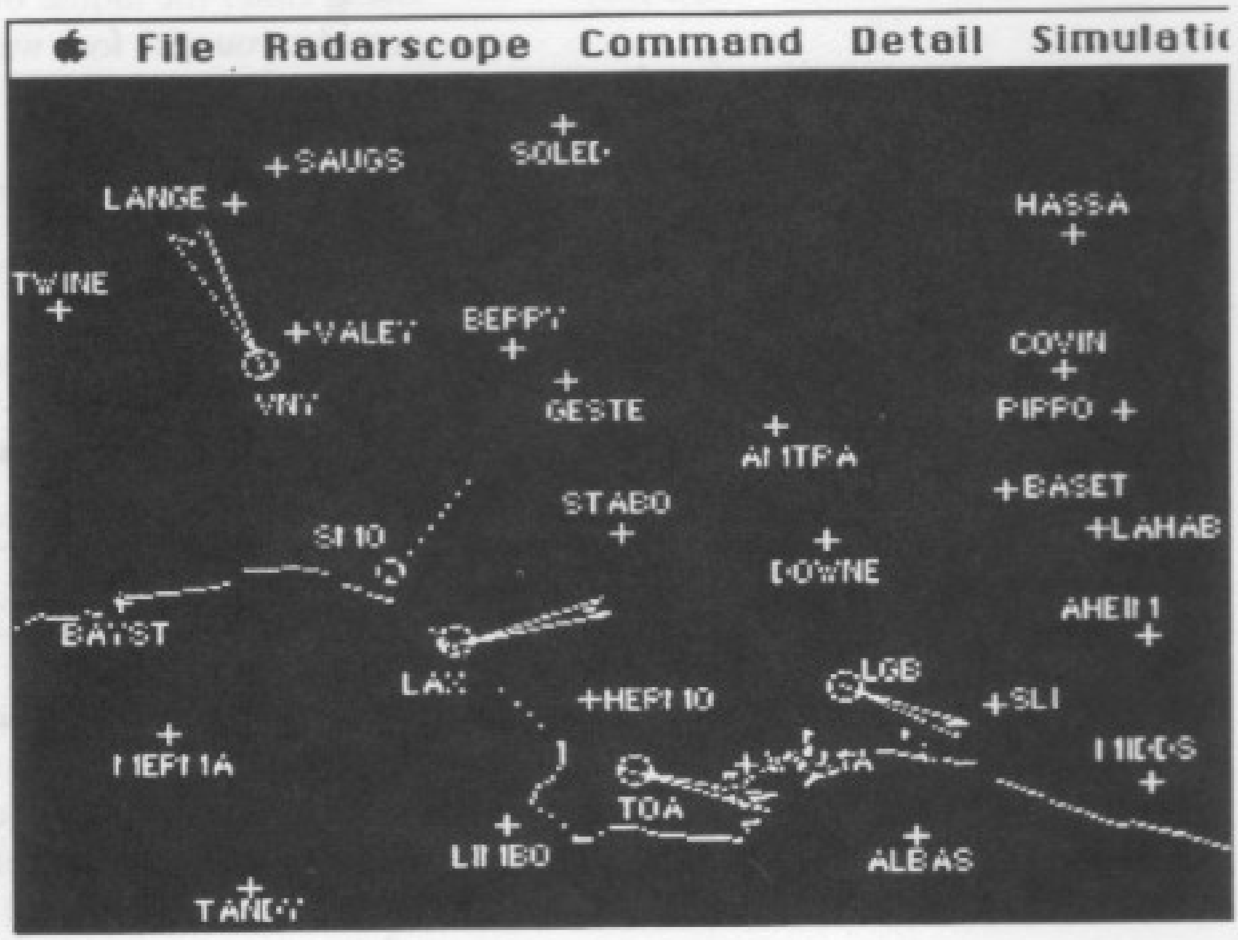
Compass - Also controlled via the **Display** dialog box, **Compass** is initiated in the same way as **Boundary**. This option overlays compass headings on the screen, and is toggled on or off as desired.

Ground - The third of four options controlled via the **Radarscope Display** dialog box, **Ground** is also initiated in the same fashion as **Boundary** and **Compass**. Choosing **Ground** will display the topography of your sector on the screen, and may be toggled on or off in the same manner as the other **Display** commands.

Sweep - Toggling **Sweep** allows you to see or remove the radar sweep from your screen.

Mapnames

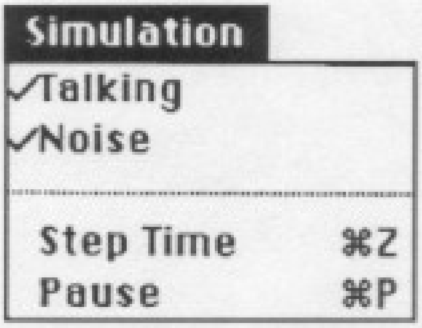
Select **Mapnames (Cmd-M)** to see a map of fix names. The map will disappear after one complete radar update. Compare the display on the next page (shown with Airways displayed as well) with the flight chart of the LAX area shown in the Appendix, and you can see how the electronic chart relates to a paper one.



Zoom In

Selecting **Zoom In (Cmd+)** will zoom the radarscope on the selected or last-selected aircraft. Each press will increase the zoom by a factor of two, so that after you press it once, the scope is shown at 2x magnification, and after the next press it is shown at 4x. You can thus look more closely at a congested area, but be careful -- events might be happening offscreen that also demand your attention.

Zoom Out — On the other hand, selecting **Zoom Out (Cmd-minus)** performs the inverse function -- it zooms back out after you have zoomed in. If you are displaying the radar-scope at 4x, the first press of **minus** will zoom out to 2x, while the next press will zoom out to 1x.



Simulation

Commands issued by way of the **Simulation** menu provide controll over the simulation's sound and time parameters, with the first two initiated by simply toggling the selected command. **Simulation** commands include:

Talking — TRACON comes with both pilots and controllers talking. **Talking** may be turned on or off by toggling this menu option with the mouse, or **Cmd-T**.

Noise — With **Talking** off, TRACON beeps, rings and whines depending on who is "communicating." This parameter defaults to on, but can be toggled on and off in the same manner as **Talking**, or by **Cmd-N**.

Steptime — Toggling this parameter (or **Cmd-Z**) jumps the simulator's clock forward one cycle. Repeated, it forces the computer to zip the aircraft across the screen as fast as its processor can go. Since a real controller's life is hours of boredom punctuated by moments of sheer terror, <u>do not use this command</u> if you want to experience what a controller really does. However, it does save time when simply finishing out a scenario and also allows you to skip over boring periods when nothing interesting is happening.

