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presents

Air Traffic Control Center™

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OVERVIEW

Air Traffic Control Center is a highly realistic simulation of actual radar sectors in the New York, Chicago and Los Angeles Air Traffic Control Centers. *You* take the position of the radar controller, guiding both small and large aircraft into and out of some of the busiest airports in the world. This program is intended not so much as a game, but as an accurate simulation of actual air traffic situations that exist hour by hour in the crowded skies. Whether you are using this simulation as a training tool for a career in Air Traffic Control, or you just want to see what it's like in the controller's chair, ***Air Traffic Control Center*** will let you experience one of the most mentally challenging occupations in the world.

Simulation Features

- Radar displays and computer entries are almost identical to what real controllers use.
- "Intelligent" pilots communicate in standard ATC phraseology and plain English.
- Realistic aircraft performance characteristics, with fully simulated weather phenomena such as winds, turbulence and storms.
- A "training program" that allows you to practice controlling at the sectors before taking tests to become certified to work "live traffic." Once certified, your performance is rated as your career progresses.

INSTALLATION AND QUICK START

1. Click on the ATCC shortcut on your desktop, or choose Start/Programs/Air Traffic Control Center/ATCC to launch the program.
2. A title screen will appear and ask for your initials. Type in the two-letter initials you want to use for your career.

3. A red box will then appear asking you to press N if you are a new employee. While the red box is still on the screen, press the N key, and you will be asked for your name.
4. From then on, you will start out at the the main screen, where you can choose which sector to train on, work or certify.
5. At some point, choose Start/Programs/Atcc/Sector Documentation and open and print out the quick reference cards and each of the sector maps and procedures. If the maps appear cut off (which is a problem with some newer versions of Microsoft Word), use Wordpad to open them, found under Start/Programs/Accessories/Wordpad.

Visit our web site at www.xavius.com for ATC tips, newsletters, and information on new versions. Or email support@xavius.com with any questions or problems, and we'll be glad to help!

READ THIS MANUAL

Because of the high degree of realism in this simulation, you will need to *read this manual* to know what all the blips, lines and numbers on the radar scope mean, and what commands you will need to issue to aircraft in your sectors. This manual is divided into the following seven sections:

1. **The National Airspace System** illustrates how aircraft are issued routings that take them from checkpoint to checkpoint along highways in the sky.
2. **The Air Traffic Controller's Role** describes the various controllers' responsibilities for keeping aircraft moving along in an orderly flow, and far enough apart to prevent midair collisions.
3. **Radio Communications** explains the various commands and instructions you can issue to aircraft.
4. **The Radar and Computer Console** details what everything on the radar scope means, the controls you can use to adjust the scope, and the computer entries you need to make as aircraft traverse your sector.
5. **Your Air Traffic Control Career** outlines the process of training on a sector, taking a certification test, and finally working "live" traffic.
6. **How to Control Traffic** will teach you the mental and procedural skills you will need to keep your sanity as aircraft deluge your sector from all directions.
7. **Sector Descriptions** list the information you need to know to begin training and

certifying on each of the six sectors, including helpful hints and strategies.

Each section ends with a summary, which you can skip to if you already know much of the information, or you can skip ahead to section 3 if you just want to know the commands and how to run the simulation.

1. THE NATIONAL AIRSPACE SYSTEM

The U.S. aviation system has evolved over many decades into a somewhat complex, and occasionally convoluted division of airspace, procedures, and regulations. The following sections give a general overview of the whole system, along with a summary of the especially important information for your job as a radar controller.

VORTACs

Scattered throughout the country are navigational radio beacons called VORTACs, sometimes referred to as VORs. Each VORTAC or VOR has a three-letter *identifier*, with a corresponding *name*. For example, "Dagget" (as referred to when spoken) is written with its three-letter identifier, DAG. Likewise, the VORTAC written as HTO is spoken "Hampton." Airports also have three-letter identifiers, such as "ORD" and "JFK," and often have a VORTAC on or near the airport grounds with the same name and ID as the airport itself.

Pilots can tune in specific VORTACs with their navigational equipment to determine what direction to fly to pass directly over them. Each VORTAC has about a 150-mile range, allowing aircraft to navigate routes in almost any direction across the entire country.

Most modern aircraft, however, no longer use VORTAC beacons for navigation. Advanced instrumentation known as RNAV, or GPS satellite positioning, allow aircraft to navigate from any point on the globe directly to any other point. However, controllers still instruct these aircraft to fly over VORTACs to maintain orderly flows of traffic through busy areas.

Airways

Airways are defined as specific connections between specific VORTACs, and are given numbers. For example, airway J9 goes from the Los Angeles VORTAC (LAX) to Dagget (DAG), to Las Vegas (LAS), and continues across the entire country. Controllers can specify routes for aircraft to fly along, by referring to specific VORTACs and airways. For example, an aircraft may be assigned a route such as "Los Angeles (LAX), J9 to Las Vegas (LAS), then direct Dove Creek (DVC), direct Dubuque (DBQ), direct O'Hare (ORD)." Pilots are required to carry the proper aviation maps that depict the appropriate VORTACs and airways.

Intersections are defined points along the airways, and have five-letter names.

The PLAIN intersection, for example, lies along J146 east of GIJ (Gipper) VORTAC. Aircraft with RNAV or GPS navigational capability can be instructed to fly directly to an intersection, but aircraft that rely on VORTAC beacons to navigate can only reach an intersection by flying along the airway. In this simulation, all aircraft are equipped with either RNAV or GPS capability.

Heading

Aircraft *direction* is specified by **magnetic heading**, ranging from a heading of 000 (North), clockwise in single degrees to 360 (also North). A heading of 090 degrees is due East; 180 due South, and 270 due West. Headings are specified in 3-digit form, and spoken one digit at a time: "heading zero four five." Heading 045 is halfway between 000 and 090, thus would be due Northeast.

The **heading** is an important concept in Air Traffic Control, so become comfortable translating a direction into a heading. For example, on a clock face, the "heading" from the center of the clock to the 2 would be about 060 degrees. From the center to the 6 would be a 180 heading; to the 10 a 300 heading and so on.

Heading 000 (due North) is used interchangeably with heading 360; both mean the same thing. However, there are no headings greater than 360.

Speed

Aircraft speed is measured in knots. One knot is slightly faster than one mile per hour, but for most purposes you can think of them as the same. Jet aircraft will typically fly along at around 450 knots, turboprop commuters at around 250 knots, and smaller private airplanes from 90 to about 200 knots.

Unfortunately, aircraft speed isn't as simple as that of a car traveling down a road. There are *four* different components to the speed of an aircraft:

- **True airspeed.** This is a measure of how fast the aircraft is moving through the air, and would be the speed of the aircraft across the ground if there were no winds.
- **Groundspeed.** A law of physics is that the speed of the wind will directly add to or subtract from the speed of an aircraft flying through the air. The resulting speed of the aircraft from point A to point B is called the *groundspeed*. A jet with a true airspeed of 450 knots that picks up a 30-knot tailwind, will end up flying at 480 knots *groundspeed* (450 plus 30). If the wind were directly head-on, it would have a 420-knot groundspeed (450 minus 30).

If the wind isn't a direct tailwind or directly head-on, the groundspeed will be affected proportionally according to *how much* of a tailwind or headwind it is. If a 30-knot wind is *almost* a direct headwind, but coming from a little off to the side, the ground speed may only be 20 knots less than the true airspeed. Or if the wind is *almost* directly from the side, but slightly more from *in front* than from behind, the groundspeed may only be five or so knots *less* than the true airspeed.

The groundspeed is the *only* speed that the controller sees displayed on the radar scope. However, controllers (and pilots) cannot directly control their groundspeed, which is the result of winds, so must estimate changes by adjusting the *indicated speed*.

- **Indicated speed.** This is the speed that appears on the pilot's *airspeed indicator* dial. This *indicated speed* is always *less* than the true airspeed. A jet cruising along at 20,000 feet may have a 450 knot *groundspeed*, but the *indicated* speed may only be 280 knots. As the aircraft climbs higher, the *indicated* speed on the dial drops more and more, even though the aircraft may hold the same groundspeed.

Controllers assign particular speeds by specifying the *indicated speed* for the pilot to adhere to. However, at altitudes above 29,000 feet, indicated speeds are less precise due to the thinner air, and *mach numbers* are used instead.

- **Mach Number.** This is the aircraft's speed as a fraction of the speed of sound, such as Mach .74 or Mach .80. When a jet aircraft is above 29,000 feet, refer to its speed in units of *mach number*.

Altitude

Pilots and airlines determine a particular flight's ideal cruising altitude based on a number of factors, including distance, weather, aircraft load, and fuel consumption. Jet aircrafts' cruising altitudes are usually between 25,000 and 41,000 feet. Commuter and business turboprops typically cruise at 10,000 to 25,000 feet, and small private aircraft usually cruise below 14,000 feet.

Controllers assign altitudes in 1,000 foot increments at and below 29,000 feet. Above that, altitudes are assigned in 2,000 foot increments, starting with 31,000, then 33,000, then 35,000, and so on. For procedural reasons, the even altitudes above 29,000 feet are not used.

Below 18,000 feet, altitudes are referred to in number of feet, such as 11,000 (spoken "one-one thousand"), or 17,000 ("one-seven thousand"). *At and above* 18,000 feet, altitudes are referred to as ***flight levels***. 20,000 feet becomes FL200 (spoken "flight level two zero zero"). 31,000 feet is FL310; 28,000 is FL280 and so on.

Why 18,000 feet is "FL180," but 17,000 feet is "17,000" has to do with atmospheric pressure and the accuracy of aircrafts' altitude instrumentation in thinner air. Nevertheless, it is important to be able to quickly translate that 25,000 feet in the air is FL250, 18,000 is FL180, and 15,000 is still 15,000.

Furthermore, controllers' radar scopes display altitudes in *hundreds*, not thousands of feet, so you must become proficient at seeing an altitude readout such as "163" and understanding it means 16,300 feet, or seeing "323" and knowing it means flight level 323 (32,300 feet).

Though controllers only assign altitudes in 1,000 foot increments, such as 15,000 (which would display as "150" on the radar scope), or flight level 330 (displayed as "330"), as the aircraft climbs or descends, its altitude will still display on the scope in hundred foot increments (such as "172" or "085" meaning 17,200 and 8,500

respectively).

IFR and VFR

Pilots can choose to fly their aircraft under two different sets of aviation rules: *Visual Flight Rules*, or VFR, and *Instrument Flight Rules*, or IFR.

VFR rules mean the pilot assumes responsibility for preventing midair collisions by keeping a constant watch out his window for other aircraft. The pilot is responsible for turning, climbing or descending in time to avoid all traffic. Pilots operating under these rules are required to fly in sky conditions with at least three miles visibility (which means flying through clouds, fog or thick haze is forbidden), and must remain below 18,000 feet at all times.

The benefit to the VFR pilot is that no permission, or even contact with air traffic controllers is needed (unless flying near specific busy airport areas or into airports with control towers); the pilot basically hops into his plane and flies away, either just to fly around the area for recreation, or even to fly across the country. VFR aircraft can change altitudes, direction, or speed as they desire, as long as they remain under 18,000 feet and in sky visibility of three miles or more. Though cruising altitudes for VFR aircraft are at the discretion of the pilot, they are supposed to fly at thousand-foot altitudes *plus or minus* 500 feet, such as 8,500 or 11,500.

Pilots who wish to fly at or above 18,000 feet (FL180), in or through clouds, or want radar controllers to separate them from other aircraft instead of having to constantly watch out their window for traffic, fly under *instrument flight rules* (IFR). IFR pilots must receive permission from controllers for any altitude, speed or routing changes. IFR pilots also must adhere to any restrictions or instructions issued to them by controllers, unless they consider it unsafe or are otherwise unable to comply.

Airliners, most military aircraft, and many private and business aircraft fly under IFR rules, and constitute the major part of the Air Traffic Control system.

Flight Plans

Pilots wishing to fly under IFR rules must first file a **flight plan** with Air Traffic Control, prior to departure. This can be done by computer, or by calling a regional office. The flight plan contains the aircraft identification, or *callsign*, the type of aircraft, planned speed (*true airspeed*, or speed across the ground without wind), requested route of flight (from VORTAC to VORTAC), planned cruising altitude, and sometimes other information such as color of aircraft, and number of people on board.

This flight plan information goes into the central Air Traffic Control Computer, which assigns the flight a code number, called a *beacon code*. The computer determines which radar sector will handle the aircraft first, and prints out the flight plan on a strip of paper called a *flight progress strip*. If the flight will depart from an airport with a control tower, the computer will print out a flight strip there as well. After it prints out, controllers can review the proposed route of flight and make changes as necessary to conform to local procedures and routings.

When the aircraft is ready to depart, the pilot calls either the control tower, or if

none, then the radar sector overlying the airport, and requests *clearance*. The controller checks the flight strip, and clarifies the routing and any changes to the routing with the pilot, so both pilot and Air Traffic Control know the exact route the pilot will fly.

The controller also tells the pilot his flight plan code number (the *beacon code*), and the pilot sets an instrument on his aircraft called a *transponder* to transmit this code. This beacon code transmission is picked up by radar, allowing the ATC computer to know exactly which aircraft it is, and which flight plan it corresponds to.

From then on, until landing, the aircraft is under jurisdiction of the Air Traffic Control system. After departure, ATC issues altitudes, speeds, headings, and sometimes re-routes as necessary, and assumes responsibility for separating the aircraft from all known traffic. After the aircraft lands, the flight plan is *closed* (removed from the computer), and the pilot turns off his transponder.

Most aircraft flying under VFR rules, while not necessarily in communication with ATC, can set their transponders to broadcast their altitude, so that radar controllers can still see where they are. Controllers just note the position of these VFR aircraft, and steer IFR aircraft around, above or below them as necessary to prevent collisions.

Navigation Summary

- Aircraft fly directly from VORTAC to VORTAC, or along named airways.
- VORTACs and airports each have a spoken name and a three-letter identifier. Intersections have a five-letter name. Airways are identified by the letter V or J and a number.
- As a controller, you can change an aircraft's route by specifying new VORTACs and airways to fly along. However, most aircraft will be on preset, approved routes, so in general you should leave aircraft on course.
- Aircraft direction is specified by a magnetic heading, which ranges from 000 to 359 degrees.

Speed Summary

- Pilots' instruments show both their indicated speed and mach number. Use indicated speeds when referring to speeds at or below 29,000 feet, and mach numbers for jets that are above 29,000.
- The radar display shows aircrafts' groundspeeds, which can vary depending on wind direction and speed. Some days may have strong westerly winds that make eastbound aircraft travel much faster than the westbound aircraft. On other days, the opposite may be true.

Altitude Summary

- Assignable altitudes are in thousand-foot increments at and below 29,000 feet, and

only odd-numbered thousands of feet above 29,000.

- *Below* 18,000 feet, refer to altitudes in number of feet, such as "one seven thousand" (17,000). *At and above* 18,000 feet, refer to them as *flight levels*, such as "flight level two four zero" (FL240, which is 24,000 feet).
- Altitudes appear on the radar in *hundreds* of feet. Add two zeroes to determine the actual altitude: 082 becomes 8,200, and 310 is 31,000, or flight level 310 (FL310).

Flight Plans, IFR and VFR Summary

- All airliners, and all aircraft that plan to fly above 18,000 feet or through clouds, must file a *flight plan* to fly under IFR rules. The flight plan lists all the flight information, including requested route of flight and planned cruising altitude. Controllers are responsible for separating these aircraft from all other aircraft, by issuing altitude, speed, and heading instructions as necessary.
- Aircraft with flight plans and flying under IFR rules will appear on your radar scope and be in communication with you by radio. All flight plan information, including type of aircraft, route of flight, current and assigned altitudes and speeds, are accessible through the computer terminal at your console, and are displayed both on the scope and on flight strips delivered to your sector.
- Aircraft that choose to fly under VFR rules will not be in contact with Air Traffic Control, but they do appear on the radar, along with their altitude. Just note their position, and steer aircraft in your sector around, over or under them, as necessary.

