ORBITER™

INSTRUCTION MANUAL

MAC VERSION

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Table of Contents

Imagine sitting in the commander's seat of NASA's shuttle Orbiter...

> With your back to the Earth and your face to the heavens you prepare yourself for the final seconds before lift-off. Moments from now you will experience the effects of 3g's (3 times the force of gravity on earth) as the shuttle system lifts off from the Kennedy Space Center. For now your thoughts turn to final system checks and the voice of Mission Control. At T-00:03 seconds the first of three main engines ignites, at T-00:02 the shuttle's Solid Rocket Boosters ignite and you are on your way. Five on-board computers process thousands of bits of data each second as you are hurtled into space. At T+02:12 you are traveling at Mach 4.5 and have reached an altitude of 28 miles. At T+06:30 minutes into the flight you are traveling at almost 15 times the speed of sound. Imagine...

ORBITER is the shuttle simulator based on the actual commands and procedures used by NASA. It will test your knowledge about the shuttle and the mechanics of space flight.

Panels and graphic displays simulate, as closely as possible, the experience of launching, landing and performing the delicate missions required of the astronauts who pilot and crew the space shuttles for NASA. Your objective is to launch the shuttle,

complete the mission of your choice and safely land the space craft at the specified base. Random mechanical failures and complications may occur as you attempt to meet your mission objectives.

The activities you perform and the number of hours expended during the mission will be kept in the Astronaut Log. You will have a limited amount of time to complete your flight objectives before your life support systems run low and you are forced to return to Earth.

You are about to experience one of the closest things to actually being in the commander's seat of NASA's shuttle. You are about to fly ORBITER...

1. Using the ORBITER Manual

The ORBITER shuttle simulation will test your reactions as you pilot the world's first reusable spacecraft. Your manual was written to help you get flying in the shortest time possible. This "real-time" shuttle simulator models the controls and instrumentation found in the actual Space Shuttle Orbiter. Since experience is the best teacher, this manual begins with a brief walk-through of the ORBITER training mission. We strongly recommend that you use the walk-through to learn basic ORBITER operations. Once familiar with launch, orbit, and landing procedures you will be prepared to fly other more challenging ORBITER flights.

Sections 5 and 6 provide detailed explanations of ORBITER pull-down menus and control panels. To develop the skill necessary for complex orbital maneuvers Section 7, *Maneuvers and Operations,* supplies additional information on shuttle and Manned Maneuvering Unit (MMU) orbital mechanics. Also included in this section are operating instructions for the Remote Manipulator System (RMS).

The experienced player will want to read Section 8, *Keyboard Equivalents and Keypad Commands,* to become familiar with the commands necessary for a manual launch, orbit, and landing. You will also find a Quick Reference Card in the ORBITER package which lists the keyboard equivalents and keypad commands.

2. Getting Started

Before you can play ORBITER, you must be familiar with the basic operations of your Macintosh™. In particular, you will need to know how to make a backup, use the mouse to operate pull-down menus, select and drag objects, and be familiar with the keyboard. Refer to your Macintosh™ owner's guide if unfamiliar with your system's operation. *This program is not copy protected. Please make backups then write-protect and file the masters for safe keeping.*

To run ORBITER from the floppy drives, begin with your Macintosh powered down*.

Single Disk Drive: Insert Disk 1, boot (i.e., turn the power on), and wait for the disk to eject. You will be prompted when to put in Disk 2. You will have to exchange disks (about 3 swaps) until Disk 1 remains in the Mac and no further prompts appear on the screen.

Double Disk Drive: If you have an external disk drive put Disk 1 in the internal drive, Disk 2 in the external drive and boot (i.e., turn the power on).

* *If you begin ORBITER from another application, you will end up swapping disks constantly.*

Hard Disk Installation: (HFS users please see the Warning section.) Boot your system using your hard drive. Insert ORBITER Disk 1 into your floppy drive and drag the folder named Orbiter•1 to a volume on your hard drive. Eject Disk 1. Insert ORBITER Disk 2 into the floppy drive and drag the folder named Orbiter•2 to the same volume on your hard drive. Eject Disk 2. To run the program, simply click on the Orbiter application icon. ***Do not copy the file titled "system" to your hard drive.***

********** **WARNING** **********

512 K Macintosh™ owners:
Do not run this program with any memory co-resident programs. No Switcher™, disk cache, de-buggers or RAM disks ! All 512K are used in the ORBITER simulation.

Mac XL™ and Mac Plus™ owners:
Switcher and Cache *may* be usable on your machines. Use your backup disks to experiment and keep the master safely filed in case problems do occur using these programs with ORBITER.

HFS users:
This program is not HFS compatible. If running ORBITER under HFS it must be installed on the top level directory and not in any folders.

Quitting ORBITER: To Quit ORBITER select *Quit* from the **File** menu and click the mouse on **OK** when asked if you are sure you wish to quit. The ORBITER disk(s) will eject and you may load another application.

3. A Training Flight "Walk-Through"

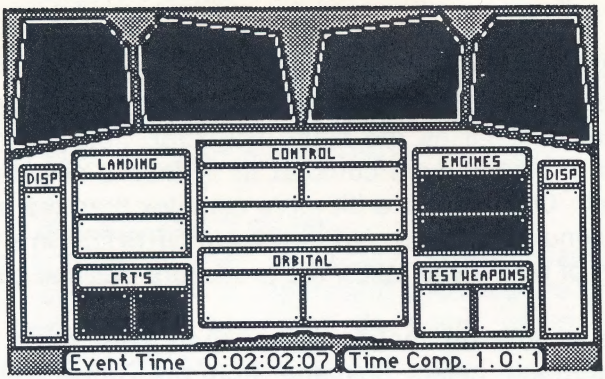
The following walk-through was designed to allow you to successfully complete your first mission by using the simulation itself as the flight instructor. Just as the real space shuttle is more complex to fly than a single engine aircraft, ORBITER is a bit more complex than the average flight simulation game. You will learn ORBITER in a shorter period of time if you follow the procedure outlined below.

If the simulation moves faster than your pace in the walk-through, select *Suspend* from the **Game** pull-down menu. When you are ready to go on, select *Continue* from the **Game** menu. You will be requested to suspend the game periodically to read important instructions prior to executing them.

Boot ORBITER as instructed in the **Getting Started** section. After your game is loaded, the ORBITER signature graphic appears. This signals the beginning of the simulation and the start of your adventure. Your first view inside the ship is of the **Forward Main Station**, which occupies the entire screen. You will not see this large view at any other time in the game. Clicking the mouse anywhere on the screen reduces the Forward Main Station and divides the screen into quadrants.

The **Engines**, **Control,** and **CRT** panels will appear in the remaining three quadrants of the screen. ORBITER will automatically display these panels every time you start a new game.

To make any other panel operable in the **Forward Main Station,** select it from the panel display in the lower right-hand quadrant (the panels are labeled according to



(Forward Main Station)

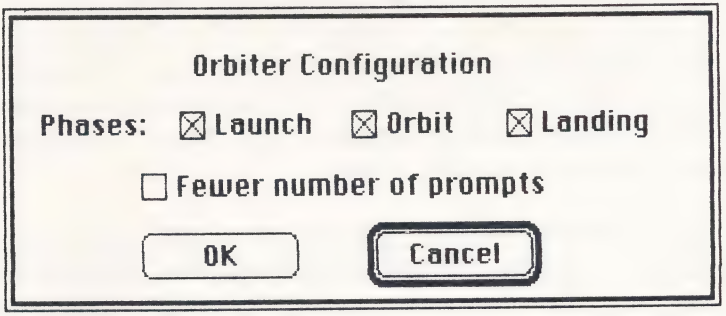
function), and it will highlight or "invert" once selected. After a panel is highlighted, position the cursor in any of the three remaining quadrants, and click the mouse. This will cause the panel to display in that quadrant and make it operable. To change between CRT screens, choose CRT#1, #2, or #3 from the CRT panel already displayed in one of the quadrants. (It will be a good idea to practice changing panel displays since you will be instructed to bring up various panels quickly during the simulation. Also, you may find it helpful to be consistent in panel location. For example, always display the CRT panels in the lower left, the windows in the upper right or left, etc.)

Because the launch sequence requires extensive use of the **Control**, **Engines** and **CRT** panels (you cannot successfully launch without them) it's a good idea to keep them displayed until the onboard computer takes over at approximately T-00:05 (5 seconds before launch).

The **CRT** panel should remain displayed throughout the walk-through. Particularly **CRT#3** since Mission Control's instructions will be detailed here. If you do not have CRT#3 displayed, and you hear a warning "beep," go to

CRT#3 and the warning message will be displayed in text form. (Details of all panels and their functions are contained in the **Orbiter Control Panels** section of the manual.)

You will now begin your first mission. Select *New* from the **Mission** menu. A series of dialog boxes will appear allowing you to choose various game parameters.



The *Orbiter Configurations* dialog box is displayed first. This dialog box allows you to select the mission phase, **Launch**, **Orbit**, or **Landing**. ORBITER will automatically select all three phases and the advanced level mode (fewer prompts). For your walk-through flight make sure you leave each of the phase boxes selected. Click in the box for "fewer prompts" to remove the X. (The walk-through should be fully prompted.) Click **OK.**

The *Mission Selection* dialog box will display next. For the purposes of this walk-through select the *Training* mission. After you click **OK** the *Current Mission* dialog box will display.

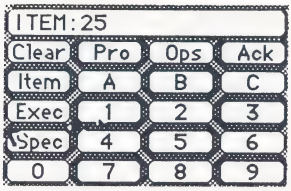
The *Current Mission* dialog box displays a description of your mission assignment from the category you have just selected (i.e., Training). This mission will involve a launch of the Hubble telescope. If during the simulation you would

like to read the mission description again, select *Current* from the **Mission** menu.

The pre-launch will now begin at T-50:00 (50 minutes before launch). Event Time depicts the actual time it would take for the real shuttle system to go through this mission. The simulation time is compressed and the ratio (Time Compression) is shown next to the Event Time on the bottom right-hand side of your screen. Listen to the directions from Mission Control (voice synthesizer) and watch the print-out on **CRT#3** (configured as *Message*). You have about one minute to respond when you are asked to "Please acknowledge." Reply "Roger" using one of the methods described below.

Execute your acknowledgement by pulling down the **Communications** menu and selecting either *Roger* (Yes) or *Negatory* (No). Keyboard equivalents are also displayed on the menu; Command key plus A (⌘ **A**) for affirmative; Command key plus N (⌘ **N**) for negative. Using keyboard equivalents to respond to Mission Control permits you to play the game at a quicker and more realistic pace.

{*The following commands from Mission Control will be given swiftly. It may be helpful to* ***suspend*** *the game here and read through the next couple of paragraphs.*}



When you are asked to "start cabin leak check...by entering ITEM 50 EXEC..." use the mouse to click on the buttons labeled [Item], [5] [0], [Exec] in the **Control** panel. What you have entered will be displayed in the blank rectangle above the buttons. If you make an error, click the [Clear] button and begin again. Follow this procedure for all of the commands

that the game will prompt you for during the pre-launch and for the rest of the flight. (See Section **8. Keyboard Equivalents and Keypad Commands** if you wish to use the keyboard instead of the mouse.)

Mission Control will alert you for an advisory check on the mission abort options. Watch for the buttons in the *Abort Option* box on the **Control** panel to blink on and off three times. Acknowledge check to Mission Control.

Mission Control will ask you to "Initiate APU prestart procedure," and press the APU START button. You will find the button in the **Engines** panel under the heading *APU'S*.

Continue entering commands as instructed by Mission Control until prompted to close the ET vents.

Close the ET Vents by clicking the [Close] button under *ET Vents* in the **Control** Panel.

The next Mission Control message will prompt you to set the APU and Main Engine Auto Shutdown buttons on. To do this, press the [Main Eng] and [APU's] buttons under *Auto Shut-Down Enable* on the **Engines** Panel.

{***Suspend*** *the game here for a moment until you have read through the next two paragraphs.*}

At this point in the pre-launch, the on-board computer takes over and **CRT#3** prompts you to press the manual [Man] button...**do not attempt to do so on this training flight walk-through.** (Selecting manual will cause the simulator to expect you to perform all the functions that the on-board computer normally executes during the launch.

We suggest you wait until you have launched many times before you try a manual procedure.) ORBITER will speed up the event time so that you will be ready for countdown in just a few seconds. Watch **CRT#3** for final pre-launch checks and countdown.