Pause — Choosing this parameter pauses the simulator, and operates in the same manner as the other **Simulation** menu options. (For the keypad, press **Cmd-P** once to **Pause**, and again to resume action.) <u>You should never use this command</u>, because it is really <u>cheating</u>, but it does allow you to stop the simulation for a moment to collect your wits. Pausing the simulator immediately deducts 10,000 points from your score so you will not be tempted to use it during a scenario that "counts."

5 *Make a Plan and Make It Work!*

The title of this chapter is an old saw in ATC circles. It means that you have to think ahead and commit yourself to a plan of action and then follow through decisively. Bad control emerges from making tentative calls and then constantly revising them. In this chapter, we will discuss how to make that plan, how to make it work, and what to do when it falls apart!

Elements of Good Control

A good air traffic controller handles traffic at several mental levels at once. The basic FAA manual of Air Traffic Control requires that a controller "Give first priority to the separation of aircraft ... and to the issuance of safety advisories." What this means operationally is that your first priority is to insure that aircraft never <u>never</u> be permitted to come within a prescribed distance of each other. In TRACON, as is generally true throughout the system nationwide, this means three miles or a thousand feet.

If they do, you have caused what is called a "separation conflict". In today's safety-oriented ATC environment, even one such separation conflict is cause for disciplinary action. You should never tolerate a separation conflict, even in this simulation. A real air traffic controller's life is spent in a zero-tolerance environment where no mistakes are allowed. Your goal should be the same: separation restrictions must always take precedence over your other activities.

Once you have separation achieved, there are other requirements you face:

Arrivals

Arrivals must be set up for their approach via a series of vector and descent commands. Typically, Center will have descended an arrival from its cruising altitude to somewhere near the top of your control sector, ten to twelve thousand feet or so. When you first see the aircraft on your radarscope, its blinking will indicate that Center has offered you the handoff. After selecting the aircraft, you have accepted it and can now issue control commands. Usually, you must continue its descent down to the FAF altitude for its destination airport. This altitude is listed in the airport information at the back of this manual and is available online under **Airport (Cmd-A)**. Select **Airport**, then click on the one you want information about.

Then, while the aircraft is descending, you must vector it into alignment with the approach course. If you have multiple aircraft inbound for the same airport, you may also want to use speed adjustments to set up all the aircraft on extended final approaches with minimal separation. Although vectors are usually given in absolute magnetic headings (e.g., "...turn left heading 170 degrees"), a handy shortcut is to turn aircraft relative to their current heading (e.g., "...turn left 20 degrees"). This latter command syntax allows you to make small adjustments to an aircraft's course without having to remember its current heading.

Once you get an aircraft within the vicinity of the approach course, you can use **Handoff** or **Cmd-X** to clear it for the approach into the airport. The aircraft will immediately turn to a heading that will intercept the final approach course, fly that heading until it is lined up for the approach, then continue inbound to the final approach fix where its pilot will switch to tower frequency and begin a descent to the field. Unless the aircraft misses this approach, it becomes the tower's responsibility at that point and you are finished with it.

Departures

Although an airport's control tower "owns" the runway and clears all departures for take-off, they must have your permission to release an IFR departure. You therefore can determine when to take an aircraft off after the tower informs you that the aircraft is ready. Bear in mind that the aircraft is sitting at the end of the runway with its engines running, so you should try to release a departure as soon as possible after you receive that request.

Once you release a departure, the tower clears it for take-off and the pilot begins to rev-up his engine. After a few moments, he starts his roll down the runway and before long is airborne. Since your radar cannot pick up targets until they reach a few hundred feet in the air, you will typically not see a departure on your radarscope until a minute or so after you release it.

Once airborne, a departure will begin turning to its on-course heading and climb to its flightplanned altitude unless you direct him otherwise. It will climb out at a normal rate of climb for that aircraft until it reaches its flightplanned cruising altitude, then level off and continue flying on course. You may, at any time, alter these initial instructions with vector, altitude, or speed commands of your own, but the aircraft must be at its requested altitude, speed, and outbound fix when it reaches the edge of your sector for handoff. If you do not issue any instructions to the aircraft before it reaches that outbound fix, and the aircraft has not climbed enough to reach its requested cruising altitude, you may still hand it off to Center normally there. If you have countermanded its normal procedures with instructions of your own, however, you must hand it off at the flightplanned altitude and speed.

Overflights

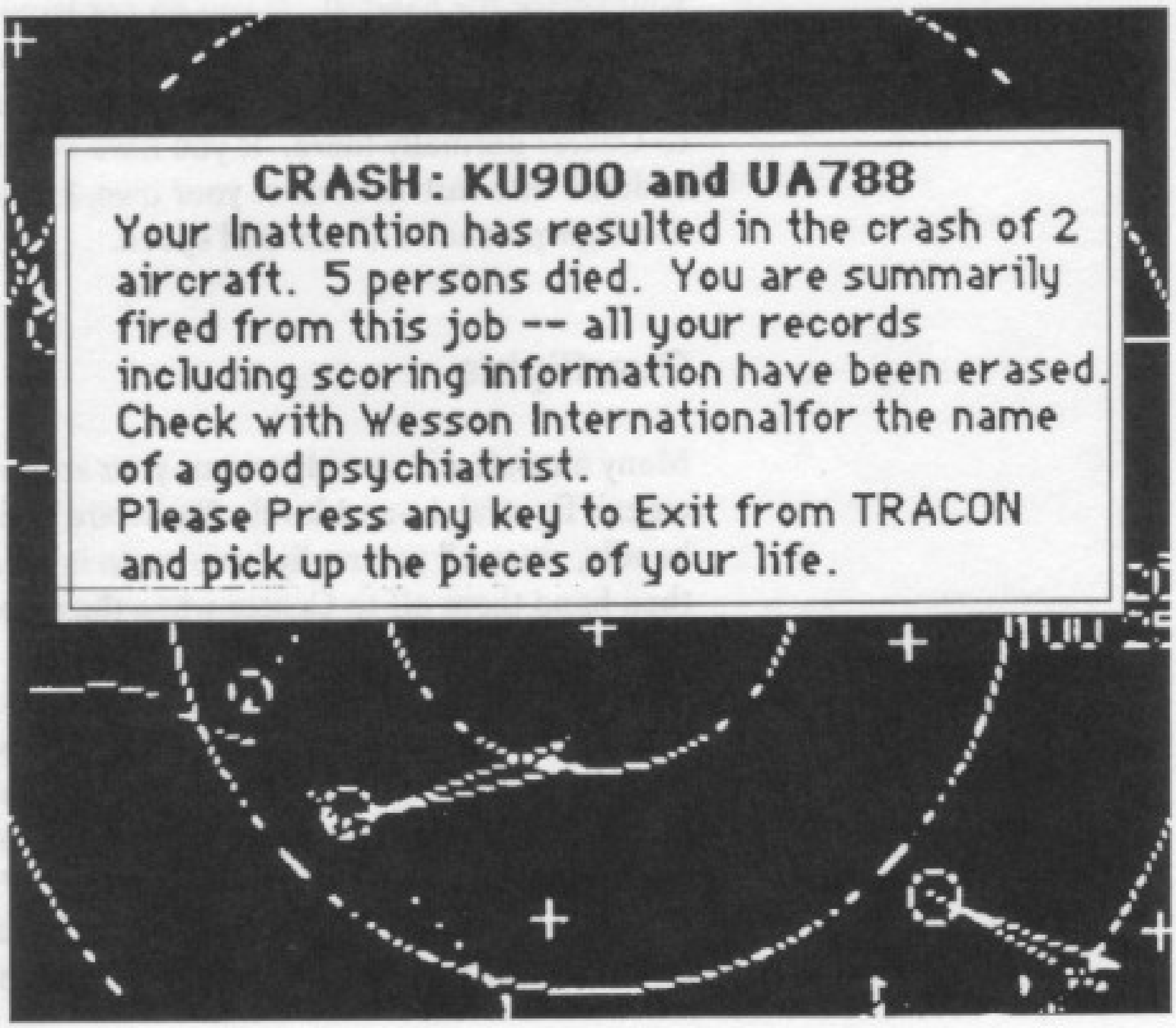
Many aircraft will merely transit your sector, flying from an entry fix to an exit fix straight-and-level. These are typically the easiest aircraft to handle, since all you really have to do is accept the entry handoff and then hand them off to Center when they reach the exit fix.