2. THE AIR TRAFFIC CONTROLLER'S ROLE

Hundreds of thousands of flights, containing millions of passengers traverse the nation's skies annually. Keeping them apart are 15,000 Air Traffic Controllers dispersed among hundreds of airports and almost two dozen regional radar centers. Generally, once a new controller is sent to an airport control tower, he remains a *Tower* controller throughout his career, though perhaps moving on to different and larger airports. Likewise, controllers sent to the Enroute Radar Centers often remain *Center* controllers throughout their careers. This is common, because methods involved in each specialty are different enough that transferring from a Tower to a Center or a Center to a Tower would entail learning new controller skills almost from scratch. It is easier, therefore, to just move from Center to Center or Tower to Tower throughout a career.

Tower Controllers

Most people associate Air Traffic Controllers as the people in the airport control towers, looking down on the airport through binoculars and dark sunglasses. These

Tower controllers are responsible for the traffic on the airport grounds, and within about five miles of surrounding airspace. Their primary controlling technique is to simply *look out the window* to see if a runway is clear, or if a taxiway is blocked, or if an aircraft is approaching a runway. In case of fog or other low visibility conditions, Tower controllers must keep track mentally, or by taking frequent notes, which aircraft are in the surrounding sky or are taxiing on the ground.

Simply looking out the window, however, has a significant limitation in that most aircraft turn into tiny specks-in-the-distance when only a few miles away. Add limited visibility due to fog or haze, and a controller relying solely on memory or notes to keep track of nearby aircraft can quickly become overwhelmed.

TRACON Controllers

Thus, the *TRACON* was devised, originally as an extension of the Tower, where controllers could use radar echoes to keep track of aircraft once they were beyond visual range. *TRACON* stands for Terminal Radar Approach Control, and is often located in the Tower itself. The TRACON is staffed by Tower controllers who rotate the duties of controlling activity at the airport by looking out the window, and controlling surrounding aircraft by looking at the radar.

As traffic volume has built over the years, TRACONs have expanded to cover more and more of the areas surrounding major airports. In areas like Los Angeles and New York City, a single TRACON covers multiple major airports and even entire regions of states. TRACON controllers at these facilities work only in front of the radar, and may be many miles away from the airports themselves.

Center Controllers

Covering the rest of the country are the Air Route Traffic Control Centers, or ARTCCs, known more simply as *Centers*. After an aircraft takes off from an airport, the Tower controller "hands off" responsibility for the flight to the TRACON controller, who steers the aircraft around traffic for 10-20 miles before handing off the aircraft to a Center controller.

From then until within range of the destination airport, the aircraft may be handed off to a dozen more Center controllers, who each issue altitudes and headings as necessary to keep it clear of traffic. Center controllers also line up groups of aircraft headed for the same airport into single streams, all evenly spaced. Then, they're handed off to the destination TRACON controllers, who accomplish any final sequencing and lining-up, and assign a landing runway. Once an aircraft is within a few miles of the airport, the TRACON controller hands it off to the Tower controller again for landing clearance.

In cases where there is no TRACON, the Center serves the same purpose of lining up aircraft for approach and handling departures just off the airport.

The Sector

After a supervisor assigns you to a particular sector (or, in this simulation, after

you *choose* to work a particular sector), you become personally responsible for all air activity within that sector. As aircraft enter your sector, you must separate them from all other aircraft, and get them where they need to go without excessive delays or unnecessary restrictions.

The *sector* itself is a defined area of sky, typically 50 to 100 miles long, and covers airspace usually from the ground to 24,000 feet, or from 24,000 feet and up. The particular shape of the sector often has strange kinks or areas that jut outward. Or, there may be "shelves" within the sector, where another sector or a TRACON lies partially or entirely within the boundaries of your sector. For example, sector 97 in New York Center covers a roughly square shape about 50 miles long, located just northwest of Philadelphia, from the ground up to 17,000 feet. However, Allentown TRACON covers the northeast corner of sector 97, from the ground to 10,000 feet. Thus, over this TRACON, sector 97 controls from 11,000 to 17,000. West of the side boundary of the TRACON, sector 97 controls from the ground to 17,000 feet.

The sector boundaries are depicted on the radar scope, but are not labeled. As a sector controller, it is your responsibility to know the *map* of your sector, where the sector boundaries are, and which sectors lie adjacent to yours (to the side, above, and below). There may be as many as eight sectors that are adjacent to yours, and you will need to know the sector numbers of each. If you forget, though, you can keep the sector map next to the console for quick reference.

Handoffs

As aircraft approach your sector, either from the side, above or below, the controllers in the adjacent sectors will *initiate handoffs* to your sector. You will see an aircraft and its flight information pop up on your scope, though it will still be outside your sector boundary. You can then look to see where the aircraft is going, and note what instructions you may need to issue to the aircraft later. Then, you *take the handoff*, by making a particular computer entry, which is covered later in this manual. Taking a handoff means you are assuming responsibility for the aircraft, and it is allowed to enter your sector. The adjacent controller then instructs the aircraft to change his radio frequency to that of your sector. The pilot will *check on* with you to let you know he is there, by stating his callsign (flight number) and altitude.

Until you hand off the aircraft to the next sector, you are said to "have radar" on it, and it is considered one of "your" aircraft. Do not let one of your aircraft fly into the next controller's sector until he has accepted a handoff. Typically you should initiate a handoff when the aircraft is about 20- to 30 miles away from leaving your sector, or is five- to ten thousand feet from the top or bottom of your sector, if handing off to a sector above or below yours. The next controller will usually take the handoff within one or two minutes.

Sector Procedures

For procedural purposes, aircraft are divided into three categories:

- **Departures** are those in the process of climbing to their cruising altitude. As they enter your sector, either from below the sector or from the side boundary, you need to issue climb instructions to get them up to their cruising altitude. If that altitude is *above* your sector, you will need to climb them to the *top* altitude of your sector, and hand them off to the sector above yours so the next controller can continue their climb.
- **Arrivals** are in the process of descending for approach, on specific *arrival routes* and descending in accordance with arrival procedures for the area. They will usually be descending to the bottom of the sector above yours, or may enter your sector from the side. You then descend these aircraft to the specific altitude according to the arrival procedure, and hand them off to the next sector along their route, whether a TRACON or another Center sector.
- **Overflights** are those level at their cruising altitude, flying along cross-country to their destinations. Most of these aircraft need no instructions from you, unless you need to turn them, or possibly climb or descend them, to avoid other traffic. After they cross your sector, you hand them off to the next sector along their route.

Each sector has specific procedures for handling each type of flight. In Los Angeles Center sector 38, for example, the procedure for aircraft that are landing at Las Vegas is to descend them to 24,000 feet by the time they reach the Dagget VORTAC, and hand them off to sector 6, one of the sectors that lie below sector 38.

There are usually only a handful of routes and procedures in each sector that you need to memorize, dealing mostly with arrivals and departures. Overflights rarely have procedures, except to leave them alone as much as possible, and hand them off to the next sector down the line.

Your Primary Responsibility

Regardless of sector procedures, your **primary** responsibility when running the sector is to keep aircraft separated from each other at all times. Your **secondary** responsibility is to move aircraft according to the sector's procedures. You do not have to adhere to a procedure, though, if it will cause an aircraft to get within the minimum separation allowed between aircraft.

For example, a procedure for an aircraft in your sector may be to descend it to FL240 (flight level 240) and handoff to the sector below yours. If the aircraft enters your sector at 25,000 feet (FL250), but there is another aircraft on the same route directly underneath, already at FL240, you might just handoff this "stack" of two aircraft to the lower sector, even though the procedure is for both to be at FL240. Procedures can be broken in this way if adhering to it would cause a loss of separation.

Often, though, there are several ways of dealing with traffic situations such as this, instead of just leaving them alone and handing off to the next controller. Strive to get *all* aircraft to where they should be according to sector procedures, *while also* maintaining proper separation between each. A good controller does both, instead of just handing off the mess to the next guy to sort out.

Separation Standard

In all Centers, the minimum amount of separation is defined as **five miles** of space between aircraft that are **within 1,000 feet** of each other. *Above* 29,000 feet (FL290), you must keep five miles of space between aircraft that are **within 2,000 feet** of each other. Some examples:

- An aircraft level at 15,000 feet and one level at 16,000 feet can fly right on top of each other, because they are separated by at least 1,000 feet.
- You must make sure two aircraft level at the same altitude never get within five miles of each other. They may be on different routes that never cross, so they may never be a factor. Or, maybe one crosses the other, but they never get closer than 10 miles apart. Just ensure they never get *within five miles* of each other. If it looks like they may, you will need to turn one, or both, or change their altitudes.
- One aircraft is level at FL200, and another is currently at FL245 and descending to 14,000. During the time the descending aircraft is between FL210 and FL190, you must make sure they are at least five miles apart from each other, because during that time they would be within 1,000 feet of each other vertically.

Above 29,000 feet (FL290), just remember that it's 2,000 feet separation, not 1,000 feet. This is why **only odd-numbered altitudes above FL290 are assigned**, otherwise an aircraft at FL320 could conflict with one at FL310 and one at FL330 at the same time. Some examples:

- Two aircraft are within five miles of each other, one level at FL310, and one climbing out of FL328 up to FL350. For the two hundred feet from FL328 to FL330, there is less than required standard separation (because you need 2,000 feet above FL290), and you will be in trouble for letting them get too close.
- In a similar scenario, one is level at FL290, and the other is climbing out of FL308 for FL310. You still have less than required separation, because above FL290 the minimum vertical separation is 2,000 feet.

Depending on the size of the sector, *five miles* may either be one inch on the scope, or two inches, or more or less depending on the radar range setting. A specific computer entry will draw a five-mile-radius ring around an aircraft to help you visualize what five miles looks like at that sector. Once you get a rough idea of how far apart five miles looks, you can just eyeball it as aircraft fly through your sector. If two look like they'll be close, you can then draw the ring around one of them just to make sure. The computer entry to draw and erase the five-mile ring is covered in a following section.

The Snitch

The **snitch** is the ATC computer which constantly monitors separation between all aircraft at all sectors. If two should fall within minimum separation, they will start blinking on your scope. You have had what controllers call a **deal**, or what the government calls an *operational error*. An alarm will go off at the supervisor's desk, and you will soon be relieved from position. An investigative team will review radar and voice tapes, and will file a report with Headquarters in Washington D.C. You will be seated before a long table of inquisitors who will grill you at length as to why you made your mistake. Finally, they will determine the best resolution to the situation, which usually involves being decertified at that particular sector, and having to retrain and undergo another certification check to work the sector again. If you have a repeated history of deals or the deal was particularly close, you may be decertified on *all* your sectors.

All parties are aware that humans make mistakes, though, and if you *just didn't* see two aircraft that were getting too close, admit your error, and resolve to improve your skills. In this simulation, your rating will suffer a little, but you can build it back up by working busy traffic again without errors.

If two targets start blinking due to your error, immediately tell your supervisor by requesting a break, and everything will be OK. If you try to cover it up, you could be fired.

It's possible, due to the large numbers of aircraft in the sky, that the **snitch** doesn't catch a loss of separation in your sector. Computers can become overloaded, and can certainly make mistakes too. Let your conscience be your guide, in this case. In this simulation, the **snitch** should catch all deals between aircraft under your control. However, the "controllers" in the sectors adjacent to yours are computerized, and may make mistakes because they lack true intelligence. Thus, you will not be charged for an error due to the adjacent computer controller's mistake in climbing or turning its aircraft within or into your sector. Even though you may see such aircraft within five miles of each other and less than 1,000 feet apart (or 2,000 feet above FL290), the **snitch** will not blink, so carry on as if nothing was happening. The situation is due to the computer controller's lack of spatial ability, and is not necessarily your mistake.

When you first choose a sector to work, a computer controller will be at the controls. Until you choose to *plug in* (your headset), the computer will continue to control traffic at the sector, and may make mistakes. As soon as you *plug in*, the computer controller leaves, and *you* become responsible for everything in the sector. **Make sure** there are no impending midair collisions or loss of separation before you plug in. If there are, wait until the situation is over before plugging in and assuming responsibility. The sleaziest *deal* would be one that happened one second after you plugged in, because *you* would take the responsibility and blame.

Summary

- Tower controllers separate aircraft by physically looking out the tower window, or by keeping track of aircraft mentally and with a notepad. TRACON controllers use radar to separate departing and arriving aircraft within about 30 miles of the airport, and line up arriving aircraft to specific runways. Center controllers oversee everything

else, guiding aircraft up to their cruising altitudes, and lining them up in evenly-spaced single streams for arrival into the airport areas.

- Center controllers are assigned to *sectors* that have specific boundary lines and altitude ranges. Sectors can be oddly shaped, and may have parts of other sectors or TRACONs jutting into the airspace. Prior to an aircraft leaving a sector, the controller must *make a handoff* to the next sector the aircraft is about to enter.
- Each sector has specific procedures for dealing with arrivals, departures, and overflights. Controllers must strive to get all aircraft at the proper altitudes or spacing according to the procedures, while keeping proper separation between each. Procedures can be waived, though, if adhering to them will cause a loss of separation.
- The ATC computer constantly monitors all aircraft, and will cause targets to blink if they get within the minimum separation standard of five miles for aircraft within 1,000 feet of each other vertically, or within 2,000 feet vertically above FL290. If this happens to you, you have had a *deal*.

3. RADIO COMMUNICATIONS

After you plug into a sector by clicking on the "plug in" button, *radio windows* will appear in the middle of your console, at the bottom of the screen. The *top* window will contain the text of the pilots' transmissions. The *bottom* one-line window represents your transmitter, and is where you type your commands. (If you want the pilots to speak, upgrade to version 1.1 at www.xavius.com!).

Your sector is assigned a specific radio frequency, listed on the sector maps. To transmit on the frequency, *key your microphone* (like with a CB radio or Walkie-Talkie) by pressing the <ENTER> key. Your transmit window will light up. Whatever you type will then broadcast to all aircraft tuned to your sector's frequency. When you are finished, unkey the mike by pressing <ENTER> again, and the transmit window will turn off.

Only one transmission, either by a pilot or you, can go over the air at one time. If two people try to transmit at the same time, both transmissions will merge, and it will sound garbled to anybody else listening on the frequency. If *you* try to transmit while a pilot is talking, your transmission will likewise come out garbled to everyone else. You will not know this, however, because your receiver turns off whenever you transmit. If this happens, somebody on your frequency will usually inform you your transmission was "blocked."

All of this may take some getting used to, especially when the sector is full of aircraft, and can be a little frustrating. Just be patient, and wait for aircraft to stop transmitting before you key your mike. Try to be quick and brief in your transmissions, so you don't tie up the frequency.

Issuing Commands to Aircraft

Issue commands to aircraft by first **keying the microphone** (by pressing <ENTER>), then typing the *callsign* of the aircraft, followed by a comma, and the command. The *callsign* appears next to the radar target, such as AAL450 or UAL173 meaning American Airlines flight 450 (spoken "American four-fifty"), and United Airlines flight 173 ("United one-seventy-three"). Private and business aircraft callsigns consist of the aircraft's registration number, which begins with the letter *N*, followed by a number and often more letters. An example is N232DL, or N101RW, spoken as "November two three two delta lima" and "November one zero one romeo whiskey."

Note: In this simulation, there are no letter "O's" in callsigns, because they look too much like zeroes. If you see a round circle in the callsign, it is a zero.

