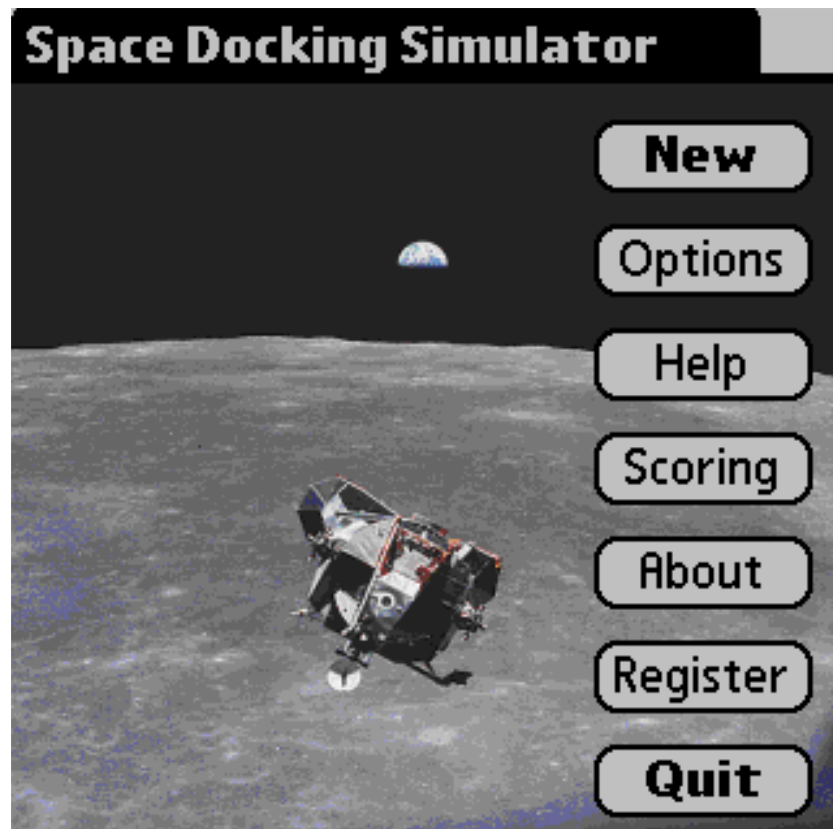


# **SPACE DOCKING SIMULATOR**



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## **I- Introduction**

### **Space Docking Simulator**

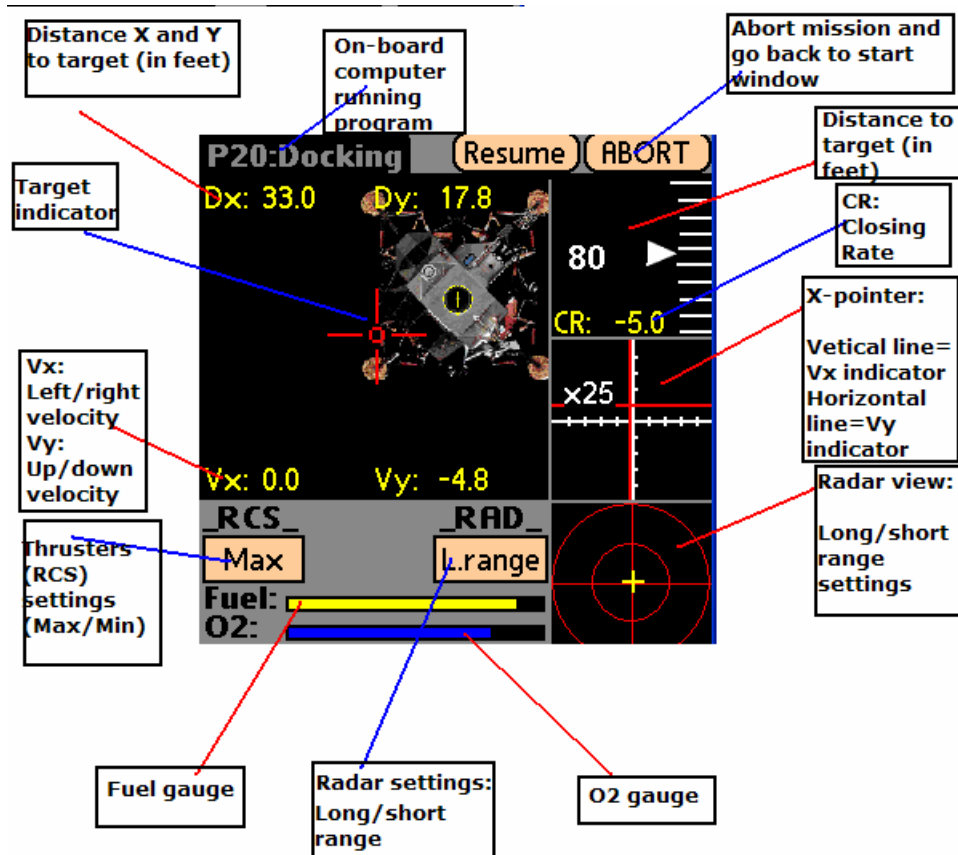
Welcome to the Space Docking Simulator, the most advanced Space Docking game for Palm/Treo devices!