Tighten your safety harness and prepare for lift-off. Watch the altitude and G-forces change by displaying the **Landing** panel and viewing the *Accel Units* (accelerometer). You can watch the roll maneuver by displaying **Left Display** panel. **CRT#1** is automatically configured to display the launch trajectory, though this will not show your course until about 48 seconds into launch. **Select these panels before the countdown begins.**

At T+2:12 event-time (2 minutes and 12 seconds after launch), the Solid Rocket Boosters (SRB's) are automatically jettisoned.

After SRB separation is complete, the Orbiter is simply gaining altitude. To see where the Orbiter is in relationship to the Earth, choose *Map* from the **Views** pull-down menu. A full screen representation of the Earth is displayed with a black dot marking the position of the Orbiter (during launch the shuttle is moving up, therefore you will not see much sideways movement of the shuttle symbol on the map). It takes the Shuttle system approximately 48 minutes to achieve orbit. ORBITER compresses the launch time sequence so that the launch actually takes less than 8 minutes.

At approximately T+9:00 event-time, the External Tank (ET) is jettisoned. **CRT#1** automatically reverts to *Payload*. To reconfigure the CRT screens select [Configure] from the **CRT** panel. When the Configure dialog box appears, choose *Map* from the CRT 1 column to see a map with

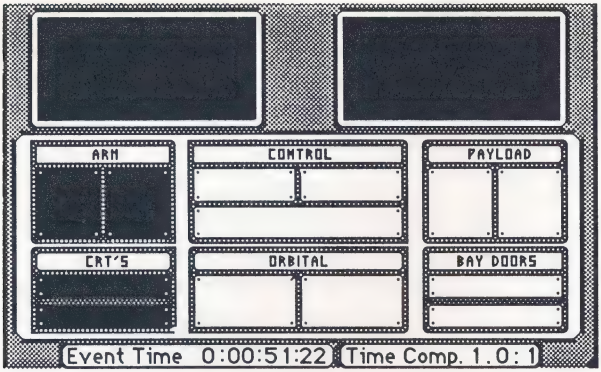
crosshairs that indicates where the Orbiter is in relation to the Earth. This map is a miniature of the map from the **Views** menu.

At approximately T+10 minutes you can look out the forward windows of the Orbiter. Click in any of the windows, the polygon shapes above the panels in the **Forward Main Station**. All of the windows will highlight when selected. After the windows highlight, position the cursor in one of the three remaining quadrants and click the mouse. The panel that was in the quadrant will be replaced by the view outside the window, which may include the Earth (largest object), stars, or moon depending upon your position and orientation.

Time Compression is a special feature of the ORBITER shuttle simulator. It is engaged automatically to compress game time while retaining an accurate "real-time" reading on the Event Time Clock. You can also set time compression yourself any time the Orbiter is **not under acceleration** and after you have achieved a stable orbit. To change the time compression ratio, select *Time Compression* from the **Special** menu. A dialog box will appear allowing you to select one of four time ratios. For example, selecting **1-10** causes the Event Time to advance 10 seconds for every one second of actual time. One of your choices will be **.1-1.** This causes the simulation to operate at a rate slower than the **1-1** actual time.

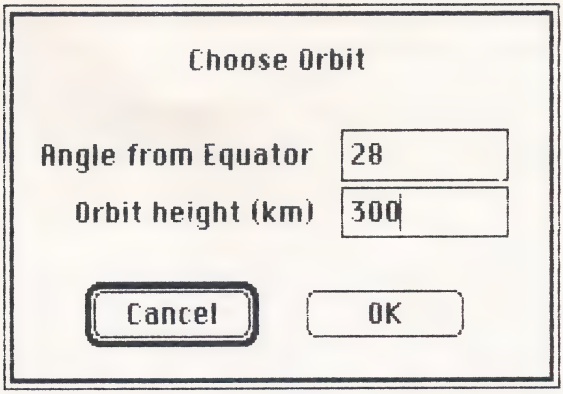
Once a stable orbit has been achieved, at about 53 minutes event-time, you will have to open the bay doors. To open the bay doors, select *Aft* from the **Views** menu. The **Aft Main Station** will replace the **Forward Main Station**.

{***Suspend*** *the game here to give yourself time to become familiar with the new panels.*}



(Aft Main Station)

Selecting and displaying panels in the **Aft Main Station** is done in the same way as in the **Forward Main Station**. In the **Bay Doors** panel, displayed in the upper right quadrant, first press the power [On] followed by [Unlock] and [Open]. View into the cargo bay by selecting the Aft windows, positioning the cursor and clicking the mouse in one of the quadrants. You will see the cargo bay view from the **Aft Main Station** deck, which includes your first look at the Hubble telescope. If you wish to refresh your memory on the specifics of the mission, select *Current* from the **Mission** menu. Remember that this dialog box displays your mission assignment including information such as the altitude and angle to assume before attempting to deploy the Hubble telescope. Select *Choose Orbit* from the **Special** menu. A dialog box will appear with two options, *Angle from Equator* and *Orbit height (km).* Let the *Angle* box stay as it is and either "tab" to the *Orbit height* box or "double-click" in it and enter 300 kilometers (the altitude specified in your mission assignment).



(Choose Orbit dialog box)

The Orbiter will assume the proper orbit. Follow the changes in altitude, angle, acceleration, etc. on **CRT#2**, configured for *Status* (in particular, watch the *RMin* and *Max* readouts).

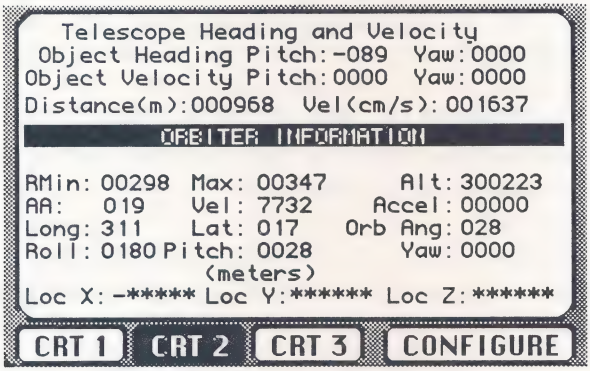
Having achieved the proper altitude, you are in position to launch the Hubble telescope. Bring up the **Payload** panel. *Payload 1* reads "Telescope."

Prior to launching the telescope, part of your mission assignment is to test it. Bring up the **Control** panel and enter the command [Spec] 91 [Pro]. **CRT#3** will tell you if payload module 1 (telescope) tests "OK."

The telescope will be launched by using the RMS, Remote Manipulator System (or Arm). Select **Arm** from the **Aft Main Station** and display in the quadrant occupied by the **Bay Doors** panel. To use the RMS, press the power [On] button, then press [Unlock] and hand [Open]. A new menu, **Arm Grabber**, will now appear on the menu bar. Select *Telescope* from the **Arm Grabber** pull-down menu. Selecting an item in the Arm Grabber menu causes the RMS to automatically grasp that item if it is within 10

meters of the arm itself. Contact between the arm and the telescope will be confirmed when the *Contact* light in the **Arm** panel highlights. Before continuing, you must press the [Unlock] button in the Payload panel to unlock the telescope from the cargo bay. Press the [Deploy] button on the **Arm** panel to actually launch the telescope with the RMS.

Now you must maneuver the spacecraft away from the telescope to make sure the two do not collide. **Before attempting this maneuver** you may wish to see how far the telescope is from the shuttle. To do this configure **CRT#1** to *Orbital* and click on the "telescope" line. To view both the Orbiter and the telescope orbital specifications, go to the **CRT#2** screen (configured



(CRT #2 *Status* Display)

for *Status*) and you will now see the telescope specifications showing above the "Orbiter Information" title.

Select the **Orbital** panel from the **Aft Main Station** and display it in one of the quadrants. Instigate a [Back] **X** translation to move the Orbiter away from the telescope (i.e., select [Back] from the choices under the ***X*** under *Translation*, and press [Start]). You may want to confirm that the telescope is clearing the Orbiter by looking out of

the forward or aft windows. If you would like to move away more quickly, stop your Back X by clicking on the [Start] button again, and choosing a time compression of 1-10 from the **Special** menu. Then restart the Back X maneuver after the time compression has been changed.

When there is a distance of 100 meters between the telescope and the shuttle, you may toggle the [Start] button off to discontinue the thrust. (For more information on maneuvering the spacecraft, refer to Section **7. Maneuvers and Operations.**)

Once the 100 meter distance has been achieved you are ready to deorbit. (Your mission has not been completed yet!) Close the bay doors to prepare the Orbiter for re-entry. To close the bay doors, display the **Bay Doors** panel from the **Aft Main Station** and select the [Close], [Lock], and Power [Off] buttons.

You must now prepare for the deorbit burn by entering [OPS] 301 [PRO] on the command keypad located on the **Control** panel in the **Forward Main Station**. A dialog box appears allowing you to select the landing site appropriate to your mission. Make sure *White Sands* is selected, then click **OK**.

The **Control** and **Engines** panels must be displayed during this pre-entry sequence. Mission Control will be issuing voice commands but it is easiest to leave **CRT#3** configured to *Message* and display it in the remaining quadrant in order to read and respond to each command.

{*It may take several minutes to position the Orbiter properly above the Earth to allow for re-entry over the appropriate site, you may wish to enter a time compression of 1-10 for this next phase.* Remember, if you are still under

acceleration the Time Compression option will not highlight.}

Enter [OPS] 302 [PRO] on the command keypad. Mission Control will confirm that you are go for deorbit burn. When prompted, start APU's by pressing the [Start] button in the **Control** panel. Mission Control will then prompt you to start the OMS engines. To do this you must disengage the autopilot by choosing [Man] (manual) under the *Shuttle* heading on the **Control** panel, then select [Start] under the *OMS* heading on the **Engines** panel.

{Optional: configure **CRT#2** to display *Status.* Display the **Landing** panel in one of the quadrants, making sure you can still view the **Engines** panel. With the **Landing** panel displayed and **CRT#2** configured to display *Status* , you will be able to monitor the Orbiter's change in altitude and orbit.}

The messages on **CRT#3** will count down the degrees as the Orbiter changes position for the OMS deorbit burn. Starting the OMS engines did not fire them to full throttle, you will be prompted to do this when the Orbiter reaches the proper attitude for the selected landing site. Remember that the **Engines** and **Control** panels must be displayed during re-entry. When prompted, throttle the OMS engines up to 110%. To do this, position the cursor at 110 in the throttle box in the **Engines** panel and click the mouse button. The indicator will move to 110% and the OMS engines will burn for deorbit.

Burning the OMS engines at the specified time will cause the shuttle's orbit to fall below an Rmin point of 90km (see **CRT#2**). When this happens, you will be prompted to stop the OMS engine burn by pressing the [Stop] button on the **Engines** panel. The on-board computer will now prompt

you to start the re-entry procedures. After the OMS engines have been shut down make sure you engage the autopilot again.

{*If you have not already done so, change the time compression back to 1-1 for this next phase.*}

Start the re-entry procedures by entering [OPS] 303 [PRO] in the command keypad. Enter each new command when prompted by Mission Control in the same way you entered the commands during launch.

*(**Suspend** the game here to read over the next procedure.)*

You will be prompted to adjust the Orbiter's Angle of Attack (AA) so that you can match the entry attitude. During re-entry it is crucial that you keep the AA between 10 and 12 degrees to successfully enter the atmosphere. You can monitor the AA on **CRT#2** (configured to *Status*). Use the *Pitch* and *Yaw* controls in the **Orbital** panel to control the AA. To begin decreasing the AA, start a yaw to the right. Watch the AA to see if it gets closer to 10 - 12 degrees; if it gets further away, reverse the direction of the yaw until it stops decreasing towards 10 - 12 degrees. Stop the yaw rotation and start an up or down pitch rotation until an AA of 10 - 12 degrees is reached. The computer will also inform you when you have matched entry attitude.

Another series of computer commands must be entered to ready the Orbiter for re-entry.

Check back to **CRT#2** when prompted to be sure your angle of attack is still within 10-12 degrees. If your entry attitude is still matched, enter the [OPS] 304 [PRO] command. This command sequence loads the atmospheric

entry program into the on-board computer. If the attitude does not match, adjust the AA using the *Pitch* rotation on the **Orbital** panel as instructed in the previous paragraph.

A dialog box appears to inform you of the radio black-out during re-entry. The actual time for this black-out is around 15 minutes. You may select to leave the black-out at any time by clicking **OK** in the black-out dialog box. If a forward window view was previously displayed you will automatically see the landing view right after you click **OK**.

The **Landing** panel must now be displayed. The camera view will give you a level view of the runway from whatever position the Orbiter is in. The window view will display an outside perspective from inside the spacecraft.