They do tend to complicate your control problem, however, since they tend to remain on your scope for long periods of time. Remember also that airline overflights tend to cruise at flight level altitudes (e.g., above 18,000 feet) so the overflights you get will usually be general aviation aircraft with relatively slow cruise speeds. A Piper Cub cruising at 50 knots will remain on your scope for a long time, cluttering it and making coordination with the faster traffic more complicated.

Keep 'Em Apart!

TRACON, like its real-life counterpart, has many constraints placed on your ability to accomplish the above procedures. Violating the primary constraint, so that aircraft do indeed come too close together, can cause three different types of errors.

The most critical of these is not to *Crash* two (or more!) aircraft together. A Crash is defined as a separation of less than 1/2 mile horizontally and 500 feet vertically. If that occurs, the simulation ends immediately: you lose your job, all your employment records (i.e., previous high scores) will be erased, and you will be unceremoniously dumped back to the DOS prompt after an unpleasant message about the number of people you have killed (computed based upon the number of passengers in the aircraft involved) and about your probable future. The program may recommend that you enter psychological counseling for killing those poor unsuspecting passengers, for instance. Causing an airplane crash is not something to be taken lightly, even in TRACON!



A less serious error is a *Near Miss,* defined as separation of less than one mile and 1000 feet vertically. This and all other errors subtract from your point score, depending on their severity. This one subtracts a lot -- it is the worst thing you can do and not be immediately dismissed. It is accompanied by a high-pitched lengthy wail that should awaken you to your error and keep you from ever wanting to do that again.

The least serious separation error -- a simple Separation Conflict -- will occur when you break the 3 mile/1000 foot rule mentioned before. While not as severe as a near miss, you still receive a reprimand and a long series of beeps. As in real life, the computer continuously monitors for these separation errors and automatically notes them in your performance review.

The above errors are substantial. The latter two are cumulative, in that every sweep of the radar will announce the error anew and deduct points from your score. Thus, the longer you have a separation conflict in progress, the more it counts against you.

Handoff Errors

Interfacing with adjacent controllers, you must accept and handoff aircraft properly, too. When an aircraft first appears on your radarscope, it will blink and announce inself in the *Communications* section. You will first see the aircraft at the edges of your scope and it will be traveling directly to the inbound fix shown on its flightstrip. If you do not accept the handoff by double-clicking on the aircraft with a mouse, it will reach the end of its Center clearance and go into a holding pattern at the inbound fix and stay there until you accept the aircraft. This, of course, will ultimately deduct from your score, since it stops the aircraft's forward motion through your sector and hence increases its delay.

Landing aircraft must be cleared for the approach before reaching the FAF for their destination airports. If you have successfully vectored them so that they arrive at that FAF within 200 feet of the required altitude for the approach and heading within 30 degrees of the final approach course, then the Tower for that airport will accept the aircraft and they will disappear off your scope normally as they descend on the instrument approach. If an aircraft is not within this envelope when you attempt a Tower handoff, it must declare a missed approach and continue on the approach heading at its last assigned altitude until you bring it around again for another try.

Handoffs to Center for aircraft leaving your airspace must be handled properly, too. If you have vectored (or allowed its own internal navigation to get it there) an aircraft to within five miles of its flightplanned outbound fix at its requested altitude, then the Center will usually accept your handoff. Of course, during bad weather, the Center controller may have his hands full with the aircraft already in his airspace, so you will occasionally "hear" him reply to your handoff request that he is too busy to accept an aircraft just then. You will simply have to hold the aircraft or vector it around for a couple of minutes and try again later. Eventually, Center should accept your handoff.

Coordinating with Center is sometimes touchy. If you attempt to hand an aircraft off to Center when the aircraft is more than five miles from its outbound fix, the Center controller will report that he cannot yet see the aircraft on his scope and to call again later. Also, if you do not have the aircraft at its flightplanned altitude and speed at the handoff point, a *Caution* message box will popup and points will be deducted from your score. This is not a severe error, but it does increase the workload for the Center controller and cause him to question your abilities.
If you forget to make the handoff altogether and allow the aircraft to reach its outbound fix or the edge of the radar without a handoff, a box will popup reminding you that you let the aircraft fly out of your sector without coordinating with the adjacent controller. Losing an aircraft like that from your scope is really bad form.

Occasionally, as these sorts of errors occur or other information needs to be shown, a small box will temporarily popup on the main radar screen. If you have a color monitor, the color of this box will mirror its contents:

Red	Bad error. Near Misses, Separation Conflicts, and losing an aircraft off your scope produce this color box.
Yellow	Not-so-severe error. Missed approaches or letting an aircraft exit your radarscope without a handoff will generate a yellow box error.
White	This sort of box displays routine information such as aircraft performance or airport parameters (only when you request it).