We believe that Space Docking Simulator is the only game of this sort for the Palm platform. Extensive research has been employed to provide you with the most realistic simulation of a space rendez-vous on PDA. As with other sophisticated flight simulators the challenge will be in perfecting your skill. Remember, astronauts didn't learn to dock in a day and neither can you. We hope this user manual will help you make the most of your gaming experience.

Thank you.  
SimToGo.

## II- Space Docking controls/instruments description

Before you can attempt your first docking, let's review your SD Simulator controls and instruments. If you need more detailed descriptions of your spacecraft controls/instruments, please see section VI of this guide.



## SPACE DOCK SIMULATOR COCKPIT

## **Space Docking Simulator instruments and indicators**

### **1) Current running computer program**

- a. **P20:** is one of the on-board computer. "P20" will be displayed on top left of the screen during the final docking phase. P20 starts at about 500 feet from the docking target.
- b. **P50:** is one of the on-board computer. "P50" will be displayed on top left of the screen during the tracking phase of a docking. P50 starts at about 6000 feet from the docking target.

**\*\* Please note that the on-board computer does not control your spacecraft during tracking or final docking. A docking is a manual affair! The on-board computer still monitor the spacecraft well being, gather and display your relative distances and velocities to the target.**

- 2) **Distance Tape:** Display your current distance from the docking target (in Feet).
- 3) **Closing Rate:** or CR, shows how fast you are approaching the target (positive CR means you are moving toward the target). This information is coming from your docking radar.
- 4) **X-Pointer:** Displays your horizontal velocities. The red horizontal line shows your Up/Down ( $V_y$ ) speed. The vertical red line shows your lateral (left/right) velocity ( $V_x$ ). These a graphical representation of your relatives velocities to the target. You can also read the exact values for  $V_x$  and  $V_y$  on the cockpit display (in feet/sec)
- 5) **Target Indicator:** The red cross in the center of the cockpit indicate where your spacecraft is heading. You will this indicator to align your spacecraft with the target.
- 6) **Fuel Gauge:** Displays current fuel left in the tank
- 7) **O2 Gauge:** Displays current Oxygen level left in the cabine. If this gauge goes to zero means that you are dead! (game over)
- 8) **RCS:** Stands for Reaction Control System. Essentially this is your spacecraft thrusters. The RCS have two modes:

Max: This mode allows you to make large velocity changes. Unfortunately this mode uses a lot of fuel so use only when needed it. Fuel is at premium in Space Docking Simulator!

Min: This mode is used when fine velocity changes is needed. For instance when very close to the target. Also uses the least amount of fuel

9) **RADAR:** Shows the target position in front of you (X-Y). The yellow cross represents the target. The radar has two modes (long and short ranges). You can switch between these two modes using the button "RAD" on the left of the radar view. With Long range, you can "see" up to 10000 feet in front of you. Use short range when in final docking mode (about 600 feet)

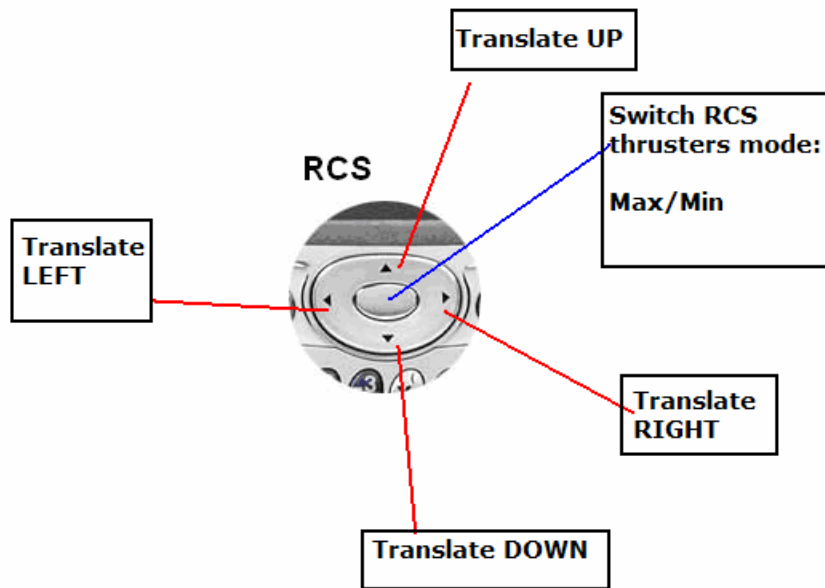
10) **Master Alarm:** This button only appears to alert you to a spacecraft malfunction. The sound can be turned off by pressing this button once (the malfunction will continue of course)