{*For this first mission, leave the autopilot on to let the computer safely land the shuttle, but watch all of the indicators so you will be familiar with the ideal landing procedures.* Note: selecting any of the controls during landing will disable the autopilot.}

CRT#1 should be configured to *Landing.* This setting is available only during the landing phase of the mission. You will see a triangle, representing the Orbiter, nose toward the runway. **CRT#2** (*Status*) will display your heading and distance in relation to White Sands. Loc (Location) X is represented by a vertical line. Loc Y is represented by a horizontal line. Your position is at the point of intersection of the X and Y coordinates. If you look at the *Map* CRT you will see the X and Y coordinates dynamically plotted; that is, they are constantly updating your position. The Loc Z is your altitude (+ or - 10 meters).

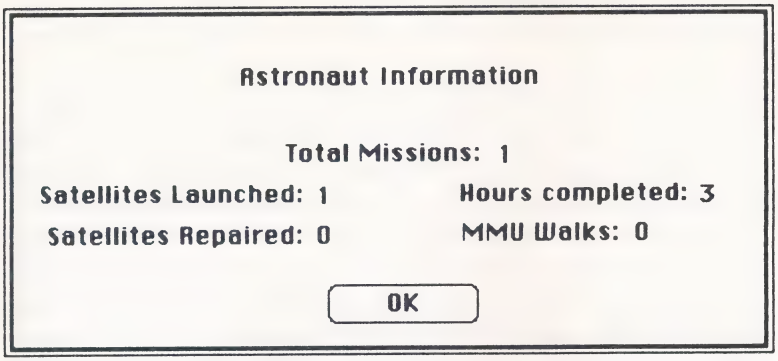
Follow your approach by switching back and forth between the *Landing* and *Status* CRT screens.

When the Orbiter is on a direct heading with the runway you will see the Orbiter on **CRT#1** on the line running through to the runway. The heading will read zero. You will see the runway at a distance of approximately 3,000 meters.

While watching this process take note of the altitude, distance to runway, airspeed, and drop rate. The ideal relation between these indicators are as follows: Altitude should be between 1/3 to 1/2 the distance to the runway. Drop rate should be approximately 1/4 the air speed. Your airspeed is the main factor in figuring the relation between the other items. Also notice that pitch controls the drop rate and altitude; your pitch will be 0 when you are on the ground. Yaw controls the heading. To land on the runway your heading must equal the runway heading to within 50 meters. Other hints: your drop rate at landing MUST be less than 12 meters per second, beyond that you will crash a very expensive Orbiter. Also, your acceleration (see accelerometer) must not exceed 3g's (gravities).

When you are within 90 meters of the runway, autopilot will lower the landing gear. Watch the [Down] button highlight as the autopilot brings you in for a safe landing. Listen for your prompts, and/or watch **CRT#3.** After touchdown the autopilot will set the speed brake to slow the Orbiter down. When you have rolled to a stop you will be prompted to enter the appropriate shut-down commands.

Congratulations! You have successfully completed your mission.



The activities you have performed during the "Walk-Through," such as launching the telescope and completing the mission, have been recorded in the Astronaut Log. Also recorded are the total number of simulation hours spent (event time) from launch through landing.

Your missions vary in difficulty depending on the mission type. Deployment missions are the least difficult while Construct and Repair missions are the most difficult. Selecting to have fewer prompts and using manual operations provides the most challenging scenarios.

If you should "expire" during the mission your current log will be erased. In order to retain logged information it will be necessary to save your place frequently during play. You may then restart the simulation, load the last saved file and continue from the last saved position.

To Save and Load a particular mission:
Each time you boot ORBITER a new Astronaut Log will be started. It is necessary to save each mission once it is completed so that you may continue with new missions without starting a new Log. Choosing *Save* from the **File** menu also saves your current position during the simulation. For example, if you must quit, but do not want to start the program all over again, you may save your present position and continue later. You must assign a name to the file, in the same manner as assigning file names in other Macintosh applications.

DO NOT SAVE FILES TO THE ORBITER #1 DISK.

You may save ORBITER files to any initialized Macintosh disk other than the ORBITER #1 program disk. The only limit to the number of files you may save is the amount of disk space available.

To Open a file previously saved, choose *Open* from the **File** menu and the Macintosh file manager will appear. Find the name of the desired file, making sure to check all disks on which you have saved ORBITER files, then click **OK** once you have selected the appropriate file.

5. ORBITER Pull-Down Menus

The following is an outline of the pull-down menus, from left to right, with a brief description of each item. Keyboard equivalents shown in the pull-down menus are detailed in section **8. Keyboard Equivalents and Commands**.

Apple Menu

About Orbiter ...game credits and copyright information.

Control Panel: Mac control panel.

File Menu

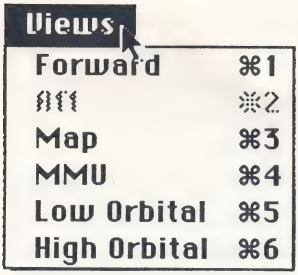
Open: Displays a list of game files saved during previous play. Check all of the disks which may contain ORBITER files.

Save: Saves your current position during the simulation. **Quit**: You may quit ORBITER at any time. Your log will retain the activity information, unless you expired during a mission.

Game Menu

Suspend: Freezes the game in mid-action (useful when the phone rings or if you need to plan your strategy).

Continue: Continues, or unfreezes, the game.

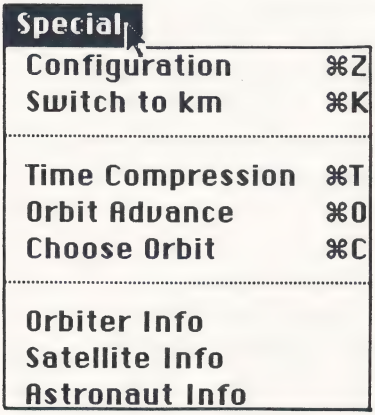


VIEWS Menu

Forward: View of the Forward Main Station, divided into quadrants. **Aft**: View of the Aft Main Station, divided into quadrants. **Map**: Large full-screen map of the Earth depicting the Orbiter's relative position. **MMU**: Manned Maneuvering Unit station. You must select this option to use the MMU.

Low Orbital: "Space" view of the Shuttle orbit showing its relationship with the Earth and other orbiting objects. The range is from 0 to 400 Kilometers.

High Orbital : The same as **Low Orbital**, but from a higher perspective: 400 to 4000 Kilometers. (If the Orbiter is very close to another object the names may overlap.)



SPECIAL Menu

Configuration: a *dialog* box will appear showing game feature options and current settings. (Highlighted items may be altered during the game.) **Switch to km/m:** Changes the distance units from Meters to Kilometers or from Kilometers to Meters. **Time Compression**: Gives choice of time compression ratio (e.g., 1-10 speeds up event time at a ratio of 10 seconds for every one second elapsed. You may also slow down the action by selecting the **.1-1** option). This feature may be implemented only when Orbiter is *not* under acceleration and after you have achieved a stable orbit.

Orbit Advance: A short cut, this option advances your position by one full orbit. Your resources will also be expended as if you had accomplished this activity manually.

Choose Orbit: A dialog box will appear which allows the player to easily select the preferred orbit without going through the manual OMS burn (manual pursuit of this activity is extremely difficult and time consuming). This feature may be implemented only when Orbiter is *not* under acceleration and after you have achieved a stable orbit.

Orbiter Info: This option offers historical and current information on the actual Space Shuttle system. This information is stored on Disk 2, so a disk-swap will be necessary if you have a single drive system.

Satellite Info: Provides some historical and current information on several satellites launched to date. This file is also stored on Disk 2.

Astronaut Info: This is your activity log. It provides information on the activities performed, such as how many walks you have taken in the MMU and how many satellites you have launched and/or repaired. Should you "expire" during your mission the information will be cleared from the log unless previously saved as described in Section **4. Simulation Activity Log**.

Communication Menu
Roger: or a YES response.
Negatory: Negative, or a NO response.

Mission Menu
New: Select to start a new game. This will also start a new astronaut log unless you are continuing play from a saved game. A series of three dialog

boxes will appear. Two will prompt you to select the program configuration and mission type, and the third will display your mission assignment.

Current: Redisplays the current mission dialog box.

The following two items appear only when the appropriate panels have been selected from the Aft Main Station. **Arm Grabber** appears automatically when the Arm panel is selected and the power is on and the arm is unlocked. **MMU Matcher** appears automatically when the MMU is selected and you have undocked.

Arm Grabber Menu

The options presented in this menu list the objects which may be automatically grasped by the RMS. Items must be within 10 meters of the Arm. (See the Control Panels section for instructions on this operation.) It is easier to use the Arm Grabber function when retrieving objects with the RMS, but not necessary.

MMU Matcher Menu

This feature is similar to the Arm Grabber in that you must select the desired object from the list. It differs in that you must activate the [Grasp] function from the MMU panel once the object has been selected in order to lock the object to the MMU (object distance may be as far as 10 meters). This function is a short cut to getting within range of the desired object. The same functions may be achieved manually. (See the Control Panels section under MMU for operation details.)

6. ORBITER Control Panels

Each panel and its components are illustrated and defined in detail in this section. The definitions below are common terms used throughout the manual, especially with regard to the panels. A glossary of space shuttle terminology and a list of acronyms are provided in the back of the manual.

Definitions:

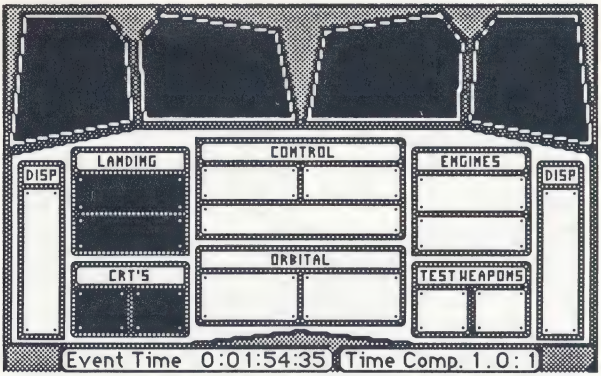
Button: A switch that may be selected by clicking the mouse on it. The button will highlight (or invert to white on black) if selected and if functioning properly. Buttons may also represent toggle switches; that is, the button may be used to switch between two settings, on or off.

Control: The position of a control displays the current setting of an Orbiter system, such as the speed brake or throttle setting. To change the position of the control, click the mouse in the desired position.

Indicator: Displays the status of various systems of the Orbiter, such as the abort site options. Indicators are for displaying information only.

Panel: Panels occupy one quarter (a quadrant) of your screen. They are composed of controls, indicators, and buttons which are organized according to function. Panels may be called up from one of the stations.

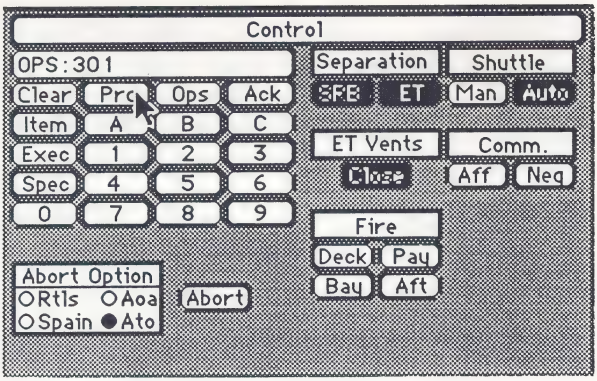
Station: A collection of panels from which to operate the shuttle. There are three stations, the *Aft, Forward, and MMU.*

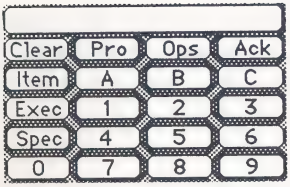


(Forward Main Station)

The Forward Main Station allows control over all flight and weapons functions of the Orbiter. It is composed of eight panels and four windows and is displayed in the lower right-hand corner of the screen.

To display and make a panel operable, click the mouse on the desired panel in the **Forward Main Station**. This will cause the panel to highlight. Move the cursor to any of the other three quadrants and click the mouse. The selected panel will display in that quadrant. The **Control**, **Engines**, and **CRT** panels are the first to be displayed when the simulation begins. During the simulation, the selected panels will remain displayed until they are replaced with another panel.





The forward **Control** panel contains the **Command Keypad**. The **keypad** is composed of various buttons which control special Orbiter systems. The computer activates command sequences presented in the format of Prefix, numbers, and a Suffix. (For a list and description of Keypad Commands refer to Section **8. Keyboard Equivalents and Keypad Commands.**)

The **Command** buttons are:

[Clear] Clears any material on the keypad display line.
[Item] Prefix for computer/system command.
[Exec] (Execute) Suffix for Item command and value.
[Spec] (Special) Prefix for special command and value.
[Pro] (Program) Suffix for Ops or Spec command and value.
[Ops] (Operations) Prefix for loading programs to the General Purpose Computers (GPC's).
[Ack] Acknowledgment to the computer system prompt.