If you have a standard monochrome Macintosh monitor, all error boxes will be white.

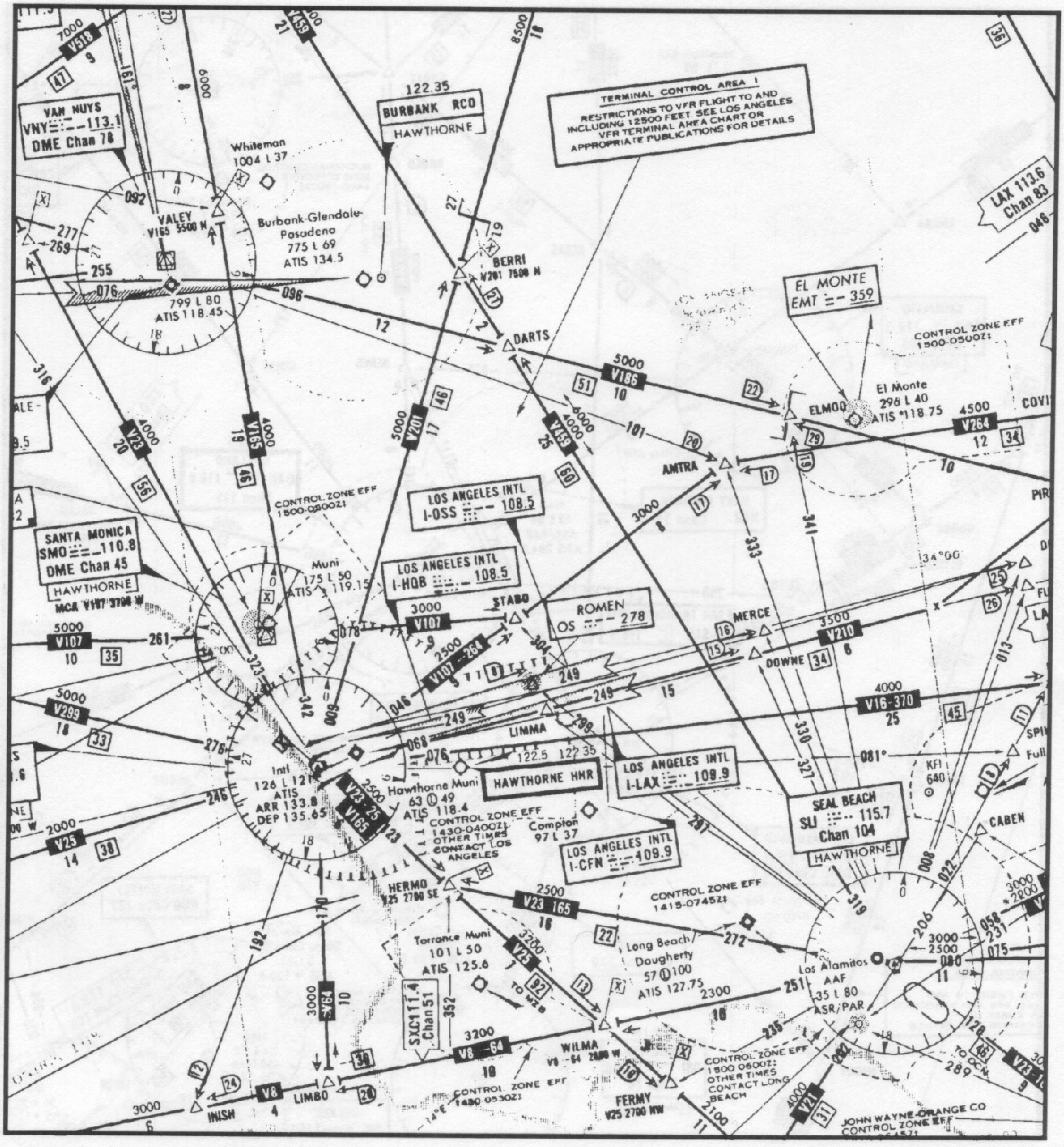
Scoring

As you successfully handle an aircraft, your score will rise according to how well you did with it. You get points each time you make a successful handoff (to either Tower or Center), but those points are adjusted downward by the distance you required the aircraft to travel beyond its requested flight path. Points are also subtracted according to how long you held the aircraft on the ground or at its inbound fix before accepting it. Finally, points are deducted for every control command you gave to the aircraft. Remember -- your job is to be unobtrusive. The more you "interfere" with an aircraft's planned route of flight, the worse you are doing (at least from his individual perspective).

Since different types of aircraft use fuel differently, the actual number of points awarded after handling an aircraft depend on its type. Military jets gulp fuel at an astounding rate and generally merit the most such fuel-related point adjustments. In descending order of importance, airline jets, corporate jets, twins, and then piston singles also get you points when they are finished.