As a shortcut, you can alternatively just type the last few digits of the callsign, but be sure there aren't two aircraft with the same last digits, or two different aircraft may answer. With airline flights, the simulation is set up so there won't be two identical flight numbers, meaning you can safely type just the flight number instead of the full six-character callsign. Private and business aircraft may have similar last digits, however, so use caution shortening their callsigns.

For example, AAL450 can be typed as 450, or even 50. UAL173 can be addressed simply as 173. Likewise, N101RW can be typed 1RW or just RW.

Communications Protocol

The standard protocol for issuing a command to an aircraft is for the aircraft to *read back* the instruction. This ensures the pilot both received and heard the instruction correctly. If the pilot does not read back the instruction, you can assume he *did not receive it*, so you should issue it again.

If the pilot reads back the instruction incorrectly, **you are responsible to catch the error**. If you tell a pilot to "climb and maintain flight level three **one** zero (FL310)," and the pilot reads back "Ok, climb to flight level three **three** zero (FL330)," he will climb to FL330 unless you correct the error. If he then collides with another aircraft at FL330, it is *your* fault for not catching the erroneous readback.

In this simulation, **aircraft will not read back instructions incorrectly**. If you type FL310, they will read back FL310, and climb to FL310. However, it is quite possible that you may inadvertently type FL330, or FL210, or any other kind of typo, which the pilot will dutifully read back. Thus, **it is important to listen to the readbacks to catch your errors**.

Pilots will read back your instructions immediately after you issue them. Occasionally, however, another aircraft will interject with a check-on message or a request for something. In that case, the first pilot will wait until the radio is clear before reading back your instruction. Remember, consider the instruction as *not received* until you *get a readback*.

Occasionally pilots will completely miss your instructions because they're busy with other duties, or just not paying attention to the radio. In that case, you won't get a readback, and should repeat the instruction, *callsign*, comma, command. Or, you can use just *callsign*, comma, and unkey the mike (meaning "*callsign*, how do you read?") which

should wake them up. If they *still* don't respond, they're probably still on the previous sector's frequency. A later section will elaborate on how to use the interphone to call the previous sector to relay instructions.

Aircraft Commands

There is a fixed *standard phraseology* for communications over the radio, so that both pilots and controllers are sure about what is intended. The command to tell an aircraft to start his climb to a specific altitude, for example, are the specific words "climb and maintain," followed by the altitude. The following command list covers altitude, heading, speed, and routing instructions.

ALTITUDES

<i>Typed</i>	<i>Spoken</i>
CM	" Climb and Maintain ," followed by the altitude, such as CMFL230, or CM14000 for "Climb and maintain flight level two three zero" and "Climb and maintain one four thousand" respectively. As a shortcut, you can say CM140 instead of CM14000. Also, you can use the <i>up arrow</i> instead of CM, which will appear as ^ in the window.
DM	" Descend and maintain ," followed by the altitude as above. You can use the <i>down arrow</i> instead, which will appear as a v.
SA	" Say altitude ." The pilot will tell you his current altitude. You would use this if your radar wasn't picking up his altitude, for example.

HEADINGS

FH	" Fly heading ," followed by the heading, such as FH320 for "fly heading three two zero," or FH010 for "fly heading zero one zero." The aircraft will turn the shortest direction (left or right) to reach that heading.
TLH	" Turn left heading " followed by the heading. If the aircraft is currently heading 080, for example, and you tell it turn TLH090, it will turn left all the way around to the 90 heading (almost a complete 360). Use this command if that is what you want, otherwise it's probably quicker and easier just to use FH . <i>Shortcut: you can use the left arrow key, plus a three-digit heading, such as <-020 for "turn left heading 020."</i>
TRH	" Turn right heading " followed by the heading, as in TLH above. <i>Shortcut: right arrow, plus a three-digit number, as in ->320.</i>
T20L	" Turn twenty degrees left ." Or whatever degree amount you wish, such as T10L or T90L for "turn ten degrees left" and "turn ninety degrees left." This

is the quickest way to get aircraft to turn a certain amount, instead of calculating what magnetic heading you would need. *Shortcut: arrow plus two-digit number, e.g. <-20 for "turn left 20 degrees."*

T20R "**Turn twenty degrees right.**" Same as T20L above, and same shortcut: ->20 for "turn right twenty degrees."

SH "**Say heading.**" The pilot will tell you his current magnetic heading, which may vary day-to-day along a given route, depending on winds. You might use this to keep two aircraft flying parallel to each other, by asking the first his heading with SH, then assigning the second the same heading with FH.

FPH "**Fly present heading.**" The aircraft will lock in its present heading, and continue on that heading indefinitely, instead of going from point to point along its route.

..*<fix>* "**Cleared direct,**" then the VORTAC or intersection name (the "fix"), such as **..LAS** for "cleared direct Las Vegas" or **..PLAIN** for "cleared direct Plain intersection." The aircraft will turn directly to the VORTAC or intersection, then pick up its assigned routing from there.

This command is used after you have turned an aircraft, to get it back on course. You must be sure the VORTAC or intersection is along the aircraft's route, by checking the routing in the computer, and on the map. *Shortcut: simply typing two dots **without** a fix name means to "resume own navigation," and the pilot will proceed direct to the next fix along his route. Use caution, though: if you have turned an aircraft **beyond** the next navigation point, and then tell the pilot to resume own navigation, he may turn **back** toward that "next" point. It's best to clear the aircraft direct to a **specific** fix name.*

SPEEDS

M280K "**Maintain two hundred eighty knots.**" Tells the pilot to maintain a specific *indicated* speed. Remember, the *indicated* speed is what appears on the pilot's airspeed indicator, and is *not* the speed your radar shows (which is the groundspeed.) Indicated speeds taper off as the aircraft goes higher, so an aircraft holding a groundspeed of 450 knots may *indicate* 320 knots when at 10,000 feet, and 270 knots at 35,000 (FL350), for example.

M300K- "**Maintain three hundred knots or less.**"

M310K+ "**Maintain three hundred ten knots or greater.**"

-300K "**Reduce speed to three zero zero (knots).**" Same effect as M300K.

+310K	"Increase speed to three one zero (knots)."
-20K	"Reduce indicated speed twenty knots." To reduce by a specific amount, the speed amount needs to be in two digits.
+10K	"Increase indicated speed ten knots."
\	"Resume normal speed." Use this to lift a speed restriction and to let the aircraft return to its normal cruising speed.
+	"Maintain maximum forward speed." Issue this command to make the aircraft go as fast as it can. The actual speed that it will go will appear on the strip.
-	"Reduce speed as much as practical." Usually this will be 250 knots, which is the slowest speed you can assign to jets anyway. Above 29,000 feet (FL290), use mach numbers:
MM76	"Maintain mach seven six."
MM78-	"Maintain mach seven-eight or less."
-M80	"Reduce speed to mach point eight zero."
+M78+	"Increase speed to mach seven eight or greater"
-M02	"Reduce speed by mach point zero two." If the aircraft was cruising at mach .82, for example, it would slow to mach .80.
SI	"Say indicated speed." The pilot will tell you his current indicated speed.
SM	"Say mach number." The pilot will tell you his current mach number.

OTHER COMMANDS

<i>Callsign</i>	Just the callsign, <i>without</i> a comma, means "Roger." Use this to acknowledge an aircraft that is "checking on" to your frequency, if you have no instructions to issue to him. For example, a pilot might check on with the message "Hello Chicago Center, NWA275 with you at flight level 330." You are required to somehow acknowledge his check-on, which you can do by issuing an instruction, or more likely just with "Northwest 275, Roger" NWA275<ENTER> .
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Callsign, "Callsign, how do you read?" Use the callsign *with* a comma to get an aircraft's attention, or to see if it is on frequency. If the aircraft is on frequency, the pilot will probably respond with "go ahead."

***132.62** "Contact <Los Angeles, New York, or Chicago> Center one three two point six two." After you have handed off an aircraft to the next sector, and it is clear of all remaining traffic in your sector, instruct the aircraft to switch to the next sector's frequency with this command. The particular frequencies are listed on the sector maps. It helps to memorize them, but you can also look at the map for reference.

Shortcut: you can omit the decimal point, and the first digit of the frequency, because all frequencies begin with the number 1. For example, *132.62 can also be typed *3262.

Even better shortcut: You can also omit the comma following the callsign. So, if you wanted to tell Delta 386 to contact New York Center on 132.87, you could type **386*3287<ENTER>** all from the keypad.

A "Affirmative" or "Approved." Used in response to a request, such as a request to deviate off course to go around a storm buildup.

N "Negative," or
U "Unable." Used to deny a request.

E "Expedite your climb/descent." Use this command after you tell an aircraft to climb or descend, if you need the pilot to increase his rate of climb or descent to get over or under some traffic. It is an "informal" request, but most pilots will increase their climb/descent rates accordingly.

You can also *combine* the expedite command with CM or DM, such as ECMFL330 meaning "expedite climb to and maintain flight level three three zero," or EDMFL240 ("expedite descent to and maintain flight level two four zero.").

SR "Say ride conditions." The aircraft will tell you whether the ride is smooth, or turbulent in different degrees.

RI (Gives plain-English ride report information). Pilots of passenger-carrying jets are usually very concerned about turbulence in-flight. The aircraft itself can safely fly through most rough air, but passengers become nervous, or airsick when the aircraft is continually tossed around. Thus, when weather conditions are forecasted to have turbulence at certain altitudes, they will frequently ask you for ride reports. Ask aircraft at similar altitudes or up ahead for ride conditions with **SR**, then tell the asking pilot by issuing this **RI** command. Though the command is only two letters, in reality you would use

plain English to describe the ride information you know. More on turbulence and other weather conditions is detailed in a later section.

Common keystroke shortcuts: As with the * command ("contact"), the arrow keys don't require a comma after the call sign. To tell Continental 803 to turn 30 degrees left, for example, you could type **803<left arrow key>30**.

Combining commands: You can issue several commands in one transmission by separating them with commas. It's usually better, though, to issue just one at a time, because a bunch of numbers issued at once could easily confuse a pilot (e.g. "DAL247, CMFL250, FH280, M290K" and the pilot may climb to FL290, fly heading 250 and maintain 280 knots out of numerical confusion).

If you do combine commands, the pilot will either respond with "... Roger" meaning all commands were understood, or will say "Unable" meaning he is unable to comply with *one or more* of your instructions. Reissue the instructions one at a time.

Advanced commands: The above commands are all you need to effectively control traffic. There are additional commands, though, that are occasionally used in real-world controlling, and are listed on the command card. The most common is the ***crossing restriction***, used to tell an aircraft to climb or descend so as to be at a certain altitude by a given point. An example is "Cross Dagget at and maintain flight level two four zero," typed **XDAG@FL240**. If the aircraft is level at FL290, for example, the pilot is allowed to stay at FL290 then start descending whenever he wants, as long as he levels out at FL240 at or prior to the DAG VORTAC. Using crossing restrictions and some of the other commands is covered in later sections.

Weather deviations: Weather is covered in a later section, but in general, aircraft will not fly through storms or storm buildups, and will request *deviations* around them. These weather areas may or may not show up on your radar; the pilot will simply state he is requesting a certain number of degrees left or right of course to go around the storms. You can simply state "approved" (A command), or use one of the following deviation commands:

DV8L "**Deviations *left* of course approved.**" You might use this if the pilot requested *right* deviations, but you had traffic off his right side, so it would be better if he went *left*. It's preferable to approve what the pilot requests if at all possible, but if you simply can't, at least approve the deviation in the *other* direction.

You can also use DV8L if the pilot has requested left deviations, just to clarify and restate the direction.

DV8R "**Deviations *right* of course approved.**"

DV8L,..<fix> "**Deviations left of course approved, and when able proceed direct**

<fix>" This is the most preferred way to handle deviations (either DV8L or DV8R), by specifying a VORTAC or intersection name *on the aircraft's route* to turn toward after the aircraft has finished deviating. The fix or intersection should be far enough away from the weather area, however, to prevent the aircraft from going in circles trying to get back on course, then deviating again, then trying to get back on course, and deviating again and so on.

A Typical Communications Scenario

Let's say you are working Los Angeles sector 38, and have taken a handoff on Southwest Airlines flight 710, which is headed for Burbank, California. Shortly after you take the handoff from the previous controller, the aircraft will check on:

Pilot: *Good afternoon, SWA710 level at flight level 280.*

As you "type" over the radio, it is best to speak, or at least *think* of the official phraseology as you type it:

You (typing): **SWA710**

You (saying): *Southwest seven-ten, roger.*

Remember, first you must *key the microphone* by pressing <ENTER>, which lights up the transmitter window. After you finish typing, you must *unkey the microphone* by pressing <ENTER> again.

A little later in this scenario, you may see that another aircraft may get closer than five miles apart from SWA710 while climbing through SWA710's altitude of FL280. You might decide to turn SWA710 a little to the right, about 20 degrees:

You (typing): **SWA710,T20R**

You (saying): *Southwest seven-ten, turn twenty degrees right.*

Pilot: *Ok, that's twenty degrees right, SWA710.*

Once SWA710 is clear of the traffic, you would clear him direct to the next fix along his route, which by looking at his flight strip you know is PMD (Palmdale):

You (typing): **SWA710,..PMD**

You (saying): *Southwest seven-ten, cleared direct Palmdale, rest of route unchanged.*

Pilot: *Direct PMD, rest unchanged, SWA710, thank you.*

At this point, SWA710 is clear of traffic, and you know the procedure for aircraft at sector 38 that land at Burbank (BUR) is to descend them to FL240 and hand off to sector 17, which lies below sector 38. You make the computer entry to initiate a handoff to sector 17 (computer entries are covered in a following section), and tell SWA710 to start

down:

You (typing): **SWA710,DMFL240**

You (saying): Southwest seven-ten, descend and maintain flight level two four zero.

Pilot: All right, down to 240, SWA710.

A little while later, sector 17 accepts the handoff (handoffs are covered in a later section also), and you see that SWA710 is clear of all traffic in your sector, so you switch him to sector 17. You look at the map to find sector 17's frequency, 132.5.

You (typing, deciding to use one of the shortcuts): **710*325**

You (saying): Southwest seven ten, contact L.A. Center 132.5.

Pilot: 132.5, SWA710, good day.

4. THE RADAR AND COMPUTER CONSOLE

This section explains what all the lines, blips and numbers on the radar scope mean, and what the buttons at the bottom of the console do.

If possible, start the simulation now, entering your initials and employee name as necessary, until you are at the main Sector Choice menu. Across the row labeled TRAIN are six blue sector buttons. Single-click on the one labeled ZAU 75.

You are now looking at Chicago Center (ZAU) sector 75. At first there will be no aircraft in the sector, but they are on the way. The gray plate labeled PLUG IN with the two black holes tells you a computer controller is currently working the sector. If you wanted to start controlling at the sector, you would click on the plate to "plug in" your headset. Don't do that yet, however.

The Radar Map

Covering the top 5/6ths of the screen is the radar display, called the PVD (for Plan View Display). You will notice there is no radar sweep, because *Center* radars are computer composites of several radar sites, and not direct radar returns. The radar information updates every *twelve* seconds.

The jumble of circles and solid and dashed lines is the *map*. Take out the sector 75 map and you will notice the correlation.

Radar Map Symbols

- **Dotted lines** are sector boundaries
- **Dashed lines** are boundaries between Center sectors and TRACONS.
- **Circles** depict VORTACs and airports.

- **Solid lines** are airways, with 10-mile gaps between the VORTACs and the start of the airway (which is a useful tool to estimate mileage when looking at the scope).
- **X's** show intersections along the airways.