Function buttons are: A, B, C.

Numeric buttons are 0 to 9.

A **display line** is located above the command buttons. Watch the display line to make sure you have entered the correct data.

Separation:
[**SRB**] - Manual control for Solid Rocket Booster separation.
[**ET**] - Manual control for External Tank separation.

Shuttle:
[**Man**] - If selected, indicates that you are piloting the Orbiter.
[**Auto**] - If selected, indicates that the Autopilot is flying the Orbiter.

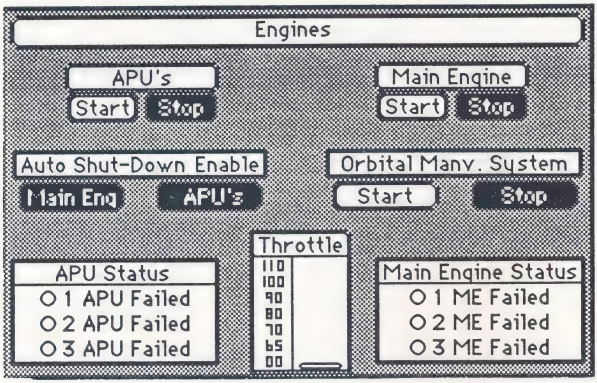
ET Vents:
[**Close**] - If selected, closes ET fuel door. Toggle button.

Fire:
[**Deck**] - Flight deck fire extinguisher
[**Pay**] - Payload object fire hazard extinguisher. [**Bay**] - Payload Bay area fire extinguisher. [**Aft**] - Aft Station deck fire extinguisher

Comm: (Communications)
[**Aff**] - Affirmative response to communications query from Mission Control. [**Neg**] - Negative response to communications query from Mission Control.

Abort:
[**Abort**] - When selected, initiates abort procedures for one of the four defined abort site options. The highlighted option shows which site you must choose. •**Rtls** - Return to Launch Site option. •**Spain** - Abort to Rota, Spain. •**Aoa** - Abort Once Around. •**Ato** - Abort to Orbit; highlighted when you have achieved orbit.

The Engines Panel



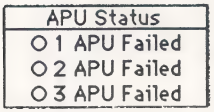
The Forward Engine panel contains engine controls and status displays.

APU's:
[**Start**] - Select to start up Auxiliary Power Units. [**Stop**] - Select to power down APU's.

Main Engine:
[**Start**] - Manual start button for Space Shuttle Main Engines (SSME).
[**Stop**] - Manual cut-off button for SSME's.

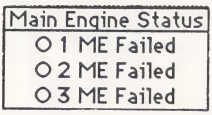
Auto Shut-Down Enable:
[**Main Eng**] - Allows computer to shut down the SSME's when a problem is detected. [**APU's**] - Allows computer to shut down APU's when a problem is detected.

Orbital Maneuvering System:
[**Start**] - Enables Orbital Maneuvering System (OMS) engines. [**Stop**] - Disables the OMS engines.



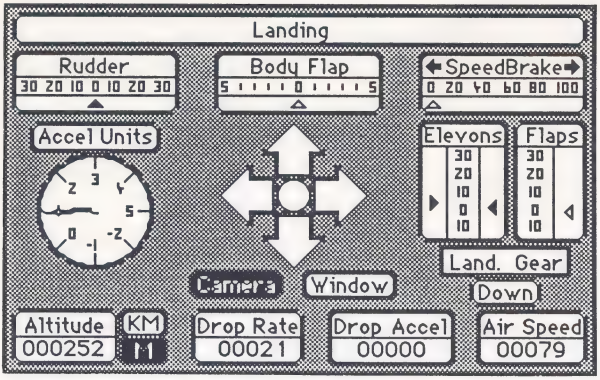
APU Status:
Status indicator for the APU functions. If highlighted, a failure has occurred and you must watch the Message CRT for updates.

Throttle:
Throttle setting measured in % of thrust. Click the mouse on the desired setting to throttle (burn) the selected engines (OMS or SSME's).

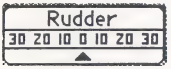


Main Engine Status:
Status indicator for the SSME's. If highlighted, a failure has occurred and you must watch the Message CRT for updates.

The Landing Panel

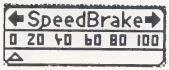


This panel contains the controls and displays necessary for a successful landing.



Rudder:
Rudder indicator in degrees, a zero degree setting indicates that the rudder is centered. To control the rudder, click on the right or left arrows.

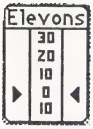
Body Flap:
Body Flap control setting in degrees, a zero degree setting indicates that the flaps are neutral. To control the body flaps, click on desired setting, these controls provide additional lift and drag.



SpeedBrake:
Aerodynamic brake setting in percentage. 100% is on full stop. Click the mouse on the desired setting to set the brakes.

Accel Units: (Accelerometer)
Measures G-Force (gravities). Each value is 9.8 meters/second squared, assuming zero g-force on the launch pad, at rest.

Directional arrows: (Joy Stick)
Used to control the elevons, pitch and yaw during landing, much like the joy stick in conventional airplanes. The arrows correspond to Orbiter movement, i.e. pitch up (ascend), pitch down (descend), yaw to the left or right. The center button centers the elevons.



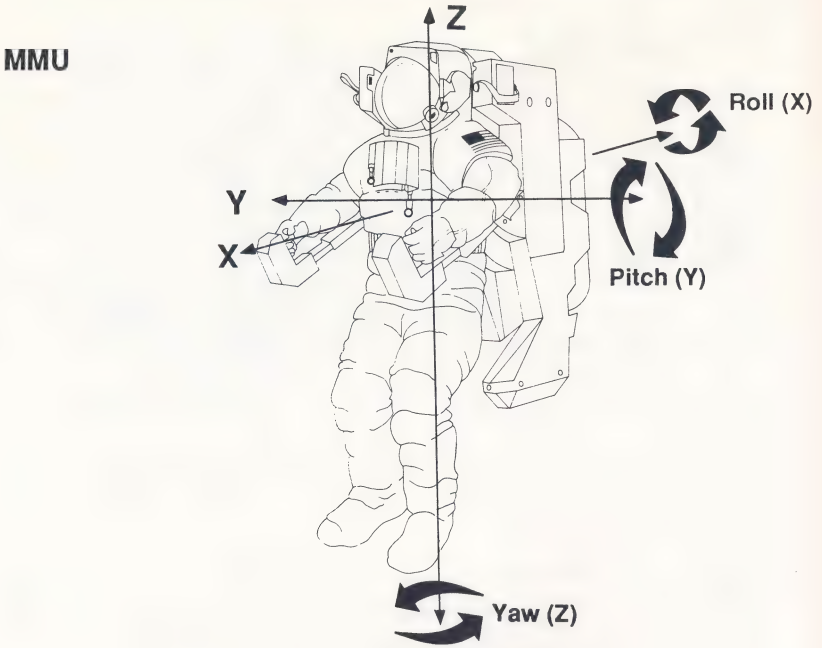
Elevons:
Displays the current position of the elevons, port (left) and starboard (right).

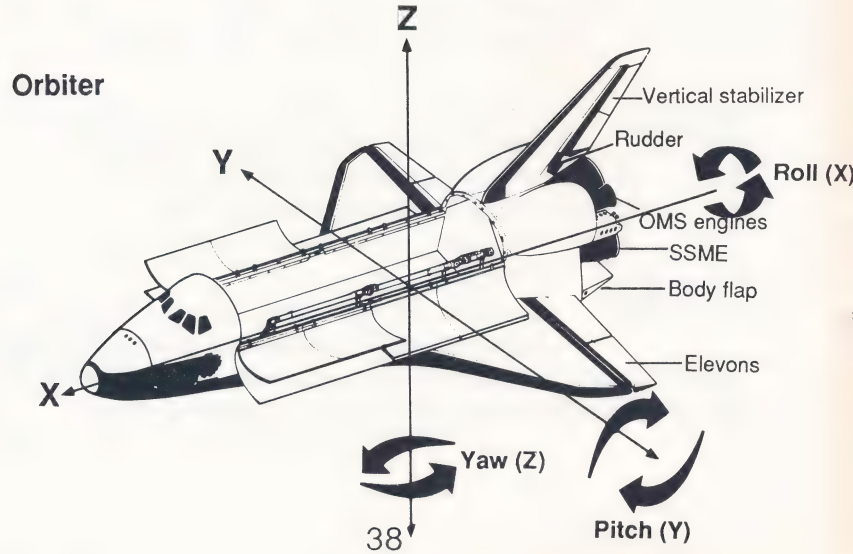
Flaps:
During final approach, one elevon on each wing is used as a flap. This control displays current position of the flaps and, like the body flap, is used to provide additional lift or drag.

Landing Gear:
The landing gear can only be lowered, not raised. When selected, the button will highlight indicating that the landing gear is down.

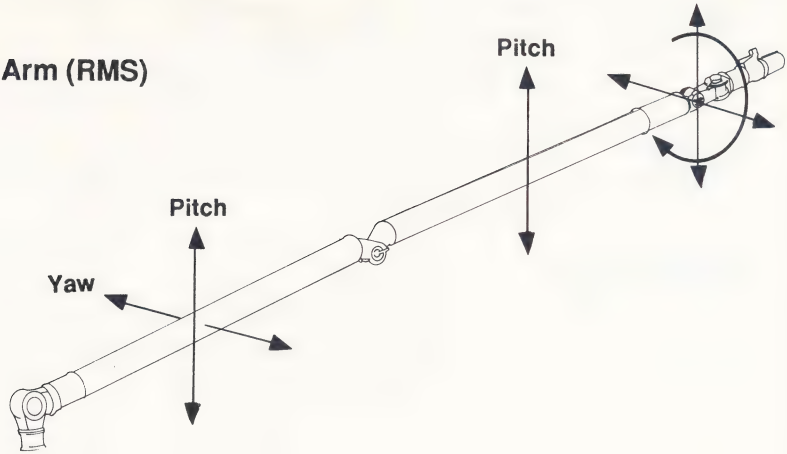
Altitude:
Displays altitude in selected units. [**KM**] - Select to display altitude in kilometers. [**M**] - Select to display altitude in meters. Meter and kilometer settings may also be selected from the **Special** menu.

X - Y - Z AXES (Translation/Rotation)



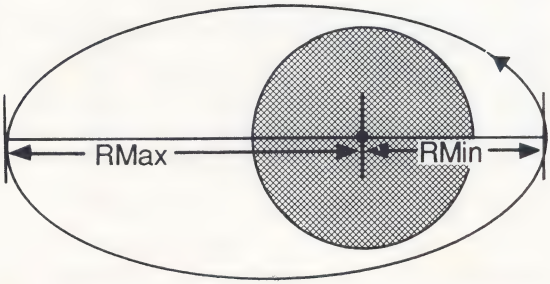


Arm (RMS)



RMin/RMax

Elliptical Orbit



Drop Rate
00000

Drop Rate:
Downward velocity in meters per second.

Drop Accel
00000

Drop Acceleration:
Downward acceleration in meters per second. (A minus indicates ascent.)

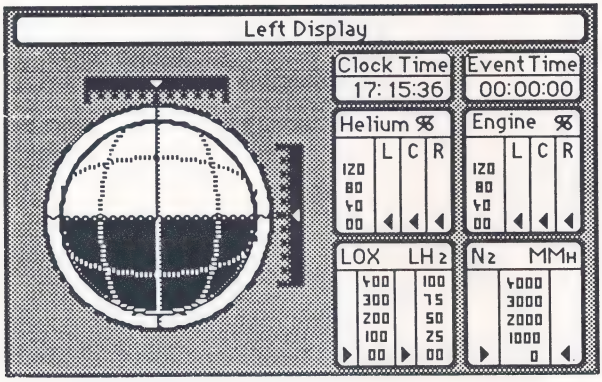
Air Speed
00000

Air Speed-
"Inertial" velocity; speed along flight path in meters per second.

Camera Window

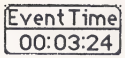
Camera:
Shows landing site, regardless of facing, as if a camera were mounted under the fuselage.
Window: Front window view of landing site.

Left Display Panel

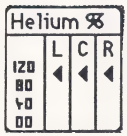


Artificial Horizon: (Large sphere on the left)
Shows current Roll position of the shuttle relative to the Earth's surface. Black on the bottom indicates that the shuttle's wings are level with the ground and the Orbiter is upright in relation to the Earth. Black on the top indicates the Orbiter is upside down in relation to the Earth.

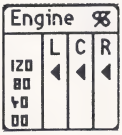
Clock Time:
Actual time of day for the player's reference.