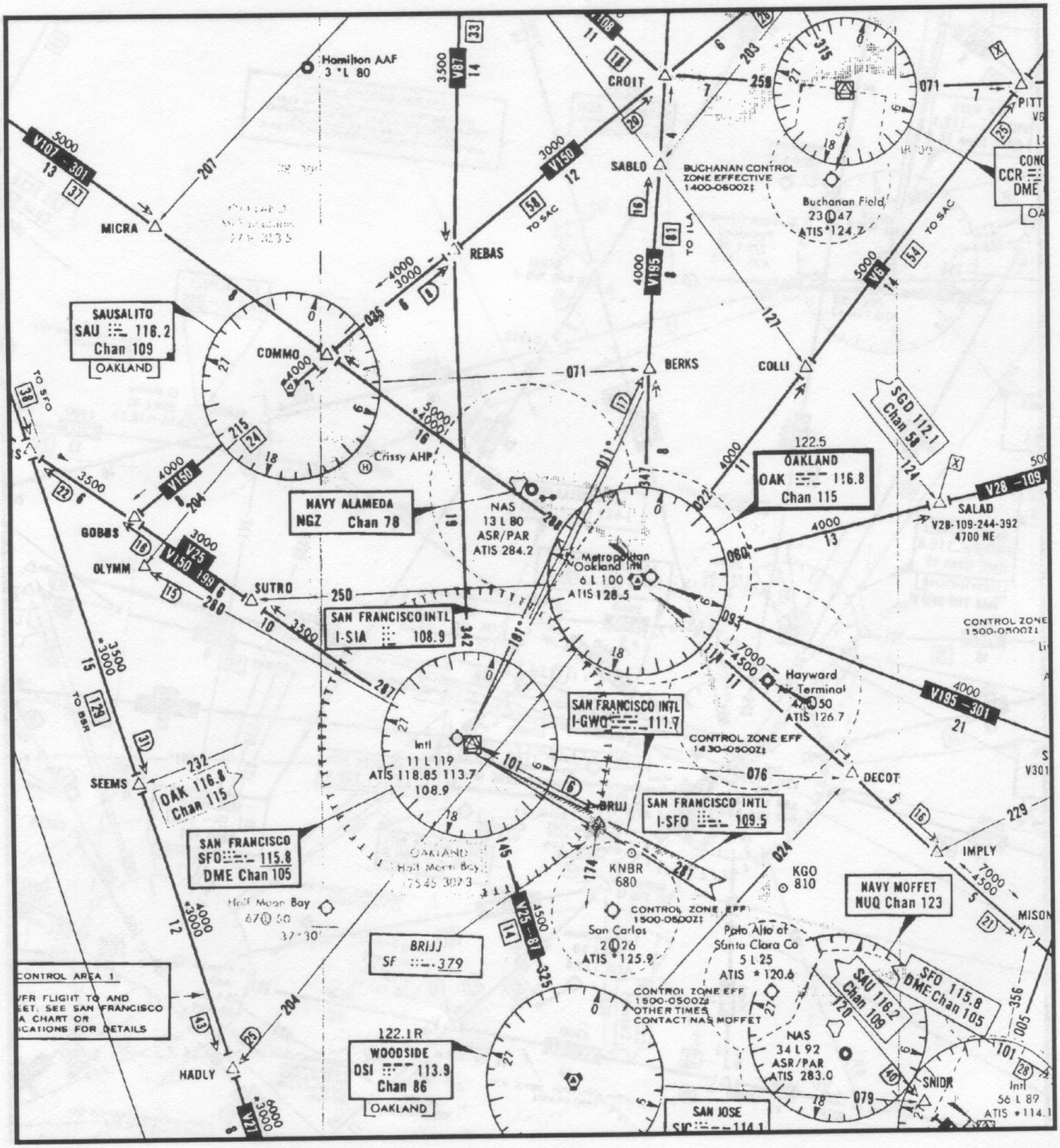
These adjustments are relatively minor compared to the sorts of negative deductions that occur with errors. Points (far more, generally) are deducted whenever you make any mistake mentioned before during the simulation. In sum, then, the more aircraft you successfully handle per unit of time, the higher your performance review at the end.

Los Angeles (LAX.SEC)



Not for Navigation – For Use with TRACON Only!

San Francisco (SFO.SEC)



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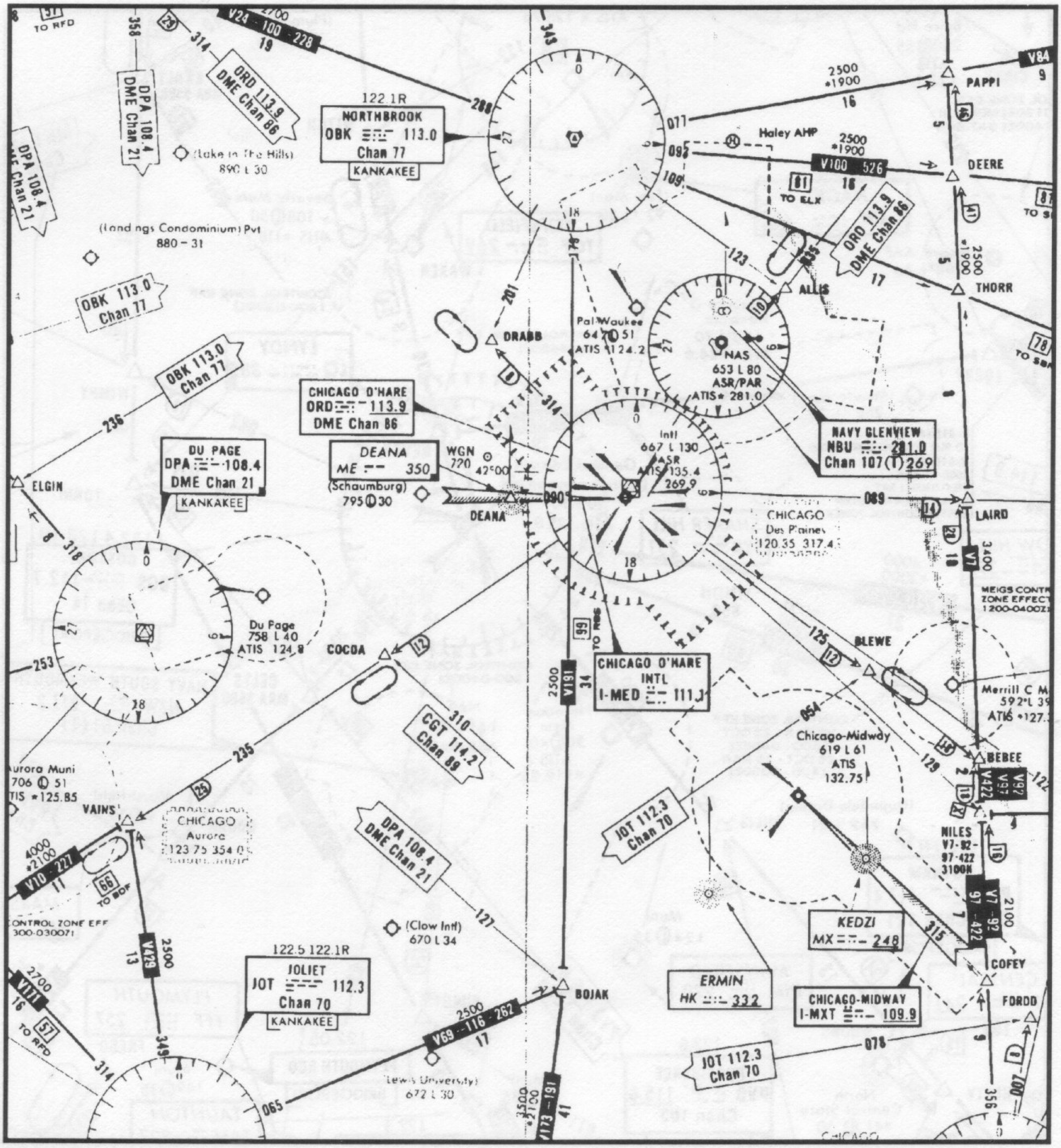
Chicago (ORD.SEC)