11) **RCS:** Stands for Reaction Control System. Essentially this is your spacecraft thrusters. The RCS have two modes:

Max: This mode allows you to make large velocity changes. Unfortunately this mode uses a lot of fuel so use only when needed it. Fuel is at premium in Space Docking Simulator!

Min: This mode is used when fine velocity changes is needed. For instance when very close to the target. Also uses the least amount of fuel.

The two modes are easily differentiated by not only the RCS button display but also by the sound that the thrusters will make. The sounds are very different for each mode.



To translate forward/backward, you need to use your Z thrusters. Z thrusters are control by hard keys 3 and 4 (hard key 1-2 have the same effects than 3-4)

Hard key 4: Translate forward (speed up your spacecraft toward the target). You can see the effect by looking at the distance tape and the closing rate (CR) value.

Hard key 3: Slows your spacecraft relative to the target. As with all thrusters (X,Y and Z) the effect of the thruster will depend on the RCS button mode (Max/Min).

**IMPORTANT:** Unfortunately hard keys 1-2-3-4 locations are devices depended. Usually hard keys are numbered from left to right. So hard key 3 and 4 are usual located on the bottom right side of the device. For instance:

Palm TREO 650:

Hard key 3= Email button

Hard Key 4= Red Phone on/off button

Palm Tungsten C:

Hard Key3= Email button

Hard key 4= Web button

Because of that, a little bit of experimentation will be needed to find the correct two buttons that controls your forward/backward RCS thruster.

### III- Quick Start Guide

Now that you familiarized yourself with your spacecraft controls and instruments, it is time to go for a ride!

The goal of the game is to:

- Dock with the target as softly as possible (small  $V_x, V_y$  and CR)
- Dock as close as possible to the center of the target (small  $D_x, D_y$ )
- with as much fuel/O<sub>2</sub> as possible in the tanks.

All these variables will be taken into account for your final score.

1- Launch the application by clicking on the SpaceDock Simulator icon:

**Note:** You can access a much shorter version of this user manual directly on your Palm by tapping on the **i** icon on the top right of the main screen.

Here are your starting conditions

The default mission is the “Docking Phase”. You can change SD Sim game options like mission type, game and sound levels by clicking on “Options” button (main screen).

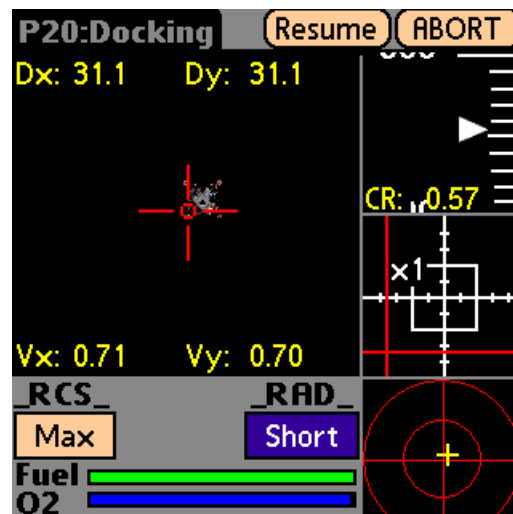


The game starts with the following initial conditions:

- game level: Rookie
- Sound Level: 50%
- Distance to target: 600 ft
- Closing Rate: less than 1 ft/s
- Horizontal velocities ( $V_x$  &  $V_y$ ): few feet/sec
- RCS mode = Max
- Program running : P20 (docking phase)
- RAD(ar) mode= Short (short range)
- Fuel level: 100%

**IMPORTANT:** All your velocities (CR,  $V_x$  and  $V_y$ ) and distances ( $D_x$ ,  $D_y$ ) are **RELATIVE** to your target. So for instance if you have a Closing Rate CR of 5 feet/sec, then this means that the speed difference between your spacecraft and the target is 5 feet/sec. You could both be going at 20000 feet/sec but your relative speed is still 5 feet/sec. The docking radar can only show relative distances and speeds. By the way, positive CR means you are approaching the target at 5 feet/sec.