Radar Controls

At the lower right of the screen are three displays, RANGE, VECT, and HIST. RANGE tells you the *radius* of the display in nautical miles. Double it to get the diameter from one side to the other. You can click up and down to expand the range in or out.

The **RANGE** should be sufficient enough for you to see the entire sector and beyond for at least 10 or 20 miles. If the range is too high, your sector will appear crowded; too low, and you won't be able to see aircraft that are coming toward your sector. It's best to leave the range at the default value, but you can click it up or down as you desire.

Skip the VECT and HIST controls for now.

Below the RANGE, HIST and VECT buttons are three small buttons labeled P, L and H. These are called the **radar filter keys**, and determine which radar targets appear on your scope.

If *everything* in the sky that returned a radar echo were displayed at your sector, your scope would be unnecessarily cluttered. Instead, you can *filter out* certain targets that don't apply to your sector. Sector 75, for example, covers only from 24,000 feet and up, so targets that are far below 24,000 feet need not be displayed. Thus you can select which targets you actually need displayed with the filter keys:

- **"H"** displays *high altitude targets*, only those above 14,000 feet.
- **"L"** displays *low altitude targets*, only those below 28,000 feet.
- **"P"** displays *primary* targets, which are raw radar returns. These include ground clutter, such as buildings or cars, or anything else that bounces off a radar signal. Aircraft that don't have transponders will show up as a *primary* target. Primary targets are depicted either as **dots** (for weak radar echoes), or **plusses** (for strong radar echoes).

Sector 75 only has **H** pressed, because only targets above 14,000 feet need to be displayed (the sector bottom is 24,000 feet). **P** is not pressed because ground clutter certainly doesn't apply to sector 75, and anything flying about 18,000 feet requires a transponder, so there should be no primary targets within the sector.

You should never need to change the filter settings, but they are there if you do need to for some reason.

AIRCRAFT TARGETS

VFR Targets

Press the **L** filter key, to display all the low altitude targets. Unless you're running the simulation after midnight local time, numerous **V**'s and **I**'s will appear. These are **VFR aircraft**, which as you recall are not in communication with ATC, and are allowed to fly around wherever they want, subject to some restrictions (clear of clouds, outside busy airport areas, and under 18,000 feet). These pilots are mostly flying around for fun, or to go short distances. The number of VFR aircraft in the sky on any given day depends on the time of day, the weather, and the day of the week.

The **V**'s and **I**'s mean the same thing: **V**'s are VFR targets below 5,000 feet, and **I**'s are VFR targets above 5,000 feet. Your only responsibility with these targets is to steer your aircraft around any that get too close. There is no separation minimum between these VFR targets and your sector's aircraft; just use common sense and keep them from colliding with your aircraft.

The little number next to the **V**'s and **I**'s is the *altitude display*. This is always in *hundreds of feet*, so 075 would be 7,500 feet, and 115 is 11,500 feet. **Add two zeroes** to the readout to get the full altitude.

You will notice next to the *bright* **V**'s and **I**'s (which indicate the target's current position) are *dimmer* **V**'s or **I**'s. These are called the **histories**. They show the position of the aircraft in previous radar sweeps, but you can think of them like a smoke trail, showing where the aircraft has been, and inferring the direction in which the aircraft is headed.

Click up and down on the **HIST** display at the bottom right of the console to specify the number of histories. You can have from zero to five histories displayed for each radar target. With zero histories, however, there is no way to tell which direction the aircraft are heading. With five histories, on the other hand, the display can become cluttered. Two or three histories are usually sufficient to indicate direction of flight without cluttering up the display, but it is your preference.

IFR Targets

Aircraft under jurisdiction of Air Traffic Control, whether in your sector or adjacent sectors, will appear as **bright backslashes**, along with their dimmer histories. These aircraft are on IFR flight plans, and are in radio communication with the appropriate sectors.

Datablocks

Next to the backslash (IFR) targets are one of two *datablocks*:

- **Limited datablocks** show the altitude of each aircraft in hundreds of feet (add two zeroes to get the actual altitude). *Above* the altitude readout is the aircraft's *transponder code*, which you don't really need to know, but is there.

- **Full datablocks** contain the callsign, current and assigned altitudes, computer ID#, and groundspeed.

To "pull up" the full datablock from a limited datablock, move the cursor over the target and click the left mouse button. The full datablock will then appear. Click on it again to turn it back to a limited.

A typical full datablock might look like this:

AAL123	(callsign)
240T287	(assigned and current altitude)
623 440	(computer ID and groundspeed)

- The **callsign** is how you refer to the aircraft over the radio.
- The **assigned altitude** is what the aircraft is climbing or descending to. You have to manually enter this by making a computer entry (detailed later) each time you tell an aircraft to climb or descend.
- The **current altitude** is the latest altitude the aircraft's transponder transmitted to the radar receiver.
- The **computer ID** is a number you can use when making computer entries referring to that aircraft (detailed later).
- The **groundspeed** is calculated based on distance traveled over the past minute. It is an *estimation*, and tends to lag behind the actual groundspeed when the aircraft is turning, speeding up or slowing down.

If the aircraft is *level at its cruising altitude*, its altitude line will show the altitude plus a capital 'C,' e.g. **330C**.

If the aircraft is *climbing to its requested cruising altitude*, the character between the *current* and *assigned* altitude will be an up-arrow, e.g. **330^217** means the *current* altitude is FL217, and the aircraft is climbing to its requested cruising altitude of FL330.

If it is *descending* to its requested cruise altitude, the middle character will be a *down arrow*: **310v327**

If the *assigned* altitude is *not* the requested cruise altitude, the middle character will be a T (for "temporary"), as in **240T287** meaning the aircraft is at FL287, descending to an interim (temporary) altitude of FL240.

More on the Altitude Display

It is important to be able to quickly read and understand the altitude line of the datablock. Remember, the current altitude of the aircraft is **the number on the right**, and the altitude he's climbing or descending to is the number on the **left**.

If the aircraft is level, it will appear as either **250C**, meaning level at FL250 and also the aircraft's requested cruising altitude, or **210T210** meaning the aircraft is at FL210, and is assigned FL210, but is requesting another altitude as its final cruising altitude.

Likewise, **350^310** means the aircraft is currently at FL310 and is climbing to an assigned altitude of FL350, which is *also* its requested cruising altitude.

In the later section on computer entries, you will learn how to enter the assigned altitude in the datablock immediately after you issue it to the pilot.

Radar Target Summary

- **Plusses** and **dots** are raw radar returns from anything that reflects a radar signal, such as ground clutter, or certain atmospheric phenomena. *Plusses* indicate strong radar returns, and *dots* indicate weaker returns.
- **V's** and **I's** represent VFR aircraft flying around on their own. Next to the V or I is the altitude display, in hundreds of feet.
- **Backslashes** represent IFR aircraft under control of ATC, whether in your sector or adjacent sectors.
- Next to all radar targets will be from zero to five *histories*, depending on how many you select with the HIST console control. Histories show positions of the targets in previous radar sweeps, and infer which direction the target is headed.

Datablock Summary

- Next to a backslash target will either be a **limited datablock**, showing only the transponder code and altitude, or a **full datablock**. A target's full datablock can be toggled on and off by moving the cursor to the backslash target and clicking the left mouse button.
- **Full datablocks** contain three lines. The first is the *callsign*. The second has *altitude* information containing the *assigned* altitude on the left, a T or up or down arrow, and the *current* altitude on the right.
- The **up or down arrow** means the aircraft is climbing or descending to its *requested cruising altitude*. A **T** in the middle of the altitudes means the assigned altitude it is climbing or descending to (or level at) is just a *temporary*, or interim altitude.

If the aircraft is *level at its requested cruising altitude*, it will appear as the altitude

plus C, as in **330C** or **290C**.

The last line of the datablock contains the *computer ID* on the left, and the *groundspeed* on the right.

THE REST OF THE CONSOLE

Vector Line

This is the control labeled VECT. Increasing this selector will draw a **line extending from the aircraft targets** that have full datablocks, in units of *five miles*. The line is referred to as a *vector line*. A selection of **1** will draw five-mile-long vector lines pointing in the **direction the computer thinks the aircraft is headed**. A selection of **2** will extend those vector lines to ten miles; **3** to fifteen miles, and so on.

The normal position is at zero. But, if you'd like to roughly estimate where a particular aircraft will be in 20 miles, say, compared to the position of another aircraft in 20 miles, you can click up the vector lines to **4** (4 times 5 miles = 20.) The end of the resulting vector lines is where the computer thinks the aircraft will be.

The two Los Angeles Center sectors (19 and 38) have a default of **1**, or five-mile vector lines. For various reasons, controllers there work traffic with these five-mile vector lines displayed. The setting is optional, however, and you can click the selection down to zero if you don't like it. One reason they do use five-mile vector lines is that the controllers can quickly see what five miles looks like, without having to display a 5-mile ring around a target (which is a computer entry covered in a later section).

Brightness Knobs Access Panel

This is the long, unlabeled gray button next to the P, L and H filter keys. Press this gray button to open up the access panel containing brightness sliders for the radar display. Click up and down on the sliders to adjust the brightness of the map, targets and datablocks on the radar. In general, the values should be left at the default: aircraft targets (RADAR) should be the brightest, datablocks (TRACKS) should be next, then the map and limited datablocks (LDB/HIST) at dimmer settings.

Interphone Button

This is the unlabeled square button just to the left of the clock. If you need to issue an instruction to an aircraft that is not on your frequency, press this button to connect to an adjacent controller, who will relay the instruction for you. As soon as you press the button, the radio receiver window will turn *green*, and after a few seconds, the adjacent controller will say "green light" or "override." This means "go ahead."

You can then issue the instruction just like you would if you were talking to the aircraft, such as **USA697,DMFL240**. The other controller will say his operating initials, then you should press the interphone button again to hang up. The controller will then issue the message to the aircraft.

If you want to tell the adjacent controller to switch a particular aircraft to your

frequency, you can just use the * command, but without a frequency number (it will default to your sector's frequency). For example, if an adjacent controller forgot to switch an aircraft over to your frequency, you can press the interphone button, wait for the controller to say "override," then type the callsign and * (no comma needed), as in **AWE120***. The controller will then give his initials, and you should press the interphone button again to hang up. AWE120 will soon check on to your frequency.

Incoming Traffic Display

The small window to the left of the radio windows shows the percentage intensity of traffic headed for the sector, from zero (no aircraft) to 100 (very busy). Usually there is about a 10 minute lag between what you see in this window, and when that traffic will hit your sector. If you see 100 in the window, get ready to get busy. If you see 50, relief is in sight.

When you are *working* a sector, you will have no control over the traffic levels headed for your sector; the simulation regulates it to keep it "busy" overall, but with ebbs and flows, as it is in real life.

If you *train* on the sector, you can click the amount up and down with arrow buttons that will appear beneath the window. You might start out with a value of 60, and go up or down from there depending on how overwhelmed you feel. Remember, though, that there is about a 10 minute lag between the level in the display and when the aircraft will actually reach your sector.

DSIDE Button

Once you are certified on a sector, you will have the option of requesting an assistant. The DSIDE button will appear beneath the traffic intensity display. Press it to request an assistant (known as a D-side) to help you, which will cause the button to blink. Within a few minutes, the supervisor will send an assistant over, and the button will stay lit once he is in place.

The D-side will initiate handoffs to other sectors, and enter assigned altitude information in the datablocks as you issue altitudes to the aircraft. This saves you both time and keystrokes, and is very helpful when you're busy.

While you're working a sector, the supervisor may also decide on his own to put in a D-side, if traffic starts to build. Also, he may take your D-side once traffic dies down. If you no longer need or want a D-side, you can press the button while it's lit or blinking to request that the supervisor take him away. Or, if the supervisor is about to take away your D-side (the button will start to blink), you can press it to ask that he stay.

If you're training at the sector or taking a certification test, there will be no DSIDE button and no D-side. You must show you can do everything on your own.

BREAK Button

The BREAK button is the closest thing to an exit or quit function. If you are training at the sector, press BREAK to leave the sector immediately and return to the main Sector Choice menu. Or, if you are taking a certification test, press BREAK to

cancel the cert check and exit the sector.

If you are *working* the sector, however, where there is *live* traffic, you must wait for another certified controller to relieve you from position. Press the **BREAK** button to *request* a break with the supervisor. The supervisor will do his best to get someone in to relieve you, but it may take up to a few minutes. When you have a break on request, the button will be lit. When another controller is there and ready to take over the sector, the button will blink. Press it while it's blinking to actually exit. If you change your mind and decide you want to stay, just ignore the relief and he'll go away.

If you are *working* a sector, never exit by resetting the computer or turning it off. Especially never do that if you're about to have a *deal* and think you can outsmart the computer supervisor. The computer will *know*, and you will be punished the next time you use the simulation. Once you are certified at a sector and working live traffic, you are expected to behave responsibly and professionally.

There is a "cheat," however: if you have a D-side at the sector, you can let him take over by pressing ALT-P to unplug yourself from the position. This is to let you answer the phone, or run to the restroom. When you return, you can plug back in as normal by clicking on the "plug in" plate that will appear over the console. As always when first plugging in, though, make sure the sector's not about to have a *deal*, because you assume all responsibility the second you plug in.

Computer Commands

The square computer screen in the lower left corner of your monitor is the ATC computer's display. Make computer entries by pressing an appropriate function key on your keyboard, which will show as a + on the monitor. As you type, your input will appear on this display, until you press <ENTER>. Then, you return to the normal mode where your <ENTER> key activates your microphone window.

The ATC computer will respond to your entries with either ACCEPT or REJECT. The functions are as follows:

Accept a Handoff <F1>(AID)

where (AID) is either the computer ID#, full callsign, or left mouse button over the aircraft's radar target (the bright backslash).

When an adjacent controller initiates a handoff to you, the aircraft's datablock will appear on your screen, with **H-xx** (xx being your sector number) blinking in the lower right corner, alternating with the groundspeed display. You should take the handoff prior to the aircraft entering your sector. If you don't, the adjacent controller is technically required to turn the aircraft around, but handoffs are rarely refused, so the aircraft will keep blinking at you and keep flying into your sector.

Taking the handoff means you assume responsibility for the aircraft, so don't take it until it is separated from all your existing traffic. Issue instructions to the new aircraft, if necessary, by using the interphone button.

Initiate a Handoff **<F1>(sector) (AID)**

where (sector) is the sector number to which you are handing off the aircraft, and (AID) is the aircraft's full callsign, computer ID#, or left mouse click over the aircraft's target. Example: **<F1>17 522** initiates a handoff to sector 17 of the aircraft with computer ID#522.

Before any aircraft under your **control** (i.e. in your sector) cross your boundary into the next sector, you must *initiate a handoff* to that sector with this computer entry. You can initiate a handoff at any time, but the next controller probably won't take it until about 10 to 15 miles from his boundary, so you really don't need to start the handoff until about 20 miles from the boundary.

When you initiate a handoff, you will see **H-xx** start to blink in the lower right of the datablock, where xx is the sector to which you're handing off.

When the next controller takes the handoff, the blinking H-xx will turn to a steady **O-xx**, and the letter **R** will appear to the left of the computer ID# in the datablock, so the last line of the datablock might look like this:

R143 O-34

This indicates that sector 34 has taken the handoff on the datablock.

If you initiate a handoff, and the next controller just won't take it, most likely you are handing it off to the wrong sector. Double check the sector map to make sure it's the right sector. Also, make sure you are following the particular procedure for that aircraft, such as descending it to the proper altitude.

Move Datablock **<F1>(direction) (AID)**

where (direction) is a number on the numeric keypad specifying the direction to point the datablock (e.g. 1 is southwest, 8 north, 6 east); (AID) is the computer ID, full callsign, or left mouse click over the aircraft's target.