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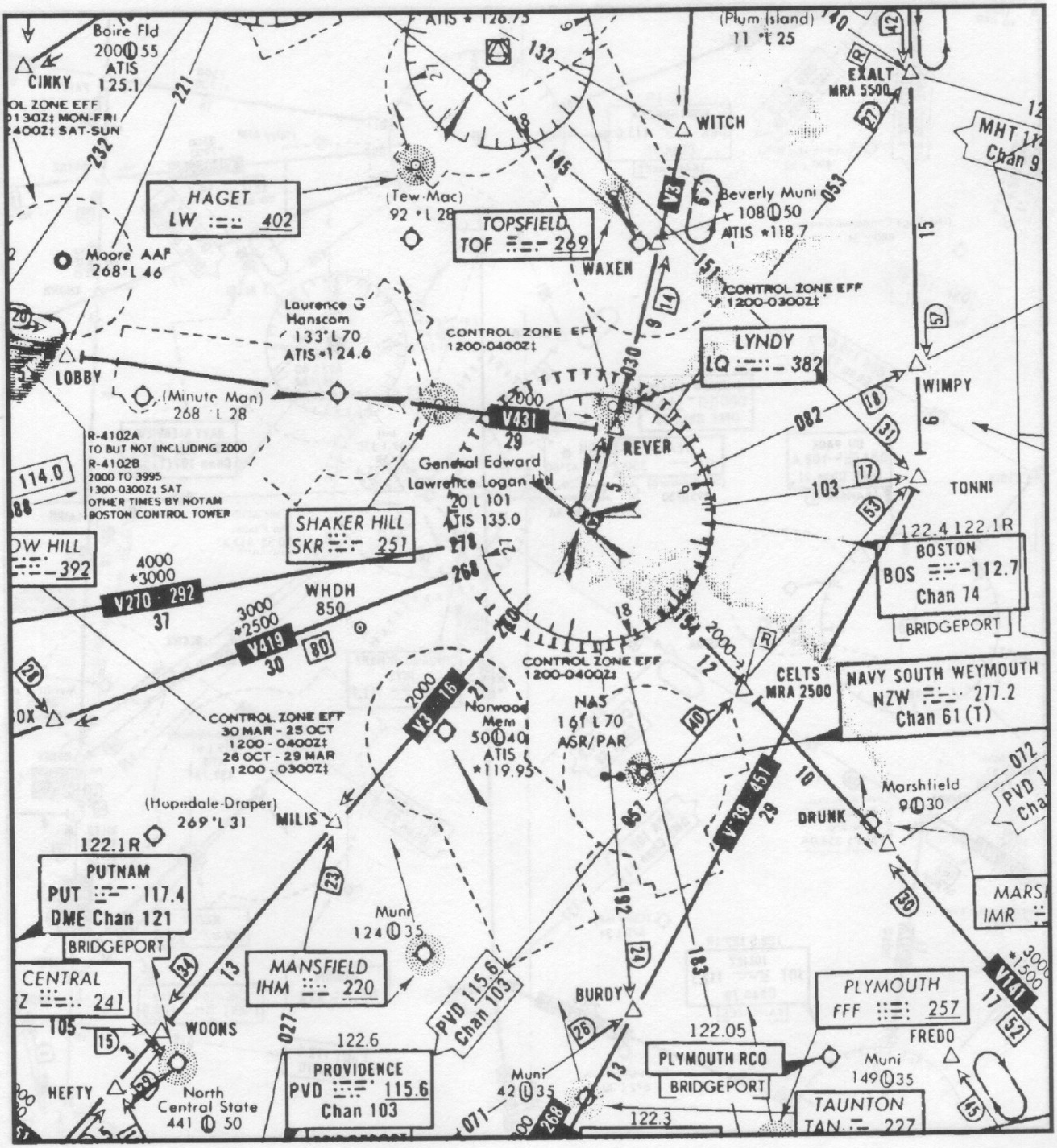
Boston (BOS.SEC)



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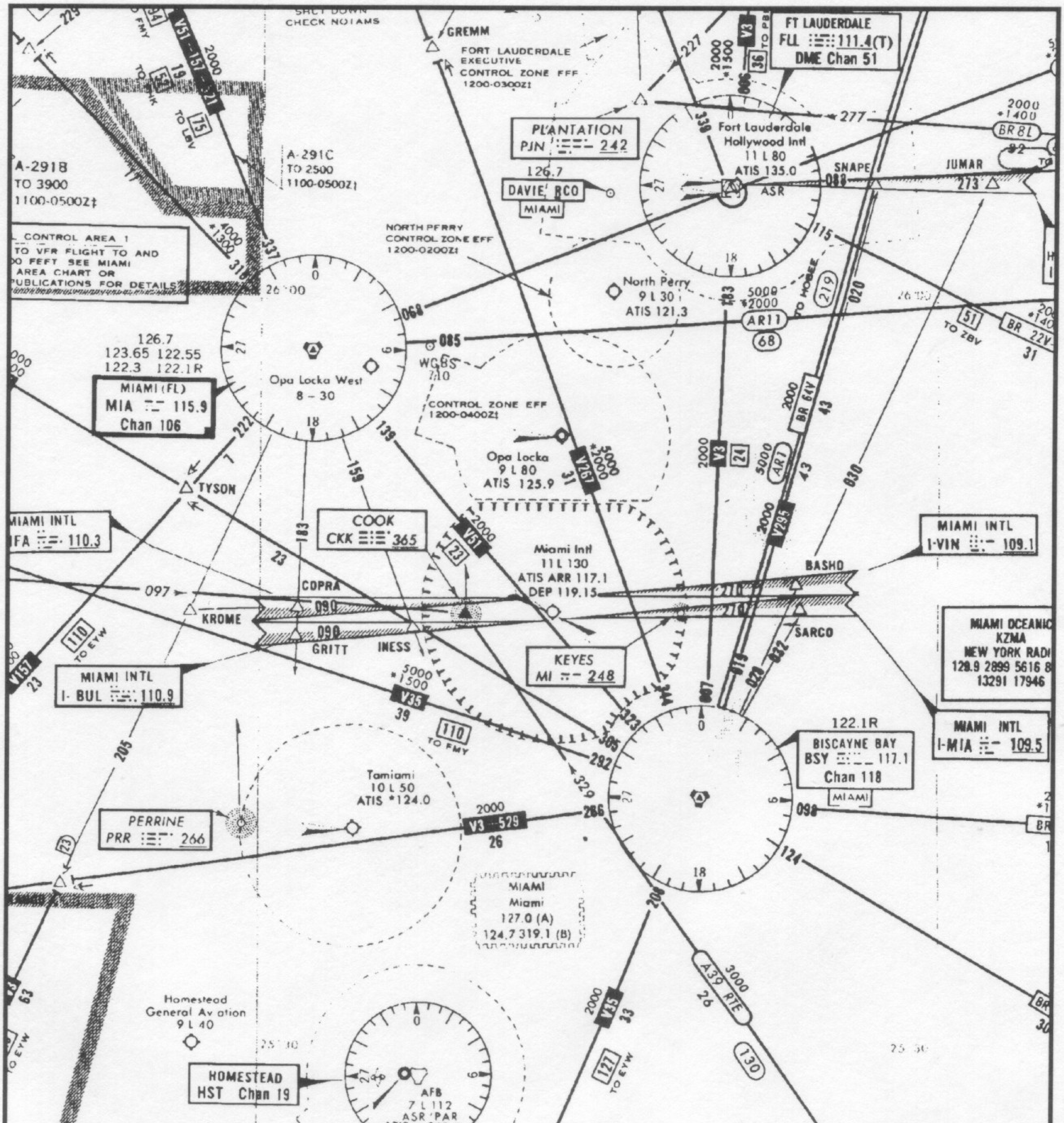
Miami (MIA.SEC)