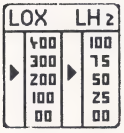
Event Time:
Time since launch (hours: minutes: seconds), and used to measure critical Orbiter events such as SRB separation and deorbit burn.



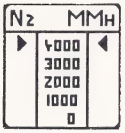
Helium %:
Shows the percentage (%) of pressure on the OMS engines, Left/Center/Right.



Engine %:
Engine thrust, Left/Center/Right, shown in % for SSME's or OMS engines.

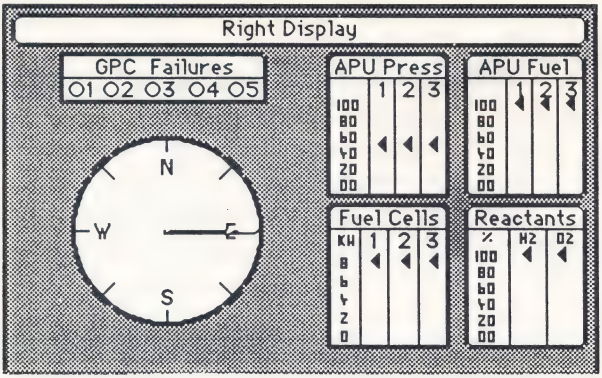


LOX, LH2:
Liquid Oxygen, Liquid Hydroxide (Propellant for SSME's) in 1000 kg units and percentages respectively.

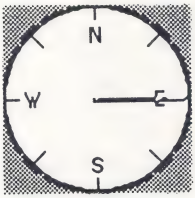


N2, MMH:
Nitrogen tetroxide, Monomethyl Hydrozene (Propellant for RCS system) in 1000 kg units.

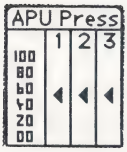
Right Display Panel



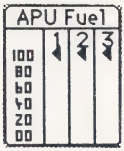
GPC Failures:
Status indicators for General Purpose Computer failures. If highlighted, a failure has occurred and you must watch the Message CRT for status update.



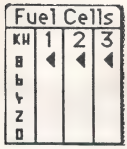
Compass Rose:
Real direction heading. Note: this is a magnetic compass and will not operate in orbit.



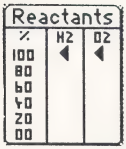
APU Press:
Auxiliary Power Unit Pressure -Three percentage indicators for the three APU systems.



APU Fuel:
Percentage of fuel left for the three APU fuel tanks.



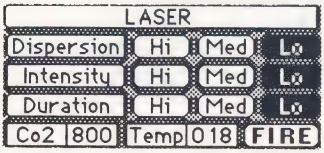
Fuel Cells:
Three Kw (kilowatt) indicators for the three fuel cells of the Electrical Power System. Each can put out between 0 (off), 2 (min.) and 8 (max) kilowatts.



Reactants:
Two percentage indicators for reactant levels of H_2 (hydrogen) and 0_2 (oxygen) used for the SSME's.

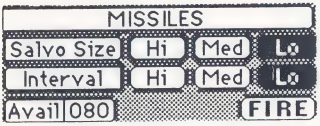
Test Weapons Panel

The Test Weapons panel was included for use with simulation scenarios which may be developed at a later date. The weapons are simulations of electronic devices which indicate if your target is within range and if your shot would have hit or missed the target. You will not be able to destroy any objects with these weapons.



LASER :
The following controls have High, Medium, and Low buttons.
[**Dispersion**] - Width of beam.

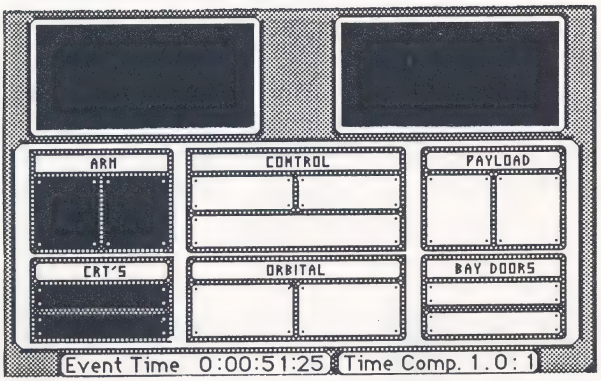
[**Intensity**] - Power of beam. [**Duration**] - Pulse time. [**Co2**] - Carbon dioxide is the fuel for this type of laser. Quantity depends upon original load and Player's firing methods. [**Temp**] - Current temperature of laser system. [**FIRE**] - Will fire laser at the object sited in the window, using the selected weapon values.



MISSILES :
The following controls have High, Medium, and Low buttons.
Salvo Size - Indicates general number of missiles to use on the target. ***Interval*** - Distance between salvos launched at estimated target range. *Avail* - Number of missiles left. [**FIRE**]-Will fire your missile selection at the target shown in your window.

Power:
[**Off**] shuts off the Missile and Laser power. [**On**] switches on the weapons power system.

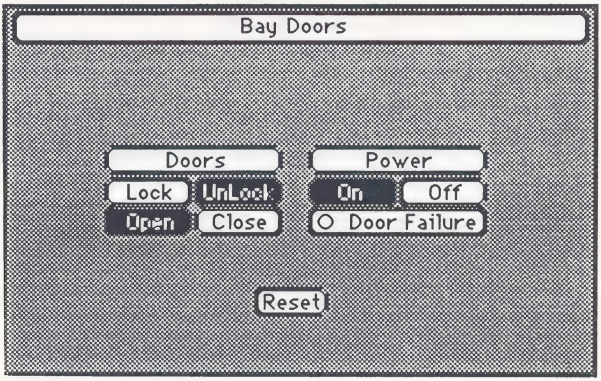
AFT MAIN STATION



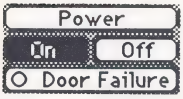
(Aft Main Station)

The Aft Main Station allows control over all payload functions of the Orbiter and operates in the same manner as the Forward Main Station. When selected from the **Views** menu, it replaces the Forward Main station in the lower right-hand corner of the screen.

Bay Doors Panel



This panel is used solely to control the Payload Bay Doors.

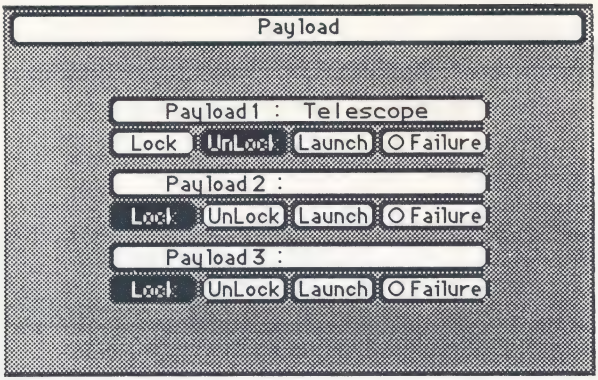


Power:
[**On**] - Activates power to door motors.
[**Off**] - Turns off power to door motors.
[**Door Failure**] - Indicates that a malfunction has occurred in the door mechanism.

Doors:
[**Lock**] - Secures the doors in the selected position (open or closed).
[**Unlock**] - Used to unlock the doors so that they may be opened or closed. [**Open**] - Opens the bay doors to space (required upon entry to orbit). [**Close**] - Closes the bay boors (required before re-entry).

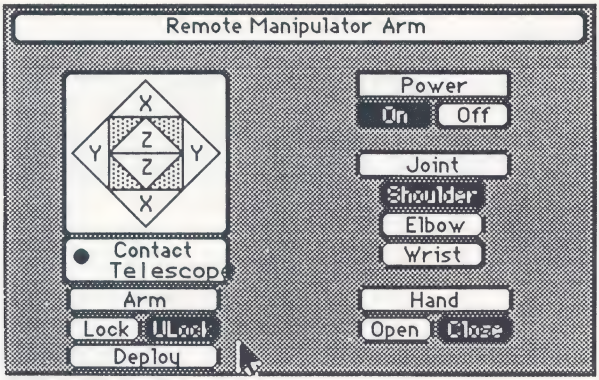
[**Reset**] - Used to attempt to reset the doors after a failure.

Payload Panel



PAYLOAD: (slots 1, 2 and 3)
[**Lock**] - Secures a payload to the bay. [**Unlock**] - Releases the clamps that hold a payload in the Payload Bay. [**Launch**] - Ejects a payload out of the bay into space. [**Failure**] - Indicates that a malfunction has occurred with a payload.

Remote Arm Panel

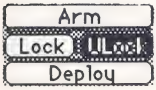


This Panel is for controlling the Remote Manipulator System (RMS), better known as the "Arm." Display the Aft

window panel when using the RMS in order to watch its movements from the Bay.

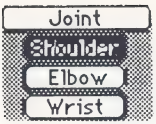
MOVEMENT STAR:
Click the appropriate triangle to rotate the selected joint in the desired direction. **X** stands for the X axis and institutes a left (upper X) or right (lower X) **Roll** movement. **Y** stands for the Y axis and institutes an up (right Y) or down (left Y) **Pitch** movement. **Z** stands for the Z axis and institutes a **Yaw** to the left (upper Z), or the right (lower Z). **Note:** detailed explanation of RMS movement is provided in Section **7. Maneuvers and Operations**.

[**Contact**] - If lit, the arm has made contact with an object in the payload bay or space. The name of the object in contact will appear in this box.



ARM:
[**Lock**] - Locks the Arm into the storage position before and after maneuvers. [**ULock**] - Unlocks the Arm from the storage position, enabling its use. [**Deploy**] - Once an object is grasped and is unlocked from the payload slot, it may be deployed by using the Arm instead of the payload launch facility.

POWER:
[**On**] - Activates the power system for the RMS. [**Off**] -Shuts down the RMS power system.



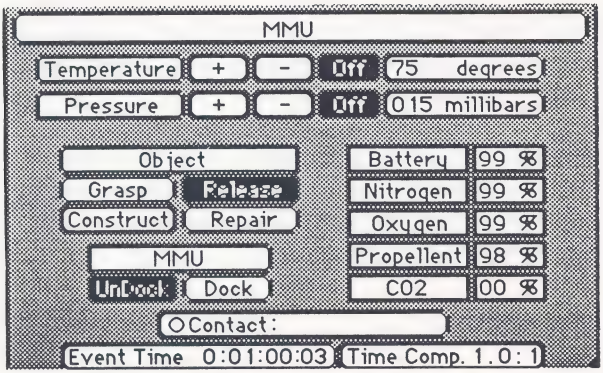
JOINT:
[**Shoulder**] - Shoulder rotation selection (pitch, yaw). [**Elbow**] - Elbow rotation selection (pitch only). [**Wrist**] - Wrist rotation selection (roll, pitch, yaw).

HAND:
[**Open**] - Opens the hand so that an object may be grasped. [**Close**] - Closes the hand to secure the object which has been grasped.

Aft Window Panel

In order to see out the Aft windows, the bay doors must be opened and a window must be displayed from the Aft Main Station. The window will give a view of the Payload Bay and whatever is in space around the Orbiter. This may include the sun, Earth, stars, the moon, man-made objects in orbit such as the space station or a satellite or two.

MMU (Manned Maneuvering Unit) STATION
MMU Control Panel

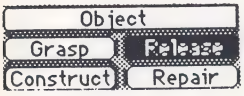


Temperature:

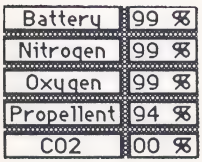
[**+**] This selection increases suit temperature.
[**-**] This selection decreases suit temperature.
[**Off**] Turns off either the **+** or **-** buttons.
degrees Suit temperature indicator - Fahrenheit.

Pressure:

[**+**] This selection increases suit pressure.
[**-**] This selection decreases suit pressure.
[**Off**] Turns off either the **+** or **-** buttons.
millibars Suit pressure indicator.

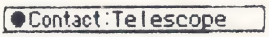


Object:
[**Grasp**] - If an object is within reach (3 meters) then you may secure it to the MMU using this button. [**Release**] - Allows the MMU to release a grasped object. [**Construct**] - If one object is grasped and another is within range, they may be attached to each other by selecting the [Construct] button. [**Repair**] - If an object is grasped, or within 2 meters, you may [Repair] any malfunction on the object using this button.