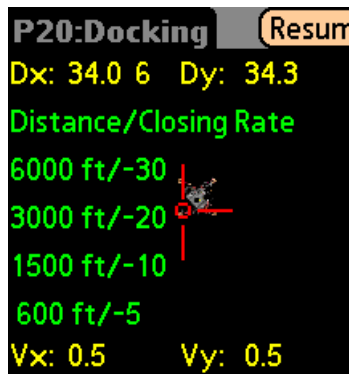
2- Press the “NEW” button



- 3- The cockpit above will be displayed and you will hear CapCom ( the **Capsule Communication** officer in Houston) say “**Houston, we ready for docking**” and “**roger that**”.
- 4- At any time during the descent, you can abort the mission and come back to the main screen by pressing the **ABORT** button on the top right of the screen. The mission will auto-save. You can go back to where you left off later (Resume button) or start a new mission (New button). To exit the



game you either need to abort or pause the game and then exit the app by pressing the HOME button on your Palm/Treo. You can also display a “flight plan”. This is just a list of actual closing rates taken from NASA documents. It allows to judge how fast you should be going while approaching the target (distance versus closing rate). You can trigger the “flight plan” by simply tapping the cockpit window area (stylus or finger). You can flight the all mission with the “flight plan” displayed if you wish to. To turn it off, tap the screen again.



- 5- The target will be visible around the center of the cockpit. You are in “station keeping” mode. This means that the target (lunar lander) is just floating around waiting for you to move in. Press Key 4 (thrust forward) to increase your closing rate. Monitor your closing rate on the top right instrument display:

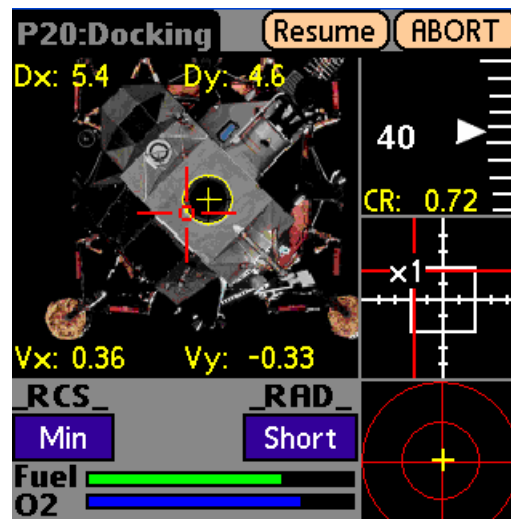


- 6- Once you are about one or two hundred feet from the target, slowly reduce your closing rate (approach velocity) by clicking on Key 3 (see above)
- 7- First aim for the center of the target by using your RCS thrusters X and Y. Try to place the target in the center of the red cross on your cockpit. Again, the X and Y thrusters are control by the 5-ways pad on your Palm device.

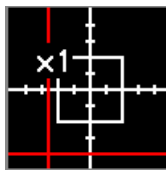
**IMPORTANT:** Try not to use too much fuel since fuel is at a premium in Space Docking Simulator. This point is really more critical in “Pilot” and “Commander” game modes. In these modes, you will not get 100% fuel level

like you do in “Rookie” game mode. Do not worry about O2 (oxygen level) in “Rookie” mode since you will have plenty to finish the docking mission. We cannot promise that you will have enough oxygen to finish your mission in “Pilot” or “Commander” level (hint: O2 leak!)

- 8- Once you are close enough, you will see a yellow cross on the center of the target. Try to match your spacecraft red cross with the yellow cross of the target. Again watch your fuel consumption (use RCS **Min** mode as much as possible)



- 9- Let your spacecraft slowly approach the target spacecraft. Watch your closing rate, your horizontal velocities ( $V_x$ ,  $V_y$ ). Use the X-pointer to quickly judge your up/down and left/right velocities. Make sure the X-pointer scale is 1 (x1) when you are very close to the target.