Not for Navigation -- For Use with TRACON Only!

Airport List

This appendix lists the important characteristics of the various airports under your control in the different control sectors. Each sector's table lists the airport three-letter designator, its name, the distance in miles from the airport to its final approach point (FAF), the FAF altitude (arrivals must be at this altitude when they reach the FAF to begin an approach), the airport elevation in feet, and the inbound heading to the airport from the FAF.

ID	Name	Dist	Alt	Elev	Heading	
Los Angeles (LAX.SEC)						
LAX	Los Angeles	5.3	1900	126	250	*
VNY	Van Nuys	7.7	4300	799	160	
LGB	Long Beach	4.3	1500	58	300	
TOA	Torrance	4.7	1900	101	290	
SMO	Santa Monica	6.7	3000	175	210	
San Francisco (SFO.SEC)						
SFO	San Francisco	5.3	1800	11	281	*
OAK	Oakland	4.6	1600	6	293	
SJC	San Jose	5.1	1700	56	302	
HWD	Hayward	6.2	2500	47	287	
Boston (BOS.SEC)						
BOS	Logan Intl.	5.2	1800	20	36	*
BED	Bedford	4.0	1700	133	112	
OWD	Norwood	7.7	1400	50	350	
BVY	Beverly	5.0	1800	108	157	
SFZ	Pawtucket	5.8	2500	441	47	

Miami (MIA.SEC)

MIA	Miami Intl.	4.6	1600	11	90	*
FLL	Ft. Lauderdale	5.0	2000	11	93	
OPF	Opa Locka	5.4	1900	9	89	
TMB	Tamiami	3.6	1400	10	90	
FXE	Ft. Executive	6.4	2200	14	87	

Chicago (ORD.SEC)

ORD	O'Hare Intl.	4.9	2300	667	90	*
MDW	Midway	5.1	2400	619	135	
DPA	DuPage	5.3	2600	758	97	
ARR	Aurora	6.1	2800	706	89	
PWK	PalWaukee	6.4	2300	647	160	

* Note: These airports have parallel runways where an arriving aircraft and a departing aircraft can be within the separation conflict boundaries without generating an error. The following rules apply:

1. One aircraft must be arriving and the other one departing at the same airport.

2. Both aircraft must be below the FAF altitude + 300 feet. If the FAF altitude is 1900 feet then they must be at or below 2200 feet.

3. Both aircraft must be within 5 miles of the airport.

Glossary of ATC Terminology

Air Route Traffic Control Center (ARTCC) -- A centralized location where numerous enroute controllers have jurisdiction over a large airspace subdivided into sectors. It is frequently referred to by pilots as the "Center."

Air Traffic Control (ATC) -- Ground-based coordination of aircraft utilizing radar and pilot/controller radio telephony intended to prevent midair collisions and expedite the safe and orderly flow of air traffic.

Airway -- A path consisting of line segments joining geographic points specified by radio beacons or intersections formed by two or more such beacons.

Approach -- (see Instrument Approach)

Approach Control -- The ATC facility responsible for radar separation and coordination of aircraft in the vicinity of an airport. Approach Control's jurisdiciton extends about 20-40 miles from the airport horizontally and 10-12 thousand feet vertically.

Approach Speed -- The recommended speed contained in aircraft manuals used by pilots when making an approach to landing. This speed will vary for different segments of an approach as well as for aircraft weight and configuration.

ARTCC -- (See Air Route Traffic Control Center)

ATC Clearance -- (See Clearance)

Automated Radar Terminal Systems (ARTS) -- The generic term for computer-mediated radar data processing facilities located in most TRACONs. ARTS II systems are used at low to medium density faciliities, while ARTS III systems are available for high density situations.

Automatic Altitude Reporting -- That function of a transponder which responds to Mode C interrogations by transmitting the aircraft's altitude in 100-foot increments.

Autopilot -- A mechanical device which steers the aircraft automatically. The more sophisticated -- often called flight directors -- allow the pilot to preprogram complex functions and give him almost "button-pushing" command of the aircraft.

Beacon -- (see Fix)

Below Minimums -- Weather conditions below the minimums prescribed by regulation for the particular action involved; e.g., landing minimums, takeoff minimums.

Ceiling -- The heights above the earth's surface of the lowest layer of clouds or obscuring phenomena.

Center -- TheATC facility, also called Enroute Control, responsible for aircraft separation and coordination while in cruising flight between departure and destination airports.

Chart -- Aviation term for map.

Clearance -- A set of flightpath parameters, generated by an ATC facility and similar to if not identical to a pilot's requested flightplan, which specifies how the IFR aircraft will proceed to its destination. It consists of assigned altitudes, airways, radio frequencies, and the like, and must be obeyed until superceded by a newer clearance.

Cleared as filed -- Means the aircraft is cleared to proceed in accordance with the route of flight filed in the flightplan.

Cleared for (type of) Approach -- ATC authorization for an aircraft to execute a specific instrument procedure to an airport.

Cleared for Takeoff -- ATC authorization for an aircraft to depart.

Codes/Transponder codes -- The number assigned to a aircraft's transponder.

Colision Avoidance System (CAS) -- A method of automatically warning pilots of impending midair collisions. Some are ground-based, relying on radar returns and controller-relayed commands; others are based on airborne transponders which use cockpit displays to directly warn pilots of the proximity of other aircraft.