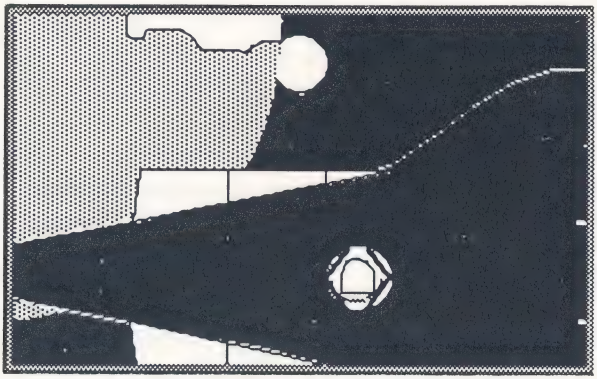
Resource status indicators (in percent remaining) for the *Battery, Nitrogen, Oxygen Propellant and Carbon Dioxide* (CO_2).

MMU:
[**Undock**] - Releases and ejects the MMU from the Orbiter 3 meters above the shuttle and facing in the same direction. [**Dock**] - Attaches the MMU to the Orbiter if within range of the bay (up to 9 meters).



Contact:
This indicator lets you know when an object has been grasped (see [Grasp]), and displays the name of the object.

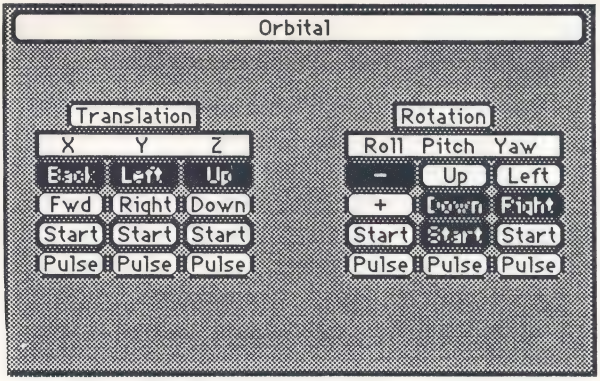
Forward, Aft, and MMU Window Panels



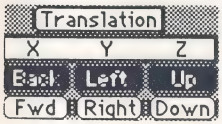
(**MMU Window**)

A window may be selected in the same manner as any other panel, and will highlight as a unit (four forward windows, or two aft windows). You may see any of several objects from the window including the Earth (the largest of the objects), the moon, stars, satellites and other man-made objects. In the case of the MMU, the window is automatically displayed in the upper left-hand quadrant and may show any of the above, plus the Orbiter.

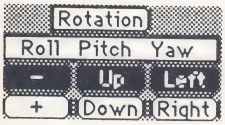
Forward, Aft and MMU Orbital Panels



Your ORBITER Glider Kit will help you understand this section on Forward, Aft and MMU Orbital Panels. Use it to visualize the descriptions that follow. (See Section **7. Maneuvers and Operations** for a complete explanation of these movements.)



TRANSLATION: movement ***along*** the three axes. ***X*** [**Forward**] - moves the Orbiter forward, nose first. [**Back**] - moves the Orbiter backward, tail first. ***Y*** [**Left**] - moves the Orbiter to the left. [**Right**] - moves the Orbiter to the right. ***Z*** [**Up**] - moves the body of the Orbiter upward. [**Down**] - moves the Orbiter downward.

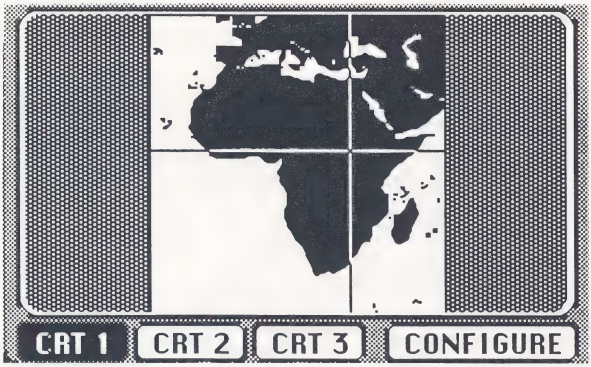


ROTATION: movement ***about*** the three axes. *Roll* [**+**] Clockwise roll about the ***X*** axis (just as an airplane does a roll in mid-air, wing-over-wing). [**-**] Counter-clockwise roll about the ***X*** axis. *Pitch* [**Up**] Upward roll of the nose about the ***Y*** axis

up to a full 360 degrees. [**Down**] Downward roll of the nose about the ***Y*** axis. *Yaw* [**Left**] or [**Right**] wing turn about the ***Z*** axis

Each axis has a [**Start**] button and a [**Pulse**] button. Select the direction of your move, then initiate movement by pressing either [Start] or [Pulse]. [Start] will burn the thrusters until selected (toggled) again. [Pulse] will burn one short burst, 3 degrees per second.

Forward, Aft and MMU CRT Panels



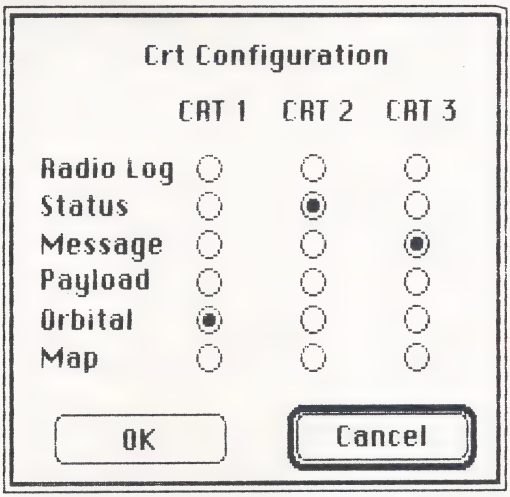
(*Map* Configuration)

ORBITER has three CRT's which may be configured for any three of eight different displays.

There are six main display options. **Radio Log** displays all messages previously received from Mission Control.

The **Status** option provides information about the orbit of the Orbiter or the MMU. This display will be used most frequently during in-space activities. Some information is

self-explantory. To understand the read-outs more fully, refer to Section **7. Maneuvers and Operations**.



The **Message** display gives you textual information regarding Mission Control's instructions and instructions or warnings from the on-board computers. This option is used most frequently during launch and landing procedures.

Payload information is displayed here when you are carrying cargo to be launched from the Payload Bay panel rather than with the RMS. It will give you the target radius, which is the altitude at which you are instructed to launch the object, and your present radius. (The latter figure will match your current Rmax read-out.) The Payload will also display the name of the object to be launched.

Orbital provides RMin, RMax, Velocity, Angle, Distance and Identification information on selected man-made orbiting objects. You will use this CRT to select objects with which to match orbits, or display current information in

conjunction with the Orbiter or MMU information on the *Status* display. To select an object, click the mouse on the line that displays the desired object. The selected object's orbital information will now be made available on the Status display above the Orbiter or MMU Information line. That object is also now available for matching orbits using the [Item] 99 [Exec] command sequence.

The **Map** option displays a "mini-map" on the CRT. It is the same map displayed using the **Views** menu, but you will not have to take up the whole screen to see where your orbital path lies. Your position is displayed with a moving X,Y grid. You are located at the point of intersection between the X (vertical) and Y (horizontal) lines.

The **Launch** and **Landing** options are available only during their respective activities. The **Launch** CRT will show a linear trajectory of your launch and includes the target altitude for your orbit as well as the SRB and ET separation points. It will also show launch deviations should you encounter certain failures before reaching ET separation. After ET separation this CRT option is no longer available.

The **Landing** option will become available once you are through the pre-entry communications black-out. It gives vital information regarding your course during the landing phase. Information displayed includes: heading and distance from the runway, your altitude, angle, velocity, acceleration, latitude and longitude, roll, pitch, yaw, and the location in X, Y, and Z coordinates relative to the map grid (see the "Walk-Through" for the importance of this information).

The following is a guide to help you maneuver the Orbiter, the MMU and the RMS with relative ease. In order to visualize the orbital maneuvers of the Space Shuttle system, put together your paper Orbiter model included in the program package. The model will help you relate three dimensional movement to the two dimensional illustrations shown in the manual on pages 38 and 39. It may also help to refer to the previous section, **ORBITER Control Panels.**

Some general laws of motion in space:
Maneuvering vehicles in space is not the same as operating a vehicle on the Earth. In space, up and down is relative to the object you are in (MMU, Orbiter). Think of yourself in space with no large object with which to orient yourself, which way is up? Up is the direction away from the bottom of your vehicle. Also, inertia is operative in space, i.e., once an object is moving in space it will continue in the same direction and at the same velocity, unless acted upon by another force, because there is no friction to create "drag." Objects may collide with one another causing a transfer of energy; or they may be affected by the earth's "gravity well," which is why objects remain in orbit instead of flying off into space.

Also, remember that you are traveling in a circle. An object may be straight ahead, but your path to get to it will be an arc. You may want to use your model in conjunction with a large ball to appreciate the movements necessary to reach another object along a curved surface.

Shuttle motion is described in terms of the X, Y, and Z axes. The **X** axis describes an imaginary line running through the shuttle from the tail to the nose. The **Y** axis

describes an imaginary line from wing to wing. The **Z** axis describes an imaginary line through the center of the shuttle from the belly through the top. (See the illustration on page 38.)

Translation is a sliding movement along one or more of the three axes.

Rotation is movement around one or more of the three axes.

Pitch is rotation about the Y axis.
Roll is rotation about the X axis.
Yaw is rotation about the Z axis.

Orbital Operations

Most orbital operations are performed from the **Orbital** panel. This section will provide more detail on the maneuvers controlled from this panel.

The [Start] button is a toggle, click once and it will burn until clicked again. The [Pulse] button will fire a short spurt, then stop.

Orbits are either circular or elliptical paths around the Earth as measured by Rmin (Radius minimum), Rmax (Radius maximum), and Angle.

Rmin is the closest end-point of an object's elliptical orbit and the location of the orbiting object's highest velocity.
Rmax is the farthest end-point of an object's elliptical orbit and the location of the orbiting object's lowest velocity.
(See diagram on page 39.)

Angle refers to the angle made when the path of an object in orbit crosses the equator.

The two terms used when discussing orbital maneuvering are Matching and Adjusting.

Matching is the process of changing the Orbiter's orbit to "match" another object's orbit to within several meters. It may be necessary to perform translation and rotation movements in order to match another object's orbit. (For aid in identifying objects seen from the shuttle window see Section **9. Object Identification**.)

The [Item] 99 [Exec] keypad command is used to perform the matching function with an object that has been selected from a CRT configured to *Orbital*. The object must be in *Low Orbit*. The computer will advance your orbit, burn fuel, and adjust the clock to reflect the "time warp" required to match the selected object. Orbital angle can only be changed by 2 degrees each time you change your orbit.

Adjusting an orbit means to adjust Rmin or Rmax. If these are equal then you have a circularized orbit.

Adjusting Rmin or Rmax requires time and patience. To effect a change in Rmin you should fire the OMS engines at Rmax. To effect a change in Rmax you should fire the OMS engines at Rmin.

To *increase* Rmax, face toward velocity and burn at Rmin.
To *decrease* Rmax, face against velocity and burn at Rmin.
To *increase* Rmin, face toward velocity and burn at Rmax.
To *decrease* Rmin, face against velocity and burn at Rmax.
(These changes are made using [Exec] keypad commands. See Section **8. Keyboard Equivalents and Keypad Commands**.)

Follow Rmin, Rmax and Angle on a CRT configured for *Status* or *Orbital.* It is, for all intents and purposes in this program, impossible to manually change your orbital angle. The physics involved are considerable.

Manned Maneuvering Unit (MMU)

The basic operating elements of the MMU are docking and undocking, maneuvering, grasping and releasing, and constructing and repairing.

Dock/Undock:

To operate the MMU select *MMU* from the **Views** menu. Three new panels will be displayed, a window, the MMU Orbital panel and the MMU control panel. When [Undock] is selected the MMU is propelled into space approximately three meters above the cargo bay and facing in the same direction as the Orbiter. When ready to return to the safety of the Orbiter, maneuver to within five meters of the bay and press [Dock]. Once docked, you are able to make another selection from the **Views** menu.

MMU Maneuvers:

Movement is described in terms of Translation and Rotation as it is with any vehicle in space (see diagram on page 38). In the MMU you may only pulse the thrusters if you are performing translational maneuvers. These short bursts keep you from moving too far from the shuttle. To move along the X axis (face-forward), select [Forward] from under the ***X*** under *Translation* in the MMU **Orbital** panel, and then press [Pulse]; select [Back] to move backwards. The ***Y*** axis controls sideways movement while the ***Z*** axis controls straight up and down movement. The rotational maneuvers will cause you to "pivot" about the axis while remaining in the same relative position. You may use both

the pulse and continuous thrusters. In the MMU window you will be able to see the shuttle from 6 different positions, front, back, 2 sides, top and bottom (see page 66). It takes a great deal of skill to maneuver completely around the shuttle, but the views are worth the effort.