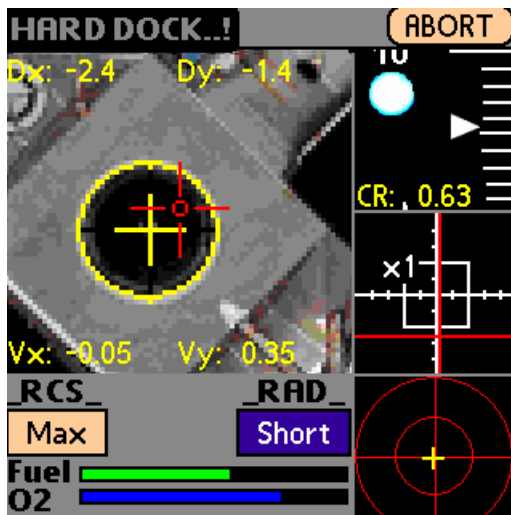


← X-pointer (scale= 1, you are going left and down)

- 10- Once you are about 6 feet from the target, a contact probe will let you know that you are very close. You will hear CapCom calls out “contact light” and a indicator light will flash on the “distance tape”
- 11- Few seconds later, if you docked successfully, you will hear a scrapping sound followed by about 12 explosives sounds in rapid succession. This is

your cue that a “hard dock” has been achieved. Houston will then congratulate you for a job well done!

12- Once you touchdown, there are 4 possible outcomes



← “Houston, we have a hard dock!”

#### A: Successfully docking With the Target

To make a successful docking, you will need:

- **Closing Rate < 1 feet/sec**
- **Speeds Vx and Vy < +/-1 feet/sec**
- **Distances Dx and Dy < +/- 5 feet**

If you successfully dock then NASA CapCom will congratulate you and will then be taken to the results window. That window will show you the mission results and your final score.

#### B: Bouncing Back from the Target

If your distances Dx and Dy are higher than 5 feet (but lower than 30 feet which is the target diameter) AND all your velocities are good (<1 feet/sec) then the target will “bounce” back. This is not considered a mission failure but you will need to re-approach the target and try again. Of course this will use more fuel and will reduce your final score.

### C: Crash Onto the Target

If any of your speeds (Vx, Vy or CR) are higher than 1 feet/sec AND your distance Dx or Dy are lower than 30 feet (the diameter of the target spacecraft) then this will be considered a crash and you will not receive any points. You will be taken to the results window to learn what went wrong and hopefully learn from the crash!

### D: Missing the Target

If any of your distance Dx or Dy are higher than 30 feet (the diameter of the target spacecraft) then this will be considered a miss (missing the target) and of course you will not receive any points. You will hear NASA CapCom indicating that you were unable to make the docking and then will be taken to the results window.

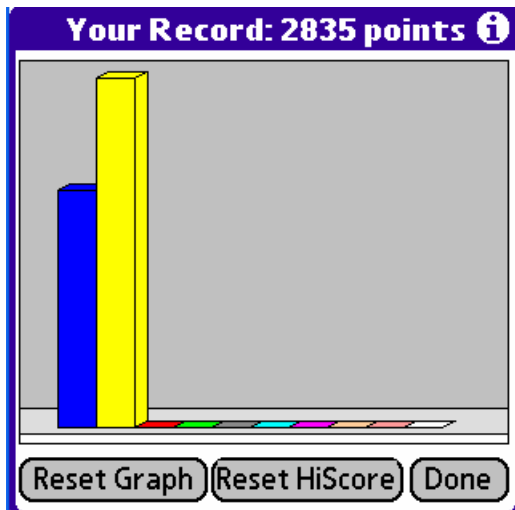
#### **GOOD!**

<b>Highest Score: 4571 points</b>		
<b>Flight Data</b>		<b>Score</b>
Vel Z (ft/s):	-0.7	152
Vel X (ft/s):	-0.2	475
Vel Y (ft/s):	-0.6	165
Dist X (ft):	-0.9	116
Dist Y (ft):	-1.4	73
Fuel Left(%):	71.8	3590
Bonus Points:		0
<b>Your Score</b>		
4571		<input type="button" value="Done"/>

#### **BAD! (very bad)**

<b>MISSION FAILED!</b>		
<b>Flight Data</b>		<b>Status</b>
Vel Z (ft/s):	-5.0	FAIL
Vel X (ft/s):	-5.5	FAIL
Vel Y (ft/s):	-3.5	FAIL
Dist X (ft):	-29.0	FAIL
Dist Y (ft):	-14.7	FAIL
Fuel Left(%):	85.6	OK
Note: You crashed onto the target!		
<b>Your Score</b>		
0		<input type="button" value="Done"/>

You can also keep track (overtime) of your progress as an astronaut by clicking on the button “Scoring” on the main window (start screen):



This window shows your 10 past scores (as well as the game level). Just click on colored bar with your stylus to display the score. ROK, PLT,CMD stand for Rookie, Pilot and Commander respectively. You can reset (delete) all the scores or the highest score. Please note that action cannot be undone. Since the window can only keep track of your past 10 scores, you will notice that once you have 10 successful docking, the all graph will shift to the left. This means that you will lose the first score (on the left). Still, it is a good way to keep track of your progress.