This entry moves a datablock to a different position. This is probably one of the most frequent computer entries you will make, because datablocks will start to overlap as the sector becomes crowded with aircraft. You will need to manually move each one to keep them apart. Or, the datablock may be partially off the screen, in which case you should move it to another direction so you can see all of it.

You can also **lengthen or shorten** the line leading from the aircraft's target to the datablock (called the *leader line*) by entering a forward slash, followed by the unit length, such as **/1** or **/2** or even **/0**. The default is the **1** position. You can combine this on the same line as the direction, so: **<F1>9/2 UAL312 <ENTER>** would move the datablock for UAL312 to the **9** position (northeast), and extend its length to two.

Display Route

<F3>(AID)

where (AID) is the computer ID, full callsign or left mouse click over the aircraft's target.

Draws a line on the radar showing the aircraft's route. The line will disappear after several seconds, or you can erase it with <F3> and no AID (just <ENTER>).

Distance Measuring From Point to Point

<F4> (left mouse)(left mouse)

This option will report the heading and distance *from* the first mouse click *to* the second mouse click. For example, to determine the distance between two aircraft, press <F4>, place the cursor over the first aircraft, click the left mouse button, place the cursor over the second aircraft (remember, the aircraft is the *bright backslash*), click the left mouse button, then press <ENTER>. You will see two displays: RNG means the distance (range) in nautical miles between the two points, and BRG is the heading (bearing) from the first point to the second.

Distance Measuring

<F4>FIXNAME(left mouse)

From Point to VORTAC, Intersection or Airport

Use this option to determine the distance and heading from a point to any known VORTAC, intersection or airport. For example, type <F4>JFK then move the cursor to any point on the radar (or over an aircraft, for example), click the left mouse button, then press <ENTER>. The computer display will tell you the heading and mileage to the JFK airport.

If the VORTAC, intersection or airport is not in that sector's database, you will get an error message.

Change Requested Cruising Altitude

<F5>(ALT) (CID)

(ALT) is the new requested cruising altitude (in hundreds of feet, e.g. 350 for FL350, 140 for 14,000), and (CID) is the computer ID, full callsign, or left mouse click over the target.

The datablock can contain two different altitudes: the aircraft's requested cruising altitude (called a "hard" altitude), and an interim assigned altitude (called a "temp" altitude). Recall from the altitude display in the datablock that an *up or down arrow* indicates the aircraft is climbing or descending to its requested cruising altitude. A **T** in between the two displayed altitudes indicates the aircraft is climbing or descending to a *temporary*, or interim altitude, i.e. *not* its requested cruising altitude.

This command changes the "hard" altitude, which you would do if the aircraft makes a specific request for a new cruising (final) altitude.

Toggle On/Off Five-Mile Ring <F7>J (AID)

where (AID) is the computer ID, callsign, or left mouse click over the target.

Draws (or erases) a five-mile (radius) circle around the selected aircraft. Normally a controller simply eyeballs potential conflicts, with a rough idea of how far five miles looks, based on the five-mile long vector line. In the case of jet aircraft, five miles is also the distance (roughly) between the target and its *third* history.

If you think two aircraft will get pretty close to five miles apart, you can put this five-mile ring (called a "J-ball" or "J-ring") around one of them, to know *for certain* how far five miles is. Then, make sure the other aircraft stays out of this ring.

You can display as many J-rings as you wish; however, your sector will quickly become cluttered, so one or two is probably the most you might need at any time.

Insert/Remove Temp Altitude <F8>(ALT) (CID)

(ALT) is the temporary assigned altitude, and (AID) is the computer ID, callsign, or left mouse click over the target. To remove a temporary altitude, omit the altitude: <F8>(AID).

If you issue to an aircraft an altitude assignment which is *not* its requested final cruising altitude, use this command to indicate this *temporary* altitude in the datablock. As you step an aircraft up to his final cruise altitude, for example, you would continue to issue new temporary altitudes and make this computer entry.

Finally, when you issue a climb instruction to his requested cruising altitude, remove the temporary altitude with <F8> and the aircraft ID as described above. The datablock will then show an *up arrow* to the cruising altitude, indicating he's climbing to his final cruise.

Make it a habit to immediately enter an aircraft's altitude assignment *as soon as* you finish typing the climb/descend command to the aircraft, and *as you* read his readback.

Altitude assignments are a *three-step* process:

1. **Mentally determine the altitude you will assign.**
2. **Issue the altitude to the pilot over the radio.**
3. **Enter the altitude into the datablock as you double-check the pilot's readback.**

In an example of an altitude assignment process, DAL476 might be requesting a final cruise altitude of FL330, but the highest you can assign him right now is FL290 due to traffic up ahead at FL310:

You(typing): **DAL476,CMFL290**
You(saying): *Delta four seventy six, climb and maintain flight level two niner zero.*

You(typing): **<F8>290 435** (435 is the computer ID)
Pilot: *Climb to 290, DAL476.*

Here you type in the temporary altitude *as* you keep an eye on the radio window for the pilot's readback. DAL476's datablock will then show 290T217 in the altitude line, for example, meaning he's at FL217 and climbing to the assigned altitude you just issued, FL290.

Later, in this example, DAL476 flies past his traffic at FL310, so you determine you can issue him his requested cruise altitude of FL330:

You(typing): **DAL476,CMFL330**
You(saying): *Delta four seventy six, climb and maintain flight level three three zero.*
You(typing): **<F8>435** (435 is DAL476's computer ID)
Pilot: *Ok, up to flight level 330, DAL476.*

Note that you made the computer entry to *remove* the temp altitude, which leaves the requested final altitude showing. You did this because the altitude you gave him *was* his requested final cruising altitude. If you had issued any altitude *other* than this final cruise altitude, you would have made another temp altitude entry instead of removing it.

Remember: make it a habit to *always* enter the assigned altitude into the datablock as soon as you issue it to the aircraft! Otherwise, you may soon forget and will start thinking the aircraft is climbing or descending to a different altitude than what he's actually assigned.

Flight Strips

Each aircraft under control of ATC has a *flight progress strip* that contains information about the flight. This information includes the aircraft's type, planned cruising speed (true airspeed, which would be the groundspeed if there were no winds), assigned route of flight, and notations on assigned speeds, altitudes, and headings, if any.

Center Controllers are required to make notes on the strip *each time* they issue an instruction to an aircraft. Conceivably, if the radar were to fail completely, the controller could use the information on the strip, along with estimated times across VORTACs, to keep aircraft separated.

The more practical use of the strip, though, is to indicate the *route of flight* of the aircraft, the *type* of aircraft, and the *requested cruising altitude* which may be "covered up" in the datablock by a temporary altitude.

Viewing a Strip

To see an aircraft's strip, **move the cursor over the aircraft's target, then press and hold the *right* mouse button**. The strip will appear in the lower right of the screen as long as you hold down the mouse button.

You can only display strips for targets that have a full datablock on the screen. (To pull up a full datablock from a limited datablock, put the cursor over the aircraft and press the *left* mouse button).

As you make altitude, speed, heading or route assignments, the information is automatically updated on the strip.

A Flight Strip Example

```
-----
| DAL523 | LAX LOOPN J9 DAG LAS | | | |
| B737/A | -----|
| T420   | | | | |
| 453 01 | 270K | 290 | | RV070 |
-----
```

Speed, altitude and heading assignments are all written in the appropriate box: the first bottom box is for speeds, the second for altitudes, the third shows the requested cruising altitude if different from the current assigned altitude, and the fourth holds headings/deviation assignments. The top box shows the aircraft's route, and if it is longer than the box will hold, some of the middle portions will be replaced with asterisks. The destination airport, however, will always be listed last.

The left-most box contains the callsign, aircraft type and planned true airspeed. The **01** next to the computer ID is the strip number, which is unimportant.

The primary use of the strip overall is to see an aircraft's type and route of flight. Seeing heading or speed assignments in their boxes will also remind you to get the aircraft back on course, or eventually lift the speed restrictions prior to handing off to the next sector.

Additional Computer Entries

ALT-C Re-centers the map display. You shouldn't need to use this, but if you did wish to move the display on your screen, place the cursor in the desired new map center position, and press ALT-C.

ALT-D Toggles large and small datablocks. You can select the default datablock size in the OPTIONS screen, or just toggle them large or small with this command.

Some lower-end monitors don't display small characters (like those in the

datablocks) very clearly, so you can use this option to "puff up" the size of the letters. However, the larger-sized datablocks are not very realistic; consider purchasing a monitor with a sharper *dot pitch* of .28mm or less.

ALT-S Toggles the sound on and off.

ALT-P Unplug/plug back in to the sector. Use this if you need to leave the sector for just a minute, to answer the phone or run to the restroom. As soon as you unplug, a computer controller (your D-side, if you are working the sector, or your instructor if you are training on the sector) will temporarily watch the sector for you until you get back.

If you are *working* the sector, this is cheating. The reality is there are no surplus controllers milling around who can just jump in and take over your sector, so the preferred way is to request a break and wait for your relief. However, there are probably more distractions where you are running this simulation than there are in real Centers, so having to leave the computer for a quick minute is understood.

If you see you are about to have a *deal*, don't try to unplug and give it to the computer controller to work out. The computer will find out if you try to cover it up this way, and you will be disciplined. Face the problem, resolve the situation as safely as possible, and admit your mistake. You are expected to behave responsibly and professionally, and your rating will reflect these efforts.

The Options Screen

At the bottom of the Sector Choice menu are two buttons, EXIT to exit the simulation, and OPTIONS. Pressing the OPTIONS button will show the default settings you can modify.

Traffic Level

This is the overall traffic intensity level, with a default of 100 (normal). When you *train* at a sector, you can directly control the level of traffic coming into the sector with the up/down arrows under the traffic intensity display. If you *work* the sector, (or take a certification check), the simulation automatically keeps things busy, at levels similar to what flies through the actual sectors in real life.

However, if you are a slow typist, or still just learning the simulation and find that *working* traffic is no fun because there are just *too many* aircraft, you can lower this overall traffic level by selecting OPTIONS, then clicking the **Traffic Level** downward. Then, you can *work* the sectors with less traffic.

If you can consistently *work* traffic with this level at 100, you are at the level of a professional air traffic controller. Consider doing it as a career!

Storms

NORMAL is the default and most realistic, but if you are new to the simulation, it is **strongly recommended** you select NEVER until you get used to the whole controlling process.

If storm cells are in your sector, everything can fall to pieces if you're not experienced issuing commands, making computer entries and staying on top of things. Just as you get used to the sector flows, and the specific routes the aircraft fly, one storm cell in the middle of everything will cause aircraft to deviate left and right, heading all over and into other aircraft and sectors. Also, your radio will become clogged with pilots making requests for deviations.

Once you feel comfortable working traffic at the sector, though, storms and aircraft deviations can make things interesting as you work out new strategies for getting aircraft where they need to go. But if you are still just learning, you may run screaming from the pressure. Turn storms off by selecting NEVER if storms make things too difficult.

VFR Targets

The default is ON. The VFR targets are the V's and I's meandering around the sky that you see if the L filter key is pressed. These clutter up the scope, and slow down the computer as it displays them all. Real *Centers* display them all, however, and they represent aircraft that are potential conflicts for the aircraft you are working.

If your computer is just getting bogged down, though, whether from a slow CPU or video card, you can turn these VFR targets off to speed up the display somewhat. You will still have the challenge of being a controller, separating aircraft under your control, but you will not be seeing everything a real controller would see.

Sound and Datablocks

Choose ON/OFF and BIG/SMALL to set the sound on or off and datablocks big or small. This works just like ALT-S and ALT-D, but makes them defaults when you start the simulation.

Choose big datablocks if your monitor doesn't display small letters too well. This is especially true with lower-end monitors that have *dot pitches* of .39mm, which can cause small letters to appear fuzzy. Consider investing in a sharper monitor with a *dot pitch* of .28mm or less.

YOUR AIR TRAFFIC CONTROL CAREER

New *Center* controllers are assigned to a particular Center, and a particular *area* within that Center. An *area* typically contains six sectors. The controller may end up staying in that Center and in that same area for his entire career, or may move around every ten years or so.

Air Traffic Control Center puts together six sectors from six different areas and three different Centers. Still, you can consider it your assigned area.

You will start out at the GS-11 level, with zero sectors, and are expected to eventually become certified on each of the six sectors in your area. Once certified, you are called an "FPL," for *Full Performance Level*. This is somewhat equivalent to *tenure* in the educational system: it's almost impossible to get fired, layoffs are almost unthinkable, and demotions rare.

Until you certify on all six sectors, you will receive a promotion after completing two sectors, then another after four. A rough pay scale (in mid-1990's dollars) for the different levels is as follows:

GS-11	\$35,000
GS-12	\$45,000
GS-13	\$60,000
GS-14 (FPL)	\$80,000

Pay is based on a base salary plus extra pay for overtime, holiday, and weekend work. Because Centers are 24-hour facilities, controllers work some day, some evening, some overnight, and some weekend shifts. A typical shift might be: Sundays and Mondays off; Tuesdays and Wednesdays 3pm to 11pm; Thursdays and Fridays 7am to 3pm; and Friday midnight shifts from 11pm to Saturday at 7am.

The Training Process

When you first start the simulation, after you have entered your initials and employee name, no sectors will be listed under your WORK row. This is because you are not yet certified on any of them. Your only choices will be to TRAIN on the sectors of your choice, or take a CERTIFICATION test on any you feel ready for.

Before you begin training on a sector, you will need to study all the information in the *sector description* for that sector. You will need to be familiar with the *sector map*, and know or at least know where to look on the map for adjacent sector numbers and frequencies, as well as the VORTACs, intersections, airways and airports within and near the sector.

You will also need to know the *procedures* for that sector, which list the possible routes, and what to do with aircraft along each of these routes. The *procedures* form the essence of the sector; you must issue commands (mostly climb or descent commands) so that aircraft adhere to the correct procedures, all while keeping them separated from each other.

Training on a Sector

Training on a given sector allows you to practice controlling traffic, with the benefit that if you have a *deal*, you are allowed to keep going. Nothing you can do will affect your overall career rating, so feel free to make mistakes. Real controllers train similarly, except they are plugged in with their instructor, who can step in to prevent *deals* before they occur.

No instructor will step in for you while you train, but you can take your time, practice issuing commands, and learn as you go. You have direct control over the traffic intensity that is headed for your sector; lower the amount if you feel overwhelmed. There is about a five- to ten- minute lag time, however, so it is best to click the level downward (maybe to 50) as *soon* as traffic starts to build. Then, after it has quieted down, click it back up to send more aircraft in.

The default traffic intensity value when training is 60. If you can work consistent traffic around the 70 or 80 level without having a *deal*, you are probably ready to take a certification test.

While you are training, you can exit at any time without having to wait for relief: simply press the BREAK button to return to the main menu.

Certification Test

When you feel practiced enough at a given sector, choose the sector number in the CERT row to take a certification test. You will have to work traffic at that sector while your computer supervisor watches you. You will have no control over the level of traffic coming into the sector, which will automatically be kept at a busy level.

If you can successfully work traffic at the sector for about 30 to 40 minutes, or otherwise impress the supervisor, you will be certified at that sector. If you have a *deal*, you will be told to keep training. However, your rating won't be affected, so don't worry. You can either train some more, or even take another certification test right away, if you want.

Working Live Traffic

After you are certified at a sector, the sector number will be added to your *WORK* row. Choose a sector out of this row if you feel like working *live* traffic. If you do well, your career rating improves. If you have a *deal*, your rating may suffer a little, and you may be decertified, but just take another CERT test and work your rating back up.