Grasp/Repair/Release:
Capturing an object requires that you maneuver to the desired object and select [Grasp] from the **MMU** panel. Several attempts are allowed. The chances for a successful capture are increased if the object is centered in the window, has the same movement as the MMU and is not rotating. Once an object is attached to the MMU it is eligible for [Construction] or [Repair]. When the object has been grasped the MMU may still be moved, but with degraded performance.

The [Repair] activity may be performed while the object is grasped or within two meters of the MMU. Several tries may be needed to complete the repair, if the object is indeed repairable. You may let go of the object by pressing the [Release] button.

If your instructions are to secure the object in the cargo bay, or if the object is not repairable and it must be returned to Earth, it may be necessary to use the **MMU Matcher** described in the next paragraph.

MMU Matcher Menu:
When you have undocked you will notice this new item appearing on the menu bar. This tool is provided to aid you in your attempts to match orbits with another object. The MMU Matcher functions as the [Item] 99 [Exec] command does on the Orbiter, but is limited to a distance of 2,000 meters. It is best to get as close to the object as

possible in the Orbiter and then use the MMU Matcher to get within grasping distance.

The highlighted options on this menu are within matching distance of the MMU. Once an object has been captured you may release it into one of the 3 payload slots by selecting the desired slot from the list at the bottom of the menu. (See page 29 in the **ORBITER Pull-Down Menus** section.)

Secure a captured object in the cargo bay by first selecting the desired payload slot from the **MMU Matcher** menu. [Release] the object, and then [Dock] quickly so that you may pull up the **Payload** panel, Aft station. Secure the object before it floats away in the selected payload slot using the [Lock] button on the Payload panel. If the payload slot shows the name of the object then it is secured. This maneuver gets pretty tricky so employing the Arm might be helpful.

Construction:
The construction process involves putting two objects together in space. Join the pieces using the [Construct] button when the objects are within two meters of one another.

Remote Manipulator System (RMS)

You may engage the Remote Manipulator System (RMS), once the bay doors have been opened and you are operating from the **Aft Main Station**. You will see the Arm as you look through the Aft windows, it will be locked on the right-hand wall of the bay. Select and display the **Arm** panel from the **Aft Main Station** in the desired quadrant. You should also have an Aft window displayed

so that you can see what the Arm is doing. Turn the *Power* button [On], then select [Unlock] to release it.

The RMS is a mechanical arm with joints and segments resembling the human arm. Each movement of the RMS requires a discrete step. You must first select the joint to be operated (shoulder, elbow or wrist) and use the "movement star" to instigate rotation of the selected joint. One or two motions may not be available for a particular joint. The Shoulder is able to pitch (Y), and yaw (Z); the Elbow can only pitch (Y); and the Wrist can roll (X), pitch (Y), and yaw (Z).

The movement star is divided into sets of triangles. Each triangle contains one letter. The **Y** set represents the Y axis, or pitch. The **X** set represents the X axis, or Roll. The **Z** set represents the Z axis, or Yaw. (See the arm rotation diagram on page 39.)

Arm Grabber Menu:
Objects in orbit will be highlighted on this menu only if they are within reach of the arm. By selecting an object within range you will automatically send the Arm over to grasp it.

If an object is in the bay, select it from the Arm Grabber menu and then launch it using the [Deploy] button. (Be sure to first unlock the object from the assigned payload slot on the **Payload** panel.)

If an object is floating in space and within approximately 10 meters of the Arm, select it from the Arm Grabber menu. To place the object in the cargo bay, select an empty payload slot from the bottom of the menu and secure the object by selecting the [Lock] button in the **Payload** panel. Then release the object and secure the arm to its position in the bay.

8. Keyboard Equivalents and Keypad Commands

Keyboard Equivalents:
When applicable, keyboard equivalents are displayed next to an option listed in the pull-down menu. Example: Reaching the **Forward Main Station** is achieved by selecting Forward from the **Views** pull-down or by simultaneously pressing the Command and F keys (⌘ **F**). A Quick Reference Card has been provided in your ORBITER package for a listing of these commands.

Keypad Commands:
The operations listed below are performed by entering the following keypad commands on the **Control** Panel. When necessary, ORBITER's on-board computer will prompt you to enter these commands. If you select fewer prompts from the *Orbiter Configuration* dialog box then many of these commands will be performed automatically. If you select to receive full prompting the on-board computer will prompt you to enter almost all of the commands listed below.

To enter keypad commands using the keyboard instead of the mouse, type the first letter of the prefix followed by the appropriate numbers and the first letter of the suffix. For example, [ITEM] 25 [EXEC], could be entered from the keyboard as **I25E**.

[SPEC] Key Commands
[Spec] XX [Pro]

XX	Indicates	When operable
91	Test Payload Module 1	Orbit
92	Test Payload Module 2	"
93	Test Payload Module 3	"
99	Special Command	"

[PRO] Key commands

[Ops] XX [Pro]

Most of these commands are performed by the On-board Computers

XX	Indicates:
99	Special Command 99
101	Prelaunch to Launch program loaded
102	Launch to SRB Separation loaded
103	SRB Separation to SSME cutoff program loaded
104	SSME cutoff to OMS 1 program loaded
105	OMS 2 Program (program) loaded
106	Orbital insertion and coast Program
301	Prepare for retro-fire
302	Retro-Fire and Pre-entry coast program loaded
303	Pre-entry system check and monitor program loaded
304	Atmospheric entry program loaded
305	Atmospheric flight and landing program loaded
601	RTLS abort program loaded
602	Glide Option #1 program loaded
603	Glide Option #2 program loaded
901	Preflight Monitor Program loaded

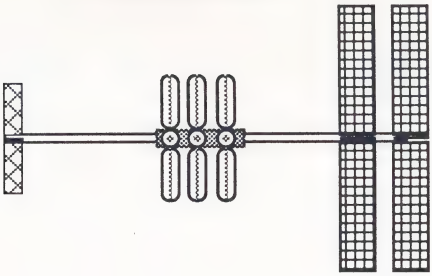
[EXEC] Key Commands

[Item] XX [Exec]

XX	Indicates:	When operable
24	Roll controls enabled	Deorbit
25	Pitch controls enabled	"
26	Yaw controls enabled	"
28	Oms engines armed and pressurized	"
36	Dumping rest of propellants	"
37	Reaction Control System armed	Orbit
38	Dumping Forward propellants	Deorbit
39	Start Moving Control surfaces	Launch/deorbit

40	Cancel Moving Control Surfaces	Launch/deorbit
50	Closing cabin pressure vents	Launch
51	Cabin pressure vents opened	"
52	Helium pressure vents closed	"
53	Helium pressure vents opened	"
55	Setting for APU pre-start	"
56	Cabin relief vents enabled	"
57	Anti-skid system disabled	Deorbit
58	Anti-skid system enabled	"
59	disable nose wheel steering	"
60	enable nose wheel steering	"
61	disable entry role mode system	"
62	enable entry roll mode system	"
63	set speed brake to manual	"
64	set speed brake to auto	"
65	set throttle to manual	"
66	set throttle to automatic	"
67	set pitch to manual	"
68	set pitch to automatic	"
69	set roll/yaw to manual	"
70	set roll/yaw to automatic	"
71	set body flap to manual	"
72	set body flap to automatic	"
90	Executing Yaw + 90 degrees	Orbit
91	Executing Yaw -90 degrees	"
92	Executing Pitch +90 degrees	"
93	Executing Pitch -90 degrees	"
94	Executing Facing to the direction of velocity (i.e. Speeding up)	"
95	Executing Facing to the opposite direction of velocity (i.e. Slowing down)	"
99	Match orbits command initiated	Orbit

Full Space Station



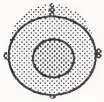
Hughes 376 Series

SBS
Intelsat 6
Telstar
Westar

Spacelab

Milsat

Module



Missiles

Leasat 2

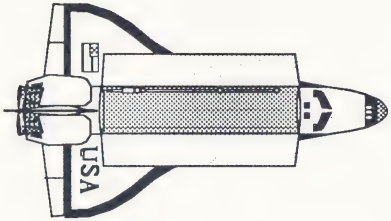
LDEF

Telescope

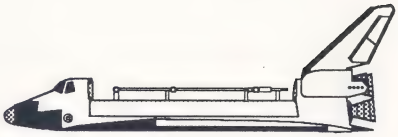
Views of the Orbiter from the MMU

Front

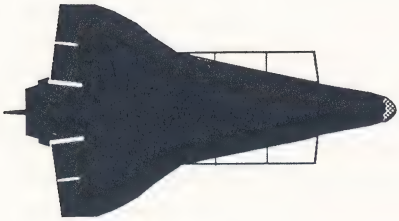
Back



Top



Side(s)



Bottom

abort -To end the mission short of its objective. An abort is usually caused by some malfunction or emergency.

accelerometer - An instrument that measures the rate at which acceleration changes.

airlock - A chamber used to adjust pressure for passage between one area and another; for example, between the Orbiter and the outside space environment.

apogee - The farthest point of an Earth orbit (Rmax).

apogee kick motor - A rocket motor that fires at the apogee (radius maximum) of an elliptical orbit

attitude - The position of the vehicle; for example, flying tail-first with cargo bay toward the Earth.

avionics - The electronics systems and instruments to monitor and control the flight.

blackout - The loss of radio signal (LOS) during entry caused by passage of the Orbiter through the atmosphere, creating shock waves and ionization. Also, the loss of consciousness from excessive G-Forces.

cathode-ray tube (CRT) - A vacuum tube similar to a television tube, on which an electronic beam can draw pictures or write words; used to display computer output.

deorbit burn - The firing of a Retro-Rocket to slow the spacecraft to a speed lower than that required to maintain orbit. On the Orbiter, this is accomplished with the orbiter maneuvering system (OMS) engines.

dock - To join two spacecraft together in space.

elevon - A control surface used once the returning Shuttle has entered the atmosphere; it acts like a combination of an aircraft elevator and aileron, controlling Pitch and Roll.

extravehicular activity (EVA) - Work done outside the pressurized part of the spacecraft; a spacesuit must be worn.

flare - A pitch-up (nose-up) maneuver that reduces speed for landing.

fuel cell - A device that mixes oxygen and hydrogen together in a controlled process to produce electricity and pure water.

g - The symbol for the force equivalent to the acceleration of Earth gravity. (32 ft. per second squared.)

g-force - Force produced on the body by changes in velocity; measured in increments of Earth gravity.

geostationary or geosynchronous orbit - An orbit 22,300 miles (35,900 kilometers) from Earth, where the orbital period is 24 hours long. A spacecraft in such an orbit hovers over the equator and seems to be always in the same place in the sky. This is especially important for communication satellites.

gimbal - An attachment with hinges or ball joints to permit movement in two or three axes. Rocket nozzles are gimbaled to allow thrust in different directions for flight control.

glidescope - The angle at which you descend in the Orbiter or other glider with respect to the ground.

hypersonic - Refers to speed above Mach 5 (Five times the speed of sound).

inertia - The tendency of a body at rest to stay at rest and a body in motion to continue in motion in the same direction.

knot - One nautical mile per hour ; 1 nautical mile equals approximately 1.1 statute (land) miles.

KU-Band - Navigation and communication device used for rendezvous and maneuvering. Range = 100 km.

lithium hydroxide - A chemical compound (LiOH) used to remove carbon dioxide from the cabin atmosphere.

Mach - The term used to describe the speed of objects relative to the speed of sound (1,085 feet/second, or approximately 740 mph). For example, Mach 2 is twice the speed of sound.

microgravity - The term used to describe weightlessness and fractional g-forces produced in orbit. In orbit, you essentially fall around the Earth, producing a "floating" condition.

micrometeoroids - Meteoric particles the size of grains of salt. They are plentiful in space and potentially dangerous due to the velocities involved. The spacecraft can be shielded by a barrier equivalent to a thin sheet of aluminum.

microprocessor - A small computer that usually performs only a few specific tasks.

orbit - A balance between a body's inertia, or tendency to fly off into space, and the gravitational attraction of a central object.

partial pressure - In a container of mixed gases (like the shuttle cabin filled with an oxygen-nitrogen mix), each gas exerts a fraction of the total pressure. This *partial pressure* is proportionate to the amount of each gas in the mixture.

pitch - Up-down rotation of the nose of the craft (see Roll and Yaw).

pounds per square inch (psi) - A measure of pressure. The metric measure is kilopascals. 1 psi X 6.895 = 1 kilopascal or 14.7 psi at sea level.

retro-fire - To fire engines in the direction of motion in order to reduce forward velocity. In orbit, this permits gravity to pull you downward.

retrorocket - A rocket that fires against the direction of motion, slowing the craft. Gravity pulls the craft downward.

rocket engine - An engine that carries its own oxidizer and fuel for combustion and, therefore, is self-contained.

roll - To rotate about the X axis, an imaginary line running through the body of the object from front to back.

rotation - Movement of the Orbiter *around* one or more of its three principal axes creating Pitch, Roll and Yaw.

rudder - A control surface on the vertical stabilizer (tail) to control Yaw.

software - Computer programming or instructions.

speed brake - The rudder on the Orbiter when it is split and spread to increase atmospheric drag and slow the craft during descent and landing.

telemetry - Data transmitted to the Earth regarding the Orbiter, crew and experiments.

thrust - The force created by a rocket engine.

transfer orbit - An oval shaped (elliptical) orbit made when changing from one nearly circular orbit to another.

translation - Movement of the Orbiter *along* one or more of its principal axes.

umbilical - A connecting cable that carries electricity and life support to an astronaut during extravehicular activity.

vernier engine - A small thruster for precise adjustments in the Orbiter position.

vertical stabilizer - The tail-piece of the aircraft containing the rudder and the speed brake.

weightlessness - See microgravity.

yaw - Left-right rotation of the nose of the craft (see Pitch and Roll).