## IV- Game Levels and missions

Currently in Space Docking Simulator, you have a choice of three game levels:

### Rookie

In this first level:

1. Your spacecraft sub-systems failures are disabled
2. The location and velocities of the target and your spacecraft are always the same
3. the fuel depletes more slowly than at other levels

This level was specifically designed to allow you the time to concentrate on developing your docking skills rather than focusing on fuel level or spacecraft malfunctions.

### Pilot

This intermediate level feels more like the real thing. All initial conditions are different on each mission. This includes:

1. fuel level
2. target location
3. initial velocities and distances

In addition, there is a likelihood that some of your spacecraft subsystems would fail during the docking. Some of those failures are recoverable. One example is a leak in the fuel tank. This will of course reduce the amount of fuel available for landing requiring you to land quickly.

Other failures may be fatal. For instance, if one the thruster decide to act up (get stuck open) very close to the target then you may crash onto the target. Please note that most sub-system failures last only for a few seconds but some can last up to a minute or more (especially in game level three). Your spacecraft sub-system failures will happen randomly during your docking while in game level 2 or 3 realistically providing you with a new mission each time.

### Commander

This level is not for the faint of heart. Initial conditions can vary much more and failures will happen much more frequently and last longer. To add to an already difficult level, the fuel will deplete faster than in the two first levels which will force you to watch that fuel gauge more closely. While you may want to start with this level we strongly suggest you master the lower levels of this game first.

There are also two missions you can choose from. Here a quick description of each mission:

#### (Final) Docking Mission

This is the default mission. In this mission, your initial conditions are:

- game level: Rookie
- Sound Level: 50%
- Distance to target: 500 feet
- Closing Rate: - 5 feet/sec
- Vx and Vy velocities: few feet/s
- RCS thrusters mode = Max
- Program running : P20 (final docking phase)

- Radar Range = Long
- Fuel level: 100%

### Tracking Phase

This mission will put the target further out and the goal is to adjust your thrusters to align your spacecraft with the target. Once you are about 500 feet from the target then you can initiate the final docking phase as normal (see above). Of course this phase is very demanding in terms of fuel so you will start up with about twice the fuel amount that you received in the default mission (final docking). Here your initial conditions for this mission:

- game level: Rookie
- Sound Level: 50%
- Distance to target: 4500 feet
- Closing Rate: - 10 feet/sec
- Vx and Vy velocities: few feet/s
- RCS thrusters mode = Max
- Program running : P50 (tracking phase)
- Radar Range = Long
- Fuel level: 100% (but twice as in the docking phase)

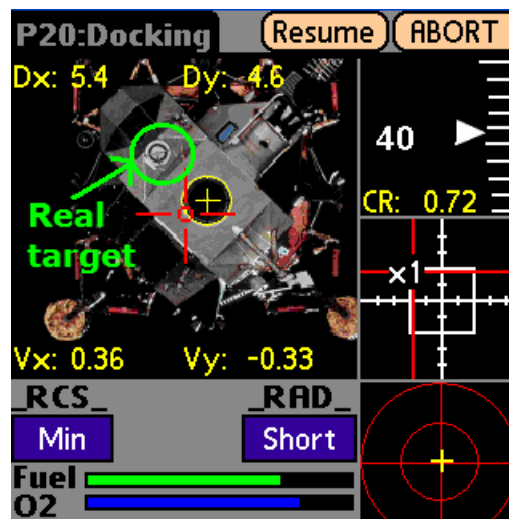
## V- The Space Docking Process

If you are interested in the “mechanics” of a real rendez-vous and docking, we would like to suggest the excellent essay by Frank O’Brian at the following URL:

<http://history.nasa.gov/afj/loressay.htm>

In Space Docking Simulator and for the sake of simplification (after all this a game!) we do not take into account orbital mechanics. The two spacecrafts (yours and the target) are considered to be floating in space away from any planetary bodies like the Moon or Earth. So for instance in the real world, changing your forward velocity will affect your orbit (altitude). As explained in the link above (essay) this fact of course is used when two spacecrafts need to play “catch up” with each other. Fortunately in Space Docking Simulator, you will not have deal with such difficulties.