You can still train on a sector even after you are certified, but the ultimate goal is to certify on everything, then *work* the sectors as real controllers do. The challenge of working live traffic and getting them where they need to go with a minimum of delays, slowing, or turns, all while keeping them properly separated, is what Air Traffic Control is all about.

Career Rating

The rating number that appears on the Sector Choice screen next to your name is your *career rating*. A value of around 70 is normal, 80 can be considered "good," and 90 "excellent." You can improve your career rating by working busy traffic without having *deals*.

Your total hours *working* traffic is also logged, and your rating will tend to improve the more experience you have working live traffic.

If you have a *deal*, your rating will take a little hit. Just work more busy traffic to impress your supervisor and boost your rating back up.

HOW TO CONTROL TRAFFIC

Before you start to actually control traffic, you should be at least comfortably familiar with the aviation topics covered so far in this manual:

Aviation Knowledge Review

- **VFR aircraft:** These aircraft appear on the radar as **V's** and **I's**, with their altitudes displayed next to the targets. They fly around on their own, and are not in radio communication with you. You must simply note their positions, and prevent aircraft in your sector from getting too close to them.
- **IFR aircraft:** These are the aircraft you are responsible to separate. The pilots file a *flight plan* prior to departure, listing their proposed route of flight. Controllers can then change their routes as necessary to adhere to departure and arrival routing procedures. An aircraft's flight plan information, including the route, type of aircraft, and planned speed and cruising altitude appear on a *strip*, which you can bring up by moving the cursor over the aircraft's target and pressing the right mouse button.
- **Sectors:** Each radar controller is in charge of a *sector*, which has a specific boundary (shown in dotted lines), and specific altitudes that it covers. There may be parts of other sectors, or even entire TRACONs within your sector too. Prior to an aircraft entering your sector, the previous controller *initiates a handoff* to you, which causes the aircraft's datablock to pop up on your scope. After you take the handoff, you assume responsibility for the flight until you hand it off to the next controller down the line.
- **Sector Procedures:** You must apply appropriate procedures to aircraft within your sector, depending on where they're going. The information on each of the six sectors will list these procedures. Aircraft flights are divided into **arrivals**, which are in the process of descending for landing, or will start their descent soon; **departures**, which are in the process of climbing to their requested cruising altitude; and **overflights**, which are already at their cruising altitude and mostly just need to be left alone.
- **Separation:** You must keep all aircraft in your sector apart from each other by the minimum separation standard: **five miles** if the aircraft are at the same altitude or within **1,000 feet** of each other vertically at and below FL290, or **2,000 feet** vertically above FL290. If you don't, you have had a *deal*.
- **Aircraft and Computer Commands:** These all appear on the command card, which you can keep next to your computer, along with the sector maps and procedures. But, you should be familiar with the types of commands you can issue (altitudes, headings, speeds and weather deviations/turbulence information), and know how to make and

take handoffs (F1 key), and move datablocks around to keep things from getting too cluttered (also the F1 key).

Keeping Awareness

It is vital that you maintain an awareness of every aircraft in your sector. Controllers call this having the "flick." If you lose the *flick*, you will suddenly see just a jumble of lines and letters and slashes, your subconscious mind will make you feel that you're *missing something*, and you may begin to *panic*. Or, you may react in the opposite extreme and stare blankly at the scope, ignoring all around you. Either case is a dangerous situation, and the following sections describe methods for *keeping the flick*, or if you do lose it, how to *get it back* without compromising safety.

Keeping the *flick* revolves around one important concept: the **scan**. Your eyes must systematically travel from one aircraft to the next, spending a few seconds at each and *reminding yourself* where the aircraft is going, and what altitude it needs to get to. After you have gone through every aircraft in your sector (typically 10-15 aircraft), go back to the top and start over. Continue scanning over, and over, and over. There will be interruptions, such as aircraft checking on to your frequency, where you will need to break your scan to locate the aircraft and respond appropriately, but after each interruption you must return to your scan.

When your mind is kept refreshed by constantly scanning, you will feel in control, and feel that you **own** the sector. If you go too long without a complete scan, maybe only 30 to 60 seconds, you will feel the awful, creeping sensation of *losing it*, and the onset of panic. Remedy this by doing a complete scan again, and you will regain the *flick*.

The Traffic Scan

Your complete scan must be sure to cover each aircraft in your sector. You may develop a technique that works easier, but a typical scan begins at one side of the sector, either top, bottom or side, and moves to the opposite side.

Each time you come across an aircraft, remind yourself where it is going, and thus what procedure may apply to it, if any. If it is approaching the boundary of your sector, say within 15 to 20 miles, initiate a handoff to the next sector.

Also look at the altitude line in the datablock, both the current and assigned altitude. Look for any aircraft within those altitudes both in the immediate area (within 10 miles) and outward along the aircraft's remaining route to double-check that you issued the correct altitudes earlier. If you find an aircraft that will be a factor, correct it *now*. Issue an appropriate altitude, heading or speed to ensure they will be separated.

If the procedure for that aircraft is to descend or climb it to a specific altitude, and you haven't issued it yet, check for any traffic that may be in the way. If there is none, issue the appropriate altitude. If there is traffic, issue an altitude that keeps separation between the two while still getting the aircraft closer to its required altitude.

Move on to the next aircraft in the scan. Your scan must be quick and efficient, not lingering too long at any one aircraft because you will *lose the flick* with the rest of your sector. If you see something that needs to be done, do it **now**, not after the next scan. There should be a slight impatience in your scan mentality; you should be eager to get

aircraft *up and out* (or down and out) of your sector as quickly as possible. As soon as the next sector takes the handoff on an aircraft, and that aircraft is clear of all traffic, you should be *glad* to switch the aircraft to the next frequency and *get rid of it*. It is one less aircraft to tie up your frequency with a long-winded request or complaint about the rides.

Above all, though, *scan scan scan scan scan*. Whenever you start to lose it, *scan again!*

Positive Separation

It is both good practice, and in fact *policy* that all aircraft in your sector shall be at *guaranteed safe* altitudes, headings and routes. It is *guaranteed safe*, for example, if all aircraft in your sector are level at different, appropriately separated altitudes. It is *guaranteed safe* if two aircraft are at the same altitude, but their routes never come within five miles of each other. It is *guaranteed safe* if one aircraft is level at 15,000 feet and another is out of FL200 descending to 16,000, because they will never be within 1,000 feet of each other vertically regardless of how many miles apart they are.

This *guaranteed safety* is what is meant by **positive separation**. By keeping all aircraft positively separated from each other, as in any of the above examples, it does not matter if your radar fails, or if you lose the *flick*. The aircraft are safely separated, and will remain that way even if you leave to answer the phone.

Consider a case where you note as part of your scan that two aircraft at the same altitude will probably get within five miles of each other, but it's a long way away, and you can "always get back to it." They are no longer guaranteed safe; it's just a matter of time before they possibly collide. Now, until you "get back to it," your subconscious mind will gnaw at you, and you may start to panic, even if you have the *flick*. The safety of every passenger on those two planes now depends on your "getting back to it." If the radar suddenly fails, or your radios lock up, or the pilots' radios fail, the situation will be critical. Or, just as you "get back to it," and are about to issue an altitude or heading to separate the two aircraft, another pilot will start transmitting a long, elaborate report on the weather, and forget to unkey his microphone. You will then listen to the sounds of idle cockpit conversation, breathing and coughing as you helplessly watch two aircraft come together.

This is absolutely no way to control a sector. You must strive to keep aircraft positively separated, in other words, *guaranteed safe* at all times. As soon as you note a confliction, *do something about it* by issuing altitude or heading commands to achieve guaranteed separation again.

When all aircraft are *separated*, you can look away from the scope with confidence, or pick up your dropped pencil, or lean back and stretch, because you know *nothing is going to happen*. This is the only way to control traffic without having a heart attack your first year on the job.

Examples of Positive Separation

EGF287		N423FG
170C		120C
143 210\		/511 140
\		/
\x-----		-----x/

In the above example, Eagle Flight 287 is eastbound at 17,000. November 423 Foxtrot Golf is about twelve miles ahead, westbound at 12,000. By procedure, EGF287 needs to descend to 11,000.

The altitude you would issue should come to you almost instantly: 13,000. This is *positive separation*, because no matter how slowly, or how quickly EGF287 descends, you will never lose separation.

The foolish way would be to issue 11,000, reasoning that by the time EGF287 gets below 13,000, they will have passed each other already and be five miles apart. That may be true. You may further reason that you can "always change it" if EGF287 descends too quickly, stopping him at 13,000. Maybe so. But it is not *positive separation*, is foolish, against policy, and may only have a 90 percent chance of working. Ten percent of your decisions *not* working is completely unacceptable.

The answer here is to issue 13,000, then later issue 11,000 *after* they have passed and there is at least a space of five miles between them.

UAL982		x-----
350^217	/	AAL420
326 380 \	/	310T375
\		462 420
\x-----	x	
	/ \	
	DAL275 \	
	290C	
	943 420	

In this example, your sector covers FL240 and above. United 982 checks on to your frequency, climbing to FL230 only. His requested cruising altitude is FL350. The procedure for *departures* such as this one is to climb them to their cruising altitude. Assuming these are the only aircraft in the sector, and the distance between UAL982 and DAL275 here is ten miles, you should be able to look at this example and give an instant, *positively separated* altitude for UAL982.

FL290 is the best answer, because AAL420 will get within five miles, and is

descending to FL310. If you issued FL350 to UAL982, it is *almost certain* that you would not have a deal, because AAL420 will pass over UAL982 within a minute, and UAL982 will still be only around FL230 or FL240. **But**, computing all that may take too much time. If you are busy, you will want to make a *quick* decision as you move along in your scan, and the *quickest, guaranteed safe* altitude here is FL290.

You could even say FL280, or FL270, because DAL275 is "kind of in the area," and you are much too busy to watch them and measure how far apart they are. Those altitudes are fine, and are even *more* guaranteed safe. With just a little experience, however, you could also quickly see DAL275 is already 10 miles away and increasing, so is no factor.

You could also tell AAL420 to stop his descent at FL350 (DMFL350), then tell UAL982 to CMFL330. That would also provide positive separation, and is another acceptable alternative. That would take longer to issue, however, so the *quickest* solution would still be the original FL290.

Obviously, there are different alternatives to a given situation. The rule to follow is to pick the *quickest, safest* altitude, then move on with your scan.

Ignoring Positive Separation

Consider a more extreme example: One aircraft is at FL290, and needs to descend to FL240 according to procedure. You see that the *only other aircraft in the sector* is at FL260, and is head-on, but *150 miles away*. Technically, the "positively separated" altitude to issue is FL270. No matter how quickly or slowly the aircraft descends, it will always be separated from the traffic at FL260. Then, you would wait for them to pass before continuing the descent to FL240.

This is probably impractical, however. In fact, the aircraft may end up flying past his destination before the two aircraft finally pass. **You are allowed to use your good judgement in waiving the positive separation policy.** There is no definition of "good judgement," except you are bestowed with an amount of trust when you are certified at a sector, and are expected to use good judgement at all times, regardless of policies or procedures.

In this example, then, it would be good judgement to descend the aircraft at FL290 all the way to FL240. They are so far apart, and you will see that aircraft descend between 1,000 and 3,000 feet per minute, usually, so by all calculations, estimations and eyeballing, they will never be a factor. Thus, go ahead and descend him to FL240.

Intentionally violating "positive separation" is sometimes referred to as "going for it." You are hoping that this aircraft gets at least 1,000 feet underneath the other by the time they are within five miles of each other. The two aircraft being 150 miles apart initially makes this a somewhat tepid example of "going for it," though. If the aircraft were only 50 miles apart, an experienced controller may still feel confident enough to "go for it." It would be no fun to watch this occur, though, and would cause unneeded stress. Still, it may be the best solution to a complex situation involving multiple aircraft.

You will learn your limits as you gain controlling experience, knowing that a miscalculation on your part could result in a *deal*, or worse. Being successful in your calculations, however, will earn you praise and admiration from your fellow controllers.

Calculating Climbs and Descents

Most difficult situations, and most *deals* occur between aircraft that are changing altitudes: trying to dive one aircraft under another (as in the above example), or trying to climb one above another are common occurrences that can go awry if the controller miscalculates.

These calculations involve *quick estimations* of the future altitude of an aircraft. Center radar controlling is one of the few real-life occupations where those story problems from high school Math class are actually useful:

A jet airplane is traveling at 420 MPH over the ground. Currently it is at 25,000 feet, and is climbing at 2,000 feet per minute. How many miles will it have traveled when it reaches 29,000 feet?

The **long, tortuous** way to solve this would be to determine it will take *two minutes* to go from 25,000 to 29,000 feet (29,000 minus 25,000 feet, all divided by 2,000 feet per minute). 420 MPH divided by 60 minutes per hour equals 7 miles per minute; thus the aircraft will travel 14 miles in these two minutes.

Controllers usually do not have time for this kind of math. You need to make quick, but accurate estimations. These estimations revolve around several rules of thumb:

Good jets are the B73S, B757, B767, A320, and most business jets. Figure they'll climb at 1,500 feet per minute (FPM).

Bad jets are the others, especially the jumbos (B747, DC10, MD11). Figure a climb rate of 1,000 FPM.

Or compute the *actual* climb/descent rate by taking the *change in altitude in one radar update*, and multiplying this by *five*. This is the climb/descent rate. For example, if the altitude changed from 246 to 250 in one update, it is a change of 400 feet. Multiplying by five yields a 2,000 foot per minute climb rate.

Jets travel at *about eight miles per minute*. Or, compute the actual miles-per-minute by dividing the groundspeed by *ten*, then dividing again by *six*.

If You Like Math

1. Figure out *how many minutes* until the two aircraft will conflict by measuring the miles until the confliction point either by eyeballing or with the <F4> (distance measuring) function key.
2. Divide this mileage by the miles-per-minute. This is the number of minutes until the confliction.

3. Multiply this number of minutes by the climb/descent rate (1,500 FPM if a "good" jet, 1,000 if "bad"). This is how many feet of altitude the aircraft will change before the conflict begins.
4. Add/subtract this from the current altitude. This is the *altitude where the aircraft will be when the two reach five miles apart*.

If you calculate in this manner that there will be *lots* of vertical distance (well over the minimum of 1,000 feet/2,000 feet), then trust your calculations and issue the climb/descent. In subsequent scans, recalculate to make sure it is working as planned. If not, go to plan B by reassigning positively separated altitudes or turning one or both aircraft away.

If your calculations show that you will *barely* have the required vertical separation, don't issue the altitude, because it likely won't work.

If You Don't Like Math

Control by *feeling*. Sitting at the sector and watching aircraft hour after hour, day after day will give you a *feel* for how the various aircraft climb, and what altitudes they will reach along various points in their departure and arrival routes. At L.A. sector 38 (ZLA 38), for example, you will find out that most "bad" jets off of LAX will be around FL250 by the time they reach J6. The "good" jets will be above FL280 by the same point. If you had traffic along J6 at FL260, your *feeling* would say a good jet could climb above it, and a bad jet couldn't, and you would issue altitudes accordingly.

Spending multiple hours *training* at a sector will let you develop a base amount of intuitive feel without risk (*deals* don't count when you're training). Even after you are certified at the sector, your intuition will continue to develop as you log more hours working "live" traffic. If your intuition ever says something won't work, or something is wrong, it is probably correct.

If you are confident enough in your math abilities, you can efficiently run a sector with the above mental math calculations. But there are also many good, efficient controllers who control strictly by intuition. In either case, always have a *plan B* in case the first doesn't work, or in case you miscalculated.

Speed Control

As part of your routine scan, you must look at aircraft along the same route, moving in the same direction, to detect *overtakes*. An overtake occurs when two aircraft at the same altitude (or within the minimum vertical separation), along the same route, are at different groundspeeds, with the slower one in front. Eventually, the faster one will catch up, and there will be a *deal*.