Conflict -- A situation in which one or more aircraft, through controller inaction, has been allowed to violate a governmental directive such as radar separation minima. A controller is charged with the prevention of conflicts as his primary job task.

Conflict Alert -- A function of certain air traffic control automated systems designed to alert radar controllers to existing or pending situations that require his immediate attention/action.

Contact (facility) -- Establish communication with a certain ATC facility.

Control Tower -- The ATC facility responsible for the visual separation and coordination of aircraft in the immediate vicinity of an airport. The Tower's airspace extends about five miles from the airport.

Controller -- Person who mans the radar scopes and performs the functions of air traffic control.

Cruise/Cruising Altitude -- Aircraft is straight-and-level flight proceeding towards its destination.

Departure Control -- The ATC facility which complements Approach control, coordinating departing aircraft via radar near a major air terminal. It is colocated with Approach control in the TRACON.

Direct Clearance -- A set of instructions which clear an aircraft directly from its present position to a specified point such as a radio beacon.

Enroute -- see Center.

Final Approach Fix (FAF) -- The geographical point at which a pilot, referring solely to a published approach procedure and his instruments, begins a final descent to an airport. This point is generally specified by a fix location and an altitude from which the approach must begin.

Fix -- A specified geographical location used in air navigation. Usually, fixes are easy-to-locate points formed by radio beacons.

Flight Service Station (FSS) -- The governmental service interface with all pilots, both VFR and IFR. The FSS provides preflight and enroute weather briefings, receives and processes flightplans, and issues initial clearances.

Flightplan -- A description of an aircraft's proposed flight, including departure time, route, altitude, etc. An IFR flightplan is a request for ATC service, subject to controllers' commands; a VFR flightplan merely records a proposed flight and aids in searching for overdue aircraft.

Flightstrip -- As an aircraft transits the various sectors and receives clearances, the current flightplan parameters are continually printed out by the computer on strips of paper. These strips are then used by each controller responsible for that aircraft as a memory aid.

Fly Heading (degrees) -- Informs the pilot of the magnetic heading (0-360 degrees) that he should fly.

General Aviation -- That portion of civil aviation which encompasses all facets of aviation except the airlines.

Glideslope/Glidepath -- Radio beacon which provides vertical guidance for aircraft during approach and landing.

Go Around -- Instructions for a pilot to abandon his approach to landing. Additional instructions follow.

Ground Control -- The ATC facility responsible for coordinating movement across and airport's surface, exclusive of the active runway(s).

Ground Controlled Approach (GCA) -- A radar approach system operated from the ground by air traffic control personnel transmitting instructions to the pilot by radio.

Handoff -- To release control of an aircraft and give it to another ATC facility as the flight proceeds past the airspac elimits of the control jurisdiction.

Hold -- A command which directs the aircraft to fly in a tight oval pattern (called a holding pattern) thereby effectively stopping its forward progress for a specified period of time.

Instrument Approach -- A procedure, standardized and published by the Federal Aviation Administration (FAA), whereby an aircraft can descend to an airport solely by reference to its flight instruments and navigational aids.

Instrument Flight Rules (IFR) -- A set of guidelines and regulations created by the FAA which define standardized requirements and procedures for flight without visual reference to the ground.

Leader line -- Connects an aircraft's identification and altitude information with the target on a controller's radar scope.

Maintain (altitude) -- To remain at the altitude specified. The phrase "climb and .." or "descend and .." normally preceeds "maintain" and the altitude assignment.

Missed Approach -- When conditions prevent a pilot from completing an instrument approach to a landing, a missed approach is declared and the pilot may elect to try again or proceed to an alternate destination airport.

Negative -- "No," or "permission not granted," or "that is not correct."

On Course -- Indicates that an aircraft is established on the route centerline.

Outer Marker -- The radio fix from which a particular kind of instrument approach -- called a precision approach -- is begun. Only the larger airports have precision approaches.

Pilot Request -- A request to the controller, initiated by the pilot, for some change in the current clearance, such as another altitude or route of flight. The controller has the option of granting or denying the request, depending on the traffic situation at the time.

Profile Descent -- An uninterrupted descent from cruising altitude to interception of a glide slope.

Radar -- Acronym for Radio Detection and Ranging. A device which, by measuring the time interval between transmission and reception of radio pulses and correlating the angular orientation of the radiated antenna beam or beams in azimuth and/or elevation, provides information on range, azimuth, and/or elevation of objects in the path of the transmitted pulses.

Resolution -- A command sequence given to the aircraft involved in a conflict which prevents or destroys the conflicting situation.

"Resume Normal Navigation" -- A command which directs an aircraft to fly back to the track and speed from which it had been vectored and proceed as specified in its clearance.

Runway -- A defined rectangular area on an airport prepared for the landing and takeoff run of aircraft.

Say Again -- Repeat.

Say Altitude/Heading -- Used by ATC to request an aircraft altitude or heading.

Sector -- A subset of an ARTCC's or TRACON's airspace over which a single controller team has jurisdication.

Separation Conflict -- The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of air traffic control procedures have been violated. In a TRACON, this is generally three miles horizontally and one thousand feet vertically.

Shrimp Boat -- A slip of paper containing an aircraft's identification, altitude, etc. manually placed next to its radar return on a controller's horizontal scope. These have been phased out with the advent of radar data processing facilities.

Squawk -- Controller instruction to activate specific modes/codes/ functions on the aircraft's transponder; e.g., "Squawk code zero two five six." (See Transponder)

Taxi -- The movement of an aircraft under its own power on the surface of an airport.

Terminal Area -- A general term used to describe airspace in which approach control service is provided.

Tower -- A terminal facility that uses air/ground communications, visual signaling, and other devices to provide ATC services to aircraft operating in the vicinity of an airport.

Track -- The airway segment along which an aircraft would ideally fly.

Pilot inattention and controller vectors both cause the aircraft to become "off-track."

TRACON -- Acronym for "Terminal Radar Approach Control".

Transponder -- An airborne receiver/transmitter combination which replies to the ground-based radar interrogation pulse with a coded signal uniquely identifying the aircraft.

Vector -- To issue a specific heading change command to an aircraft, usually as a collision-avoidance technique. The aircraft is said to be "on a vector" until another command, such as "resume normal navigation," cancels it.

Visual Flight Rules (VFR) -- A set of governmental regulations and guidelines for aircraft not under continual control of an ATC facility and flying by visual reference to the ground.

VORTAC -- Also called VOR or omni, a VORTAC is a navigational radio beacon broadcasting in the VHF frequency band.

Waypoint -- A radio fix along the route of flight. An aircraft flies from waypoint to waypoint until it reaches its destination.

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