IMPORTANT: For the space buffs out there, you will notice in the default target (Lunar module) that the target is at the center of the lander. In reality that was the location of the docking tunnel! The astronauts did not target that location but used a special target as seen on the picture below (left):



If look carefully on the picture on the right (simulator game) you will also notice the real target on the top left of the picture. To make the approaching lander a little bit more impressive and to simplify the game, we have decided to aim for the docking tunnel instead!



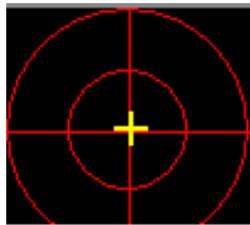
## VI- Spacecraft Sub-Systems Description

To help you successfully dock, you will need instruments to monitor your flight, a propulsion system to change your trajectory.

Here is a more complete description of instruments, controls and systems that you have at your disposal in Space Docking Simulator.

### Instruments and indicators

#### Docking Radar



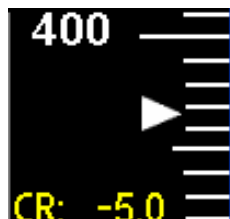
The docking radar shows the target location in front of you. The yellow cross is the target spacecraft. The radar has two modes:

Long Range: You can detect the location of the target up to 10,000 in front of you.

Short Range: This radar mode can be used when you are very close to the target.

You can switch between these modes simply by clicking on the RAD button located on the left side of the radar display..

#### Distance Tape



Located on the top right side of the screen, this instrument relays your distance to the target from the docking radar. It is called a tape because originally it was

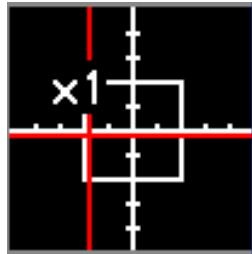
basically a long piece of tape with markings scrolling up or down. The white arrow indicates your current distance to the target.

The number in yellow (CR) at the bottom of the tape is your closing rate (if that speed is negative then you are approaching the target)

### **Contact Light indicator**

This indicator, also located on the distance tape screen, illuminates when you reach 6 feet from the target. This sensor goal is to signal you that you are about to dock. You should make sure your docking conditions are meet when you see this indicator.

### **X-Pointer**

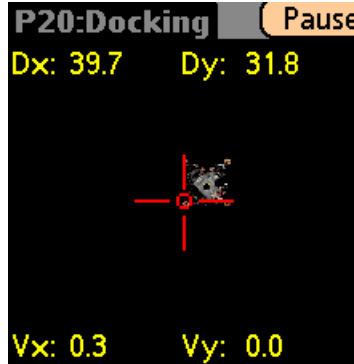


Located just below the distance tape is the X-pointer. This instrument graphically displays your horizontal velocities ( $V_x$  and  $V_y$ ). This data is also coming from your docking radar. The red horizontal line is your up/down velocity ( $V_y$ ). The line is above zero when you are going up and below zero when going down. You can also read your  $V_y$  velocity on the cockpit window

The vertical red line is your left/right velocity (left or right speed). So for instance, if you are drifting right then the vertical red line will be shown to the right of the white center line.

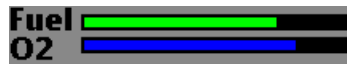
The X-pointer has two scales (X1 and X25). The scale will automatically switch from X1 to X25 if any of your velocity becomes higher than  $\pm 1$  feet/sec. You need to be on X1 scale at contact to make a successful docking.

## Target Indicator



The red cross circle at the center is your cockpit is your heading. This indicator helps align and dock with the target. The target also has a similar cross (visible on the target only when you are close enough). To dock successfully you will need to match those two target indicators using your spacecraft thrusters.

## Fuel and O2 Level indicators



The bargraph at the top shows you the amount fuel left in your tank (in percentage of maximum fuel). Please note that in "Pilot" and "Commander" game modes, the fuel amount will be different for each mission. When the fuel tank level goes below 10%, the color of the fuel-level number will change from green to red and you will hear CapCom saying "**low level**". This means that you limited amount of fuel to finish your docking.

The bottom graph is the O2 (oxygen) level. In normal situation (no system failures), the rate of O2 consumption is slow and so you should be able to dock w/o time constraint. In Pilot and Commander levels, the rate can increase dramatically and so may force to speed up your docking. Of course if you run out of oxygen before docking then you are dead and it is game over!

In any game levels, the score you get depends on the fuel and O2 amount left in the tanks at docking. So make sure you do not use too much fuel or O2 during the docking.