There are various ways to deal with overtakes, including changing their speeds,

turning one or both, or changing their altitudes. Or, you may do nothing, if their routes will diverge prior to their getting within five miles of each other.

As with altitude changes, you can mathematically calculate when the overtake will result in a loss of separation, or just control by feeling, or both.

Overtakes by Mathematics

First you need to know how much spare mileage you have between the aircraft. Because you need five miles separation, anything over five miles is "spare." If the aircraft are 15 miles apart, for example, you have 10 miles to spare.

Next, calculate how often you lose a mile of separation. If the overtake is by 60 knots, you will lose one mile per minute. If it is 30 knots, you will lose one mile every two minutes. Thus, you can roughly estimate how many minutes you have until you will lose separation.

At 8 miles per minute, you can then figure how many miles you have until the *deal* will occur. If the two aircraft will split up before that, the overtake is not a factor. Or, if you plan to change their altitudes before that point, they shouldn't be a factor.

Overtakes by Feeling

Think of 10 or 20 knots as "a little," 30 to 60 knots "big," and over 60 knots a "huge" overtake.

"A little" overtake (10 or 20 knots) you can ignore, unless they are *really close* together (less than 10 miles apart).

A "big" overtake (around 30-60 knots) is a problem if they are "close" together (within about 30 miles).

A "huge" overtake (more than 60 knots) requires some kind of action.

Fixing Overtakes

As with any air traffic confliction, there are often multiple safe solutions. Ideally you should then choose the option that is the *least restrictive* to the pilots. For example, if two aircraft are flying along the same route, at the same altitude, and will be that way for the next 1,000 miles, it is unfair to make the faster aircraft slow to the speed of the slower aircraft for the entire journey. A better option would be to change their altitudes, preferably climbing one aircraft to a higher cruising altitude, because aircraft save fuel by flying at higher altitudes. Another option might be to turn the faster aircraft out, perhaps 20 degrees, until it is adjacent to the slower aircraft, but at least five miles away (sort of like moving into a "passing" lane). Once the faster aircraft passes the slower, you (or the next controller) can turn the passing aircraft back on course. This solution requires more work by the controllers, but may be the least restrictive overall.

Matching Speeds

If the two aircraft will only be along the same route for a short time, are both climbing to different altitudes, or are both headed for the same airport and about to start

their descent anyway, the least restrictive option will probably be to match their speeds. If possible, ask the slower aircraft to speed up to the speed of the faster one. Pilots trying to keep their schedules don't mind speeding up, but they hate having to slow down.

To do this, ask the speed of the faster aircraft with SM (Say Mach number) if above FL290, or SI (Say Indicated) if at or below FL290. Then assign that speed to the front (slower) aircraft. It may take a few minutes for the front aircraft to speed up, but eventually you will see the groundspeeds match, and your overtake problem will disappear.

Quite possibly, though, the front aircraft won't be able to cruise at the same speed as the back one. 737's, for example (B73S), cruise at about Mach .76, with a maximum speed of about .79. 727's (B727) typically cruise around Mach .82, which is beyond the maximum speed of the 737. If you had a 737 in front of a 727 at the same altitude, you could compromise by assigning "maximum forward speed" to the 737 (with the + command), then check the strip to see what it is (probably around .78 or .79). Then assign .78 mach to the 727. It is restrictive to the 727, but if it's just for a short distance, it is an acceptable solution.

Common Speeds

Type	Cruise speed	Climbout speed
B73S	.76 mach	300 knots
MD80 A320	.78	310
B757 B767	.80	320
B727 B777	.82	330
DC10 MD11	.84	340
B747	.85	340

Speeds will vary depending on the weight of the aircraft, the total flight distance, and other factors (including pilot's style, and airline policies.) But, these will give you a good estimation. Maximum speeds are about .02 mach above the cruising speed, and 10 to 20 knots above the climbout speed.

The best way to determine the aircraft's speed, though, is to *ask the pilot* with SI (Say Indicated) or SM (Say Mach number). A 737 may climb at 280 knots one day, and 320 knots the next. But, in general they will follow the above guidelines.

Other Speed Information

x----- * ABC (VORTAC)
 |
 TWA472
 330C
 456 440

Here, both Continental 236 and TWA472 are headed toward the VORTAC, which is the common converging point. Measuring the distance from COA236 to the converging point would show perhaps 11 miles; from TWA472 to the converging point might show 17 miles. Subtracting the two gives you your current spacing: *six miles*.

Also note the groundspeeds when determining current spacing. Here, the front aircraft (COA236) is *faster* than the back one (TWA472), so you are said to have six miles and *increasing*. By the time both pass over the VORTAC, you might end up with *seven* miles spacing, in this case.

If the rear aircraft were faster than the front, you would need to match their speeds if you wished to *hold* the current spacing of six miles, otherwise the spacing would gradually decrease.

Sequencing Multiple Aircraft

x----- x----- * ABC
 (VOR) | |
 AAL603 UAL880
 330C 330C
 431 450 412 440
 /
 /
 x/
 \
 DAL715
 370C
 741 440

In this example, all three aircraft are headed over the VORTAC on the right, so you would use that as the point of convergence. Measuring from there, you might find United 880 is 19 miles from the VORTAC, Delta 715 is 21 miles, and AAL603 is 40 miles away. In this example, the procedure is to get 10 miles of spacing between the aircraft.

To accomplish this, first determine who will be number one, number two, and number three. Usually, whoever's the closest already should be number one; in this case, UAL880. Number two should be the next closest, and so on. Whenever two aircraft are

pretty much the same distance (within a mile or two), make the *naturally faster* aircraft go ahead of the slower one. For example, if a DC-10 (normal cruise about .84 mach) and a 737 (normal cruise .75) were tied, or within a few miles of each other, you should make the DC-10 #1, and the 737 #2.

Once you have clarified who you will make number one, number two and number three, make it work. UAL880 in this example is number one. Number two is DAL715, who is currently two miles behind UAL880 (21 minus 19). You need to get 10 miles between these two. The next is AAL603, who is 19 miles behind the one in front of him in line (DAL715). Since you only need 10 miles, you have room to spare between those two.

The first step is to get DAL715 10 miles behind UAL880. A good rule of thumb is to **use vectors to get the spacing, and speeds to hold it**. "Using vectors" means turning the aircraft out, maybe 30 degrees, to either side. This will cause DAL715 to progress toward the VORTAC *slower* than UAL880. If you turned DAL715 by 30 degrees, say to the left, and remeasured the distances about 2 minutes later, you might find you now have 8 miles. Then, turn DAL715 back to the converging point (with the "cleared direct" command ..), and by the time he completes the turn, you may end up with 10 miles. Perfect!

Meanwhile, though, #3 in line has been steadily moving toward the VORTAC. After you turn DAL715 back in, now 10 miles behind UAL880, remeasure the new spacing between DAL715 and #3 in the sequence, AAL603. Oops! You find you now have *eight* miles. So turn out AAL603 for a little while until you get your 10 miles again.

Meanwhile, whoever's behind AAL603 in the sequence may need to be turned out also, and whoever's behind *him* as well, and on and on. There is frequently a cascading effect such as this when aircraft are closely packed together.

For example, if AAL603 were initially only 10 miles behind DAL715, and DAL715 were only two miles behind UAL880, you would still turn out DAL715 by maybe 30 degrees. To prevent AAL603 from catching up, though, you should turn *him* 30 degrees as well. Then when you turn DAL715 back to the VORTAC several minutes later, turn AAL603 back in too. Your spacing should then hold.

This is Confusing

It sure is! It's almost impossible to get the feel for sequencing and spacing just by reading. You have to *do it*, and *practice, practice, practice!* You may want to practice some sequencing first, then re-read this section and it may make more sense. Both L.A. sector 19 and Chicago sector 75 involve quite a bit of sequencing, though 75 has a lot more room, so is probably easier. See the sector descriptions for more on each of those sectors.

If you *try your best* at sequencing, but it just doesn't work, don't worry. Just hand them off to the next sector and vow to do better the next time. The computer controllers don't even bother sequencing, because it is so difficult. You should try, however, because the *Art* of sequencing and spacing is truly an integral part of Air Traffic Control.

Weather

When you first start your career in this simulation, you should select *never stormy* in the OPTIONS screen. Storms can create absolute havoc in your sector if you're not up to top speed and efficiency. Do not enable the storms option again until you feel comfortable enough with the normal traffic flows in the sectors you work.

Storms are disruptive because pilots simply will not fly through them. They will fly through *rain*, and normal *clouds*, but not storm clouds. These thunderstorm cells are among the most violent forces in nature, and can rip an aircraft apart in mid-flight.

Pilots have weather radar in their cockpit that shows the precise location of the storm cells. The controller's radar, however, only shows rain, and then only *some* of what's actually out there. This rain appears as closely-spaced lines on your scope.

Storm cells are concentrated areas of violent weather activity, and may range from a few miles across to a solid line of multiple cells 100 or more miles long. Storm clouds may extend up to 50,000 feet or more; in general, the higher the buildup, the more severe the storm.

Aircraft can fly above and around the cells, however. There is no real way to tell if an area of weather on your radar is just rain, or severe buildups. Some aircraft will fly through it, and others will ask to go around it.

You *must* approve requests to *deviate* around storms. If you say nothing, or deny a request, the pilot will eventually turn on his own, and is completely justified in doing so. If there is a *deal* because of this, it is still your fault.

If a pilot asks to deviate to the left, for example, but you have traffic off the left side at his altitude, you do have some options. You can approve a *right* deviation instead (the DV8R command), though that may be more inconvenient to the pilot. Try your hardest to accommodate pilots' requests when weather is the concern. You might turn the other aircraft out of the way, for example, to allow the pilot to deviate in the direction he wants.

You do not have to approve requests *right away*; most pilots will make the initial deviation request when still about 50 or so miles away from the storm, so you have a *little* time. But again, try to accommodate the pilot's request as soon as possible.

Along with approving the deviation (either left or right), you should specify instructions to follow after the aircraft is finished deviating, to get it back on course. Usually, you can specify to proceed direct to a VORTAC or intersection on the aircraft's route, when finished with deviations. This VORTAC or intersection should preferably be the first one outside your sector, to prevent the aircraft from having to make course-reversing turns toward a specified fix if the deviations were significant and the specified fix was close to the initial weather area.

A sample deviation command, in response to a pilot's request to deviate left, might be **DV8L,..LAS** meaning "Deviations left of course approved, and when able proceed direct Las Vegas."

Or, if the pilot requests deviations to the left or right, you could respond with **A,..LAS** meaning "Approved as requested, and when able proceed direct LAS." It's usually best, though, to restate the deviation direction just so everyone is clear.

Another shortcut would be to say simply **A**, meaning "Approved." If no routing instruction is included in the authorization for deviations, as in this case, the aircraft will proceed to the *next fix on its route* after getting around the storm. Watch out, however, because if this next fix is *within* the storm itself, the computer pilot may become agitated

or irrational.

Havoc

Deviations cause havoc in your sector because the normal routings are designed to keep things running smoothly, such as keeping climbing aircraft in one corridor and descending aircraft in another. With deviations, however, aircraft may be flying all over the place, and you will need to improvise. This is when controlling is the most challenging. You may have a perfectly spaced line of arrivals, for example, then suddenly the front aircraft needs to deviate off course, but the one behind him doesn't. Now your spacing is all messed up, and you will need to think fast and act creatively to get everything back in place.

Turbulence

Turbulence may be present even with the storms option turned off. Turbulence can be scattered around the sky, and is often only at certain altitudes. There are many causes of turbulence, but usually it is due to unstable air masses. Some days may have none, and others turbulence at all altitudes. Pilots will tell you as they encounter it, and you should form a mental picture of where it seems to be located (both general position and altitude range) to inform other pilots as they enter your sector what to expect.

These are common types of turbulence, ranging from lightest to most severe:

Light chop: This is like traveling down a bumpy road. Most pilots don't mind flying through light chop, unless it is continuous.

Moderate chop: Much more annoying than light chop, like driving over strings of potholes. Most pilots will ask to change altitude rather than fly through lengthy moderate chop.

Light turbulence: Turbulence has longer "cycles" than chop, which is mostly quick bumpiness. Turbulence also has more side-to-side motion and rocking of the aircraft's wings. Aircraft will usually ride out light turbulence, if they can expect it to last only a short time.

Moderate and Severe turbulence: Pilots will be anxious to get out of moderate turbulence. Severe turbulence is rare, but can cause significant injuries to passengers, and even structural damage to the aircraft. Pilots in severe turbulence are justified in changing altitude on their own, and will tell you as they do it.

The two commands for dealing with turbulence and chop are **SR**, "say ride conditions," and **RI**, shorthand for issuing ride information. If an aircraft at FL350, for example, reported to you that he was in continuous light chop, and you had another aircraft behind him about 50 miles also at FL350, you should tell the back aircraft this

information by "issuing" the **RI** instruction. In real life you would use plain English to tell the back pilot what to expect up ahead, but in the simulation you simply say **RI**.

If you are working a sector on a day that is particularly bumpy, pilots will tie up your frequency asking about rides, and reporting chop. You can keep them quieted down somewhat by using **RI** liberally, such as when aircraft first check on with you. Then, they'll know what to expect, and won't bug you with their complaints.

If every aircraft on a particular route in your sector at FL330, for example, asks to descend because of continuous moderate chop, and then you get a new aircraft on that route at FL330, you might as well descend him as well, because you know he will bug you later on for a lower altitude. Also, he will appreciate your descending him to avoid the rough air altogether.

Summary and Helpful Hints

Keep your awareness of everything by maintaining a constant scan of all aircraft. If you ever feel rushed, or don't feel like you know what's going on, you are probably forgetting to scan. Never linger too long or fixate on one area of the scope, because you will lose track of what's happening in the other parts of the sector. After you finish scanning, scan again, and again, and again. When your mind is constantly refreshed in this manner, you will feel *in control*.

At each aircraft in the scan, remind yourself of who he is, where he's going, and where he needs to go (such as descending or climbing to specific altitudes). If you see something that needs to be done with that aircraft, *do it now, not later*. Double-check your previous altitude issuances by first looking around for imminent traffic, then along the aircraft's route and to the sides for traffic you may have missed. If it is time to start a handoff to the next sector (about 20 or so miles from the boundary usually, though it's your choice), do so *now, not later*.

Decisions must be made quickly, so you don't spend too long at one aircraft and interrupt up your constant scan. Use positive separation (guaranteed *safe* altitudes or headings) whenever possible, so you don't have to mess around with calculations, especially if you are very busy. If two aircraft look like they *might* be traffic for each other, then they are! Don't mess around; issue altitudes or turns to separate them for certain, and the next time through you can reevaluate and maybe ease the restrictions or get them back on course.

Sit back and look at the *big picture*. It's probably not as busy or complex as you think! Keeping a constant scan and absorbing the big picture will make things run much more smoothly.

Your mentality should be to get aircraft *out of your sector*. Get them moving, get them up to their cruise altitude, and handed off to the next guy. Each aircraft you switch to the next sector is one less complaint or question that can tie up your

frequency. Of course, you can't switch aircraft to the next sector until that sector takes a handoff. And even if they take the handoff, don't switch the aircraft until it is clear of all other traffic in your sector.

When a handoff first pops up on your scope, make it a habit to ensure it is clear of all traffic before you take it. If there is a conflict, get on the interphone and issue the appropriate heading, altitude or speed command, then wait to make sure the aircraft is doing it. Once separation is achieved, *then* you can take the handoff. This also applies to two handoffs coming to you from the same sector. The previous controller may not see that they're about to get within 5 miles of each other, same altitude...don't just watch it, get on the interphone, issue a descent or climb to one of them, wait for the aircraft to become separated, *then* take the handoffs. Part of your job is to *fix* mistakes others make.