11. Acronyms

ADI	Attitude Direction Indicator
A/G	Air-to-Ground
AMI	Alpha/Mach Indicator
APU	Auxiliary Power Unit
ATU	Audio Terminal Unit
AVVI	Altitude/Vertical Velocity Indicator
CFES	Continuous Flow Electrophoreses System
CSS	Control Stick Steering
DCM	Displays and Controls Module
DOD	Department of Defense
EAFB	Edwards Air Force Base
EMK	Emergency Medical Kit
EMU	Extravehicular Mobility Unit
ERBS	Earth Radiation Budget Satellite
ET	External Tank
EVA	ExtraVehicular Activity
FRCS	Forward Reaction Control System
GMT	Greenwich Mean Time
GSFC	NASA Goddard Space Flight Center
HAL/S	High order Assembly Language/Shuttle
HSI	Horizontal Situation Indicator
HRSI	High temperature Reusable Surface Insulation
IUS	Inertial Upper Stage
IVA	IntraVehicular Activity
KSC	Kennedy Space Center
LCC	Launch Control Center (KSC)
LDEF	Long-Duration Exposure Facility
LED	Light Emitting Diode
LFC	Large Format Camera (IMAX)
LOS	Loss Of Signal
LRSI	Low temperature Reusable Surface Insulation
MAPS	Measurement of Air Polution (aerial camera)
MBK	Medications-and-Bandage Kit
MCC	Mission Control Center

MCC/H	Mission Control Center at Houston
MET	Mission-Elapsed Time
MLP	Mobile Launcher Platform
MMS	Multimission Modular Spacecraft
MMU	Manned Maneuvering Unit
OMS	Orbital Maneuvering System
OPF	Orbiter Processing Facility
ORS	Orbital Refueling System
PAM	Payload Assist Module
PLBD	PayLoad Bay Door
PLSS	Portable Life-Support System
POCC	Payload Operations Control Center (Goddard)
POS	Portable Oxygen System
RCC	Reinforced Carbon Carbon
RCS	Reaction Control System
RHC	Rotational Hand Controller
RMS	Remote Manipulator System
RSS	Rotating Service Structure
SCA	Shuttle Carrier Aircraft
SCAPE	Self-Contained Atmospheric Pressure Ensemble
SIR-B	Shuttle Imaging Radar - B
SOMS	Shuttle Orbiter Medical System
SRB	Solid Rocket Booster
SSME	Space Shuttle Main Engine
SSIP	Shuttle Student Involvement Project
SSUS	Spinning Solid Upper Stage
STS	Space Transportation System
tacan	Tactical air navigation
TAEM	Terminal Area Energy Management
TDRS	Tracking and Data Relay Satellite
TPAD	Trunnion Pin Acquisition Device
TPS	Thermal Protection System
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
WCS	Waste Collection System
WS	White Sands -Northrup Strip- New Mexico

ADDENDUM TO THE MAC ORBITER MANUAL

Some of the disks are still labeled version 1.00, but we have updated the disk to version 1.10. Check the "Get Info" file for the ORBITER icon to verify the version number. Version 1.10 is now HFS-compatible.

ORBITER 1.10 on an 800k disk for the Mac 512kE, Mac Plus, and Mac SE

1. Initialize a disk for 800k.
2. Copy System 3.2 and Finder 5.3 (or later) to the 800k disk.
3. Create an empty folder named "OrbiterData" on the 800k disk. The folder must be named exactly this or else the program will not run.
4. Copy all of the files except System, MacinTalk, and Orbiter from the two ORBITER disks to the folder named "OrbiterData." Do not copy the Orbiter•1 and Orbiter•2 folders. The complete list of files to put in the "OrbiterData" folder is: Orbpics.rsrc, Mission.data, Spectrum.text, Satellite.text, Orbiter.data, Mission.text, and Shuttle.text.
5. Copy the Orbiter application file to the 800k disk but not in the "OrbiterData" folder.
6. Copy the MacinTalk driver to the System folder on the 800k disk.
7. This step is **optional**. If you want this disk to boot into ORBITER, select the Orbiter icon by single-clicking on it, leaving it highlighted. Pull down the Special menu and select the Set Startup option.

ORBITER 1.10 under HFS on a hard drive

1. System 3.2 and Finder 5.3 (or later) must be installed on your hard drive.
2. Create an empty folder named "OrbiterData" on the hard drive. The folder must be named exactly this or else the program will not run.
3. Copy all of the files except System, MacinTalk, and Orbiter from the two ORBITER disks to the folder named "OrbiterData." Do not copy the Orbiter•1 and Orbiter•2 folders. The complete list of files to put in the "OrbiterData" folder is: Orbpics.rsrc, Mission.data, Spectrum.text, Satellite.text, Orbiter.data, Mission.text, and Shuttle.text.
4. Copy the Orbiter application file to the same level directory as the "OrbiterData" folder. Do not put the Orbiter application file in the "OrbiterData" folder.
5. Copy the MacinTalk driver to the System folder on the hard drive.

QUICK REFERENCE CARD

[Ops] XX [Pro]

XX	Indicates:
99	Special Command 99
101	Prelaunch to Launch program loaded
102	Launch to SRB Separation loaded
103	SRB Separation to SSME cutoff program loaded
104	SSME cutoff to OMS 1 program loaded
105	OMS 2 Program (program) loaded
106	Orbital insertion and coast Program
301	Prepare for retro-fire
302	Retro-Fire and Pre-entry coast program loaded
303	Pre-entry system check and monitor program loaded
304	Atmospheric entry program loaded
305	Atmospheric flight and landing program loaded
601	RTLS abort program loaded
602	Glide Option #1 program loaded
603	Glide Option #2 program loaded
901	Preflight Monitor Program loaded

Command Keys

Suspend	**⌘S**	**Roger**	**⌘A**
Continue	**⌘Q**	**Negatory**	**⌘N**
	Current ⌘M		
Forward	**⌘1**	**Configuration**	**⌘Z**
Aft	**⌘2**	**Switch to km**	**⌘K**
Map	**⌘3**	**Time Compression**	**⌘T**
MMU	**⌘4**	**Orbit Advance**	**⌘O**
Low Orbital	**⌘5**	**Choose Orbit**	**⌘C**
High Orbital	**⌘6**		

[Spec] XX [Pro]

XX	Indicates	When operable
91	Test Payload Module 1	Orbit
92	Test Payload Module 2	"
93	Test Payload Module 3	"
99	Special Command	"

[Item] XX [Exec]

XX	Indicates:	When Operable
24	Roll controls enabled	Deorbit
25	Pitch controls enabled	"
26	Yaw controls enabled	"
28	Oms engines armed and pressurized	"
36	Dumping rest of propellants	"
37	Reaction Control System armed	Orbit
38	Dumping Forward propellants	Deorbit
39	Start Moving Control surfaces	Launch/deorbit
40	Cancel Moving Control Surfaces	Launch/deorbit
50	Closing cabin pressure vents	Launch
51	Cabin pressure vents opened	"
52	Helium pressure vents closed	"
53	Helium pressure vents opened	"
55	Setting for APU pre-start	"
56	Cabin relief vents enabled	"
57	Anti-skid system disabled	Deorbit
58	Anti-skid system enabled	"
59	disable nose wheel steering	"
60	enable nose wheel steering	"
61	disable entry role mode system	"
62	enable entry roll mode system	"
63	set speed brake to manual	"
64	set speed brake to auto	"
65	set throttle to manual	"
66	set throttle to automatic	"
67	set pitch to manual	"
68	set pitch to automatic	"
69	set roll/yaw to manual	"
70	set roll/yaw to automatic	"
71	set body flap to manual	"
72	set body flap to automatic	"
90	Executing Yaw + 90 degrees	Orbit
91	Executing Yaw -90 degrees	"
92	Executing Pitch +90 degrees	"
93	Executing Pitch -90 degrees	"
94	Executing Facing to the direction of velocity (i.e. Speeding up)	"
95	Executing Facing to the opposite direction of velocity (i.e. Slowing down)	"
99	Match orbits command initiated	Orbit

OPERATING INFORMATION

ORBITER requires a lot of memory and uses a lot of high level number crunching; if you use desk accessories during play be aware that this will strain the memory and slow down the operations.

For Hours Completed in the Astronaut Information box and the Orbital Angle in the Choose Orbit box, the numbers will be rounded to the nearest whole number. Some numeric displays will refresh every two or three seconds so the display will show incremental increases rather than consecutive ones.

Events such as an abort from a launch sequence may take from 5 to 10 minutes (Rota is a long way away). It depends on your altitude at the time of abort. ORBITER will revert to the landing phase when your altitude has reached 38 kilometers.

If you would like to choose only one or two of the program phases instead of all three - Launch/Orbit/Landing - you may do so when you select a New Mission.

Most automatic operations, except changing your orbital angle, may be performed manually. Manual operations require patience and practice to acquire the necessary skills.

** ERRATA - ORBITER MANUAL **

Pg. 7. Hard Disk Installation: (add.) ORBITER must be installed to a volume containing the hard drive System and Finder. Or, transfer the System and Finder to the ORBITER volume.

Pg. 9. Paragraph 3, last sentence: (chg.) The Forward Main Station will not break into quadrants prior to selecting a New Mission.

Pg.s 9-10 Last paragraph: (chg.) In order to use the panels when first booting ORBITER a New Mission must be selected from the Mission Menu.

Pg. 12. Paragraph 1, sentence 5: (chg.) You have about 10 seconds to respond to a query from Mission Control or the Computer.

Pg. 17. Paragraph 3: (chg.) The mission does not require testing the telescope.

Pg. 18. Paragraph 1: (add.) After deploying the telescope, put the arm away using Orbiter from the Arm Grabber Menu (see page 61 for Arm Grabber info.).

Pg. 20. Paragraph 1, sentence 3: (chg.) Start APU's from the Engines Panel.

Pg. 22. Paragraph 4, sentence 8: (chg.) The Map CRT will not be active during landing.

Pg. 25. Save/Load game: (add.) Saved games will not completely save to disk unless you have a single drive system or until you **Quit** the program using the **File Menu**. If you have a power failure or if the system resets during play, whatever was saved during that session may be lost.

When saving on top of a previously saved game, make sure the old name is not highlighted and that the dialog box appears asking if you want to replace the old file.

Pg. 26. Apple Menu: (add.) About Spectrum HoloByte has been added to this menu.

Pg. 40. Camera: (chg.) The camera shows only a forward view.

DEDICATION

ORBITER is dedicated to the memory of the crew of the Challenger:

Frances R. Scobee.. Commander
Michael J. Smith..... Pilot
Ellison S. Onizuka... Mission Specialist
Gregory B. Jarvis..... Payload Specialist
Ronald E. McNair..... Mission Specialist
Judith Resnik..... Mission Specialist
Christa McAuliffe..... High School Teacher
("Teacher In Space")

The Space Shuttle Challenger exploded 75 seconds after launch on January 28, 1986. There were no survivors.

NASA's shuttle system successfully launched 24 shuttle flights before the fatal Challenger explosion.

These men and women were pioneers, individuals who understood the risks associated with spaceflight. Their main objective was to enhance our knowledge of the final frontier. Space exploration will continue; we are deeply saddened that this crew's part in it ended so soon.

HOTLINE

If you have any questions or problems regarding the program or game, please send a stamped, self-addressed envelope with your questions to:

Wizardworks
5700 W. Broadway, #300-A
Minneapolis, MN 55428-3590
or call: 612-537-4085

WIZARDWORKS • MINNEAPOLIS, MINNESOTA 55416

Thank you for your purchase of another fine Wizardworks product!