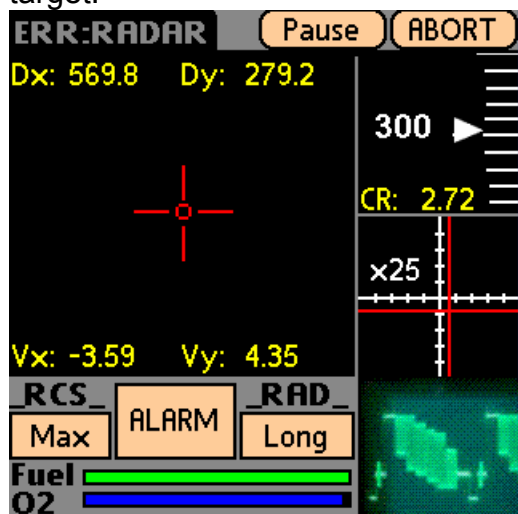
## Master Alarm indicator



Yet another invisible indicator, this audio warning will indicate that the spacecraft computer has detected an anomaly with one of the spacecraft sub-systems (fuel tank, main engine, RCS thrusters and so on). The computer will also display a short description of the failure such as “**FAIL:Thrusters**” or “**FAIL:fuel tank leak**” in top left of the screen. To stop the loud siren sound just press the “Master Alarm” button once. The button will turn blue. Of course this action will not stop the failure which you will still need to cope with. Here are some of the failures you may encounter and what you can do about them:

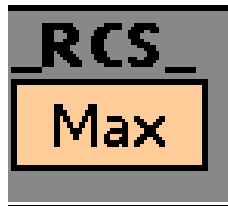
- **Fuel leak:** Every second that this alarm is on, the fuel will deplete a little faster than normal. Hope it won't happen while you are low on fuel and very close to the target!
- **Engine:** This alarm indicates that there is something wrong with the descent engine (DPS). This failure will bring the engine down to 0% for a short period of time (engine shutdown). You can compensate by going in manual mode (DPS=MAN) and increasing the engine thrust yourself after the malfunction stops.
- **Thrusters:** RCS thrusters may get stuck and will change the attitude of your spacecraft. You can compensate for this effect by using the opposite thruster. So for instance, if the spacecraft seems to go up, you can try to go down using the “down” thruster (5-ways pad). Same for left/right or forward/backward.
- **False alarm:** No need for explanation! Sometimes the alarm sound even so everything seems nominal. That 's a false alarm!

Here is a screen shot of a failure: In this example you just have lost the radar display. In this case it is not a fatal failure since you are close enough to see the target!



←Radar display failure!

## Propulsion/Attitude Control



To approach align and dock with the target, your spacecraft is equipped with a series of thrusters called RCS (Reaction Control System). These are small rocket engines placed around the spacecraft. They allow to make translation movement (up/down, left/right and forward/backward). Since sometimes you can be far away from the target and need to do large distance corrections, the RCS has two modes. "Max" mode can be used when you have to make large distance correction (ie: far away from the target). Be careful of this mod since you thrusters will be asked to provide a large thrust and so will use a large amount of your precious fuel). When you are very close to the target, you can switch the RCS mode to "Min". In this mode the fuel depletes much slower than in the Max mode.

## **VII- Frequently Asked Questions**

Here some answers to questions you may have about the game.

**Q:** Can I pause the game?

**A:** Yes. During a docking mission, just click on the top of the screen. The game will be paused and the button will change to “Resume”. At this time, you will be able to go back to the main window (click Abort). Once in the main window, you will be able to start new mission (or resume the current mission), change game settings or simply exit the application (Quit). Or you can simply click on “Resume” to continue the mission.

**Q:** Why are my Palm keys disabled during game play?

**A:** This is needed to keep the device from exiting the game while you are playing. If you need to exit the application, first press the ABORT button.

**Q:** How often do the malfunctions happen during a game?

**A:** In the Pilot mode they are not frequent but occur from time to time. In the Commander level, you may experience multiple failures during a single mission. You can actually disabled the failures completely not matter the game level. To do that, open the options window and uncheck the box labeled “Enable Failures”. You have now a “perfect spacecraft”!

## **VIII- Registration and Support Information**

You can register Space Docking Simulator at the site where you downloaded this copy. There you will also find the developer (SimToGo) contact information which you can use if you need assistance with the game registration or have any comments/suggestions about this application.

With Space Docking Simulator loaded on your Palm/Treo device, you are now ready to have fun docking anywhere and anytime.

Thank you for your support and enjoy **SPACE DOCKING SIMULATOR**

**SimToGo**