If you forget to take a handoff, or are just too busy to take any more aircraft, they will still fly into your sector. However, you will not be charged with any deals that occur with them. This will make the previous controller's job much more difficult, because he's technically required to reverse the aircraft's course. In reality, though, handoffs are rarely refused. Keep your awareness, take handoffs, and keep things moving.

If the next controller isn't taking *your* handoffs, you probably have the handoff flashing to the wrong sector. Take the handoff back, and flash it to the correct sector.

Keep the scope uncluttered. As soon as an aircraft that you've handed off and switched exits your sector, either by climbing above, descending below, or crossing the boundary, *take the datablock off the scope* with the left mouse button, or <F1> and ID#. You no longer need to watch the datablock after the aircraft has left the sector, so there's no need to clutter everything up.

To keep datablocks from overlapping, move them around with the <F1> computer entry. Avoid putting the datablock in front of the aircraft's target, because it may cover up other traffic.

You can use datablock direction as a tool to remind you what route aircraft are on, or which procedure they need to follow. For example, in L.A. sector 38, you might put all aircraft headed *over* Las Vegas in the **7** position (northwest), and aircraft *landing* at Las Vegas in the **3** position (southeast). Thus at a glance you can quickly tell which ones need to be sequenced for landing, and which can continue on their merry way. Another good technique is to put datablocks in the zero length position (the <F1>/0 entry) after you have switched the aircraft to the next sector, to remind yourself that the aircraft is "gone."

The **first** job priority is safety. Your supervisor's greatest concern is that you not have a *deal*. The **second** priority is to descend, climb or sequence aircraft according to the proper procedure. If you can't get the right spacing, or can't descend an aircraft

to the proper altitude because of traffic, just do your best, and hand it off to the next controller anyway.

The **third** priority overall is to restrict pilots as *little* as possible. Slowing an aircraft down, or turning him out, or not letting him climb to his cruise altitude quickly, will burn lots of extra fuel, and these factors combined nationwide can cost his airline millions of dollars, or even put them out of business. A good controller can keep everybody safe, adhere to all procedures, and be only marginally restrictive if at all. Strive to find the easiest, quickest, and safest solution to the traffic situations you encounter.

Keep altitude assignments **correct for direction of flight**: nationwide under FL300, westbound aircraft are assigned *even* altitudes, and eastbound aircraft *odd* altitudes. Above FL300, westbound aircraft get either FL310, FL350, or FL390 (or FL430, but very few aircraft can fly that high). Eastbound get FL330, FL370, or FL410. By keeping aircraft "right for direction of flight," you will encounter fewer head-on situations at the same altitude. For example, if an eastbound aircraft currently at 11,000 wants FL330, but has traffic up ahead at FL190, you *could* assign FL180 until they pass, then continue the climb. But a better habit is to keep the eastbound aircraft at odd altitudes, so 17,000 would probably be a wiser choice.

Learn to *selectively ignore* some transmissions, if you are busy or have higher priority things to do. If you miss a pilot's transmission, he will say it again if it is important. If a pilot doesn't hear, or ignores you, however, get his attention with the plain comma command, as in **N421EW**, <ENTER>. If he *still* doesn't respond, get on the interphone and issue the * ("contact") command to him without the frequency, which is shorthand to make him come over to your frequency.

Simulation Notes

The computer pilots can become disoriented, especially if there are unusual weather formations and the pilots need to deviate far off course. If a pilot ever expresses confusion about his route, just issue a heading that sends him in the right direction, and hand him off to the next controller down the line. Or, if the pilot says something that doesn't seem to make sense, it is because the computer has limited "intelligence" and is trying to express a concept the best way it can. For example, a pilot may suddenly say out of the blue, "We can't go that way." Possibly, the aircraft has become boxed in with weather on all sides and its feeble computer mind can't find a way out. The best you can do is issue a heading and hope the pilot finds some hole in the storm.

Normally, controllers cannot turn, climb or descend aircraft in another controller's sector without permission from that controller. In the simulation, permission is always implied. You have "control on contact." As soon as the aircraft checks on to your frequency, you are allowed to turn, climb or descend him as necessary without

permission. Likewise, after you switch an aircraft to the next controller, he may also climb, descend or turn the aircraft. Thus, don't switch the aircraft until it is clear of traffic. (The computer controllers in this simulation won't turn aircraft, only climb or descend them for other traffic in their sectors).

Occasionally, you may want to climb an aircraft to an altitude above or below your sector. For example, if your sector covers from the ground to FL230, and you have a departure whose procedure is to climb to FL230 and hand off to the controller above you, but you have traffic up ahead at FL230, just pick a higher altitude and climb your departure to it, like FL240, or FL250 to get above the traffic. Normally, you would call the higher controller on the interphone to ask his permission, but in this simulation it is always implicitly granted.

As in real life, the radar or computer may fail. A warning message will blink on your scope, but you may not see any targets, or they may freeze in place. Aircraft will continue flying and calling you on the radio as usual, completely unaware of your situation. **You are still responsible to separate all aircraft** even when the radar is down. Fortunately, most radar or computer failures are only momentary. Use common sense and good judgement if the outages last longer, to make the best of a bad situation.

Much more common will be occasional radar "misses" of aircraft targets: on a given radar update, the target will disappear, and you will lose its altitude readout. The histories will remain, though, and the datablock will continue to move along where the computer thinks the target should be. Usually the radar will resume picking up the target on the subsequent update, but if no radar hits are made after several updates, the datablock will stop moving, and you had better find out where the aircraft is or what happened to it.

Advanced Commands

These are additional commands used in Air Traffic Control, but are not really needed in the simulation. Still, if you are a real controller or pilot, you may know about them and may wish to use them:

Intercept a radial inbound or outbound: The "=" command means intercept: =DAG214RI means "Intercept the Dagget 214 radial inbound." =PMD067RO means "Intercept the Palmdale 067 radial outbound." Aircraft must be assigned an appropriate heading for the intercept first, or you can combine it with a comma: FH040,=JVL320RI to "Fly heading 040, intercept the Janesville 320 radial inbound."

Don't issue tight intercepts, or intercepts too close to the VOR, because the pilots may lose their spatial orientation and overfly the radial.

Non-Radar commands: The following are supported:

SA	"Say altitude."
SP	"Say position."
SE	"Say (time) estimate (to next fix)."
RRFL350	"Report reaching FL350."
RL14000	"Report leaving 14,000."
RPCIVET	"Report passing CIVET."

Non-radar controlling is beyond the scope of this manual, but in general it involves keeping all aircraft on airways, and calculating the times each aircraft will cross each intersection in the sector. Aircraft crossing within 10 minutes of each other are considered a factor, and must be altitude separated from each other by the time they are within five to 15 miles of the intersection, depending on the angle between the aircrafts' directions. Aircraft along the same route at the same altitude must be at least 20 miles apart, with the back aircraft's speed at or less than the one in front.

If the radar does fail, you are probably better off just using common sense and positive separation while you pray for it to come back on, rather than getting involved in all the time estimates and intersection crossings. Technically, though, you are supposed to resort to official non-radar control techniques if everything goes blank. Good luck.

Crossing Restrictions: You can issue a restriction to cross a point *at* an altitude, *at or above* an altitude and climb/descend to another, or *at or below* an altitude and climb/descend to another:

XDAG@240

"Cross Dagget at and maintain FL240."

X20WJVL-FL260,DMFL240

"Cross 20 miles west of Janesville at or below FL260, descend and maintain FL240."

X10NEDBQ+FL290,CMFL330

"Cross 10 northeast of Dubuque at or above FL290, climb and maintain FL330."

The pilots may become confused if you try to combine additional commands in the same transmission as a lengthy crossing restriction, so issue one at a time.

With crossing restrictions that involve a descent, pilots are allowed to start down whenever they wish, as long as they meet the restriction. They will report to you when they begin the descent.

People (and especially computer pilots and controllers) will make mistakes:

procedures may not be followed, handoffs may not be taken, instructions may not be adhered to. Part of your job is to *fix mistakes* as you find them. Fix them, keep things moving, get aircraft on their way and out of your sector. For example, maybe the computer controller just isn't taking a handoff. You have it flashing at the right sector, but it just keeps flashing. Don't worry about it...let the aircraft fly off your screen if necessary. Keep things moving! Or, maybe the next sector takes the handoff, but soon after you switch the aircraft over, the pilot comes back and says "Nobody home on 000.00." Of course, you didn't give him that frequency; the computer pilot simply made a mistake. Give him the right frequency again: *132.62, or whatever it is. If he still comes back, forget about it. Let him fly off your screen. Your rating won't suffer for these pilot errors.

If the computer pilots and controllers in this highly realistic simulation were error-free, it would prove the job could be done by computers in real life. But it can't, yet, because computers, including those in this simulation, lack the intuition and common sense that only humans possess. All-in-all, though, this program is about as close as it gets to the real thing!

Sector Descriptions

The following gives an overview for each of the six sectors provided with the simulation. More detailed information and sector maps are located in the files named Sector 38 Info, Sector 38 Map, and so on, in your ATCC\DOC folder.

Though you can always train on any of the sectors, it's best to concentrate on one sector at a time. Practice controlling traffic at that sector until you feel comfortable enough to take a certification test. Once certified, you can move on to the next sector, or alternate working live traffic on your certified sectors with training on the others.

Real controllers typically train on the first sector for around 100 to 150 hours to become proficient at controlling traffic in general. Subsequent sectors may only require 40-60 hours of training each, because once initial separation and sequencing skills are perfected, the new things to learn are mostly individual sector quirks and rules of thumb.

You probably won't need this much training to become certified, though. Once you have memorized the sector procedures, are comfortable making and taking handoffs, issuing climbs and descents, and entering altitudes into the datablock, it's just a matter of being able to keep your awareness of traffic in the sector. You may require only a dozen hours of training, or even just a couple. If you take and fail a certification test, your career rating won't be harmed, so take as many tests as often as you wish.

Your First Sector

The six sectors provided with the simulation range from straight-forward to complex. The following list gives an overview of each sector, ranging from arguably the easiest sector to the most difficult:

Chicago Sector 82 (ZAU 82) is probably the best pick for a first sector. It is located over southwest Michigan, covers 24,000 feet and above, and

comprises a major west-to-east corridor of flights to the northeast U.S. The majority of the traffic moves in one direction, from west to east, and most aircraft are overflights, already level at their cruising altitude. Some aircraft are still climbing out of O'Hare, and need to be fit into the overflying streams of same-direction aircraft. Others need to be descended for arrival into Detroit. With the storms option at "never," this sector is probably the easiest of the six.

Los Angeles Sector 38 (ZLA 38) is a good second sector, overlying an area northeast of Los Angeles from 24,000 feet and up. Most aircraft in this sector are jet departures from the L.A. basin, including LAX, Burbank, Ontario and Orange County airports. Most of these departures are destined for the midwest and northeastern U.S., and need to be climbed to their requested altitudes. Some, though, climb up to their cruising altitude then need to descend for arrival to nearby Las Vegas, requiring a spacing of 10 miles apart by the time they exit your sector. Other traffic in the sector include arrivals into Burbank airport, and some overflights. Thus, you get a good general mix of departures, arrivals, and overflights all in one sector.

Chicago Sector 75 (ZAU 75) is a very large high-altitude sector (about 250 miles wide), covering much of eastern Iowa and northwest Illinois/southwest Wisconsin. This sector is an initial funneling point for jet arrivals into O'Hare from the west and southwest U.S. You must try to get the ORD arrivals 10 miles-in-trail, while also handling overflights and some westbound ORD departures. The large size of the sector gives you plenty of room and time to vector and sequence, but will also fill up with aircraft during busy periods. In the summer months, you may get numerous weather deviations that can disrupt your sequencing. Sector 75 is both challenging and interesting in its mix of traffic.

New York Sector 66 (ZNY 66) lies almost entirely over the water, bounded by the southern edge of Long Island to the north, and the eastern shore of New Jersey to the west. It covers from the water to 23,000 feet (FL230). The main traffic flows are an arrival route of jets from the southeast U.S., and another from trans-atlantic flights descending into JFK that must be merged together; departures from JFK headed to the south and over the Atlantic, and both props and jets flying to and from New England, Philadelphia and Atlantic City. The mix of climbing and descending aircraft from 747's to tiny Cessna 152's can make things very complex and require quick thinking and creative vectoring.

New York Sector 97 (ZNY 97) lies over southeastern Pennsylvania, covers from the ground to 17,000 feet, and is an entry and exit point into the highly congested New York Metropolitan area. Much of the traffic in the sector is private aircraft skirting around the New York City area to and from New

England and the Washington D.C./Baltimore region. A number of commuter props also start their descent into JFK, Newark and Lagaardia airports here. Other traffic includes departures from Philadelphia, jet arrivals into Lagaardia and Philadelphia, and both departures and arrivals into Allentown, Pennsylvania. Like sector 66, the mix of jets and props can often make things complex.

Los Angeles Sector 19 (ZLA 19) handles most jet arrivals into the second largest city in the U.S. Any jets coming from the midwest, northeast, east, or southern U.S. all funnel into one arrival point in sector 19, CIVET intersection. Sector 19 must line up, sequence and space apart all these arrivals into a single stream 10 miles-in-trail. Controllers at this sector must be extremely quick and efficient, because one bad vector or slow reaction in turning aircraft out or in can cause a cascading chain reaction effect with subsequent arrivals that may last for an hour. There are some overflights, and arrivals into other southern California airports, but the bulk of the sector is lining up jet arrivals into LAX.

Detailed information on each, including the maps and specific sector procedures, can be found under Start/Programs/Air Traffic Control Center/Sector Documentation. Open up and print out the information in each document, for reference.

None of these sectors will have the same complexity from day to day; some sessions may be a breeze, and others may make you consume antacid tablets ("controller candy") in bulk. The unpredictability, though, is what makes the job interesting...

Troubleshooting

Sector maps appear cut off: Use Wordpad to open the files. This is usually found under Start, Programs, Accessories.

Pressing "N" for "New Employee" does nothing: Press N *while* the red box telling you to do so is still on the screen, i.e. don't escape back to the sign-in screen.

Numbers in some places are completely garbled -- Some OEM versions of Windows ME seem to get this problem. First try re-installing ATCC. Next check your desktop font by right-clicking the desktop, choose Properties, General, and make sure it's on "Small fonts." If it's still not working, email support@xavius.com with your system type (e.g. Packard Bell, HP, etc) and Windows ME version (right-click My Computer, Properties, General, and look under "Microsoft Windows Me").

Aircraft fly onto the screen, but never call on the radio: -- Remember, you have to first take

the handoff with the F1 key before they enter your sector. As they near the sector boundary, the previous controller will then tell them to switch to your frequency, and they'll call you up.

Aircraft keep asking for lower or keep saying "What was the frequency?": You need to *make a handoff* to the next sector, prior to the aircraft exiting your boundary. Once the next sector takes the handoff, you then have to tell the aircraft to switch to the next sector's frequency with the * command. If you tell them to switch, but the next sector doesn't have a handoff, they'll send the aircraft right back to you. (All of this is covered in the manual...)

Program crashes or exits to desktop after 10-30 minutes: Find and click on the *MemoryFix* icon in your C:\ATCC folder, which will cause the DOS console to quickly blink on then off. Then *RESTART* Windows with Start/Shut Down/Restart. (MemoryFix renames the files *autoexec.bat* and *config.sys* to *autoexec.old* and *config.old*, but you can undo this fix if you need to, by clicking on MemoryUndo).

Contact support@xavius.com if you're still having problems!

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