Management of the Crater Gusev "Redrover Goes To Mars" Mars Station at the Centro de Astrobiología in Madrid

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Red Rover, Red Rover…
Send Jackie[*] on over…

-- Command given during a
game of player-exchange,
played by teams of children

[*] During the Redrover game, children
can say whichever child's name that they prefer.

Much of this management manual is a photo-essay. We have prepared these sections:

Daily Checklist for Crater Gusev Mars Station Managers

1) Perform turning test for both Rovers.

 Turn each rover leftwards and then rightwards with the web browser from its console (preferably not by internet). Watch the webcam display in the browser to ensure that the camera and software are working well. Listen to the sounds the rover is making and monitor the rover's movement, to make sure the mechanical systems are working OK. Fix mechanical or software problems as they occur. Fix any overturns or tether cable problems with each rover. Sometimes this needs to be done more than once per day.

2) Check that the Redrover web server software is working

  This is most easily checked by logging in from the Microsoft Explorer Web Browser on the console of each machine, and driving a little. Don't use the Redrover GUI program to test the Redrover software; driving with the GUI does not allow the manager to easily test the Redrover web server software. The manager might want to test periodically (through the day or week) from a remote connection (in the manager's office or outside of CAB) to see that everything is working fine remotely. Sometimes this needs to be done more than once per day.

   If there are software problems, then:

> A) First, shutdown the server program (right mouse click on the little RR icon in the Microsoft Windows tool bar, and then exit);
> B) Second, reboot the computer;
> C) Third, before the computer finishes rebooting, turn the yellow RCX brick back on, by pushing the red button on the yellow RCX box;
> D) Fourth, after the computer has rebooted, a browser window should appear; make sure you're on the home page for the rover (press the "home" button if the browser is not on the home page);
> E) Fifth, test drive the rover a little with the Microsoft Internet Explorer browser interface, to make sure everything is working.

3) Study the message logs for each rover

  By studying the message logs, the manager can see if the users are complaining about problems, and the manager can also see if there is excessive use of foul language (retaining such excessive foul language is probably not a good idea, since children drive these rovers too).

   Sometimes the manager will need to shutdown the Redrover server program and then edit out the foul language with a text editor (the files are in the C:*Archivos de Programs/Redrover4.531/Temp* directory),
 and then restart the Redrover server program.

4) In the complete logs, count the numbers of drivers in the last day

  Write this count down, in the back of the blue administrator's log book that should be on the table of the MarsStation. By studying the log files and counting the numbers of drivers, the manager will see how much the system has been used, and record this use historically. This is useful for psychological purposes for the manager. But also, if the

number of drivers gets too low, then some advertising or other techniques can be used to attract more drivers.

5) *Check on the number of Internet-address cards in the red box*
   If the supply is running low, then get some more.

6) *Try to do something weekly to improve the system*
   This is what any good systems manager should do. But always try to leave the system so that it is working at least as good as before. Some examples of things that could be improved:
   A) Replace outdated or inadequate imagery on the walls of the diorama;
   B) Replace the IR/RCX motor control system with an interface box;
   C) Improve the tether cable system so that the drivers can driver better with the tether cables;
   D) Replace the cameras with wireless cameras, such as are available at http://X10.com , resold by Miguel Motos at DECOM in Valencia for less than 300 Euros;
   E) Change the design of the rovers so they drive better;
   F) Fix remaining software bugs in the internal Redrover engine, in conjunction w Csaba Gyulai at Visionary Products, Inc.;
   G) Change the LEGO decorations or obstacles in the diorama.
   H) Improve the Javascript for the outer shell of the Redrover, either for the message passing between the rovers, or for the skyview camera;
   I) Translate the Redrover website to Spanish;
   J) Add better documents and images to the Configuration of the Mars Station, so that people know more about the Crater Gusev or the Rovers Atenea and Hermes.

7) *Interact with the drivers who are logging in remotely to drive Atenea or Hermes*
   This can be done by writing instant messages to any remote drivers who might be driving the system at the same time as you are managing the system. Try to excite them about the system. Maybe do some cooperative activity between the two rovers, driving the 2nd rover while some remote driver is driving the 1st rover.

History of the:
Planetary Society's "Redrover goes to Mars" Project at CAB

The Planetary Society (headquarters in California) developed Mars Station and Redrover concepts over the past few years, together with LEGO Corp. (headquarters in Denmark) and Visionary Products, Inc (Utah). The Mars Station concept basically consists of a diorama of Mars. The Redrover concept basically consists of a Mars Station robotic rover, made out of LEGO parts and webcam, which is maneuverable through computer control. For some time, the Planetary Society has been using a Redrover Mars Station in their headquarters, as a local and portable public outreach tool, either inspiring visitors to their headquarters or inspiring crowds of students at science fairs and schools.

Before the end of 2001, the Director of Projects for the Planetary Society, Bruce Betts, contacted the director of the Centro de Astrobiología, Juan Pérez Mercader, in order to discuss a new concept with Prof. Pérez Mercader. This was the "Redrover *goes to Mars*" concept. This "Redrover goes to Mars" program was composed of several parts, including:
1) Adding internet-driving capabilities to the Redrover software, and creating several Mars Stations around the world, one of which was the Mars Station at the Centro de Astrobiología in Madrid:
   http://redrovergoestomars.org/drive.html
2) Creating two characters, Sandy Stardust & Biff Starling to write diary entries in the new Martian e-chronicle, "Astrobot Diaries":
   http://redrovergoestomars.org/astrobots/
3) Sending a DVD with each of the Opportunity and Spirit rovers, with the names of all the Planetary Society Members recorded on it, and with images of Sandy and Biff on the DVD. See:
   http://redrovergoestomars.org/dvd.html
4) Conducting an international contest to select student astronauts; among the final winners was Spain's own Tomás Kogan:
   http://redrovergoestomars.org/studast.html

In the summer of 2002, Director Pérez Mercader recruited Dr. Patrick McGuire to manage the Mars Station at the Centro de Astrobiología. He also recruited Dr. Jesus Martinez Frias to manage the student astronaut contest; Martinez Frias is also the Spanish coordinator of the Planetary Society. The Centro de Astrobiología does not have much involvement in the other two parts of the "Redrover goes to Mars" program (neither the Astrobot Diaries nor the DVD that was sent to Mars).

With regards to the Mars Station at the Centro de Astrobiología, much help along the way has come from: Dr. David Fernandez Remolar, Jose Antonio Rodriguez Manfredi, Kai Neuffer, Dr. Antonio Giaquinta, Dr. Alain Lepinette, Fernando Camps Martinez, and the

management teams of both the Centro de Astrobiología and the Computer Services Group at INTA.

GENERAL SYSTEMS OVERVIEW

Figure 1)

Two images showing the general layout of the Crater Gusev Mars Station. In the image on the left, the south rim of the main crater at Gusev is at the bottom of the image, and the putative water channel leaves the southeast part of the main crater, in the lower left side of this image. A small auxiliary crater with white "mineral" deposits is on the lower right. Some of the images taken by the currently-active Spirit Mars Exploration Rover (MER) are visible on the walls of the diorama..

In both of the images (left and right), the two rovers are shown, and their tether cables for communication from the rovers to and from the computers are shown. In the image on the right, the webcams of each of the two telerobotic rovers are visible. These webcams are useful for identifying the two rovers. The rover with a blue-topped webcam was formerly known as "Bluehair", but has recently been renamed by IES Las Veredillas students as "Atenea". The rover with the blue-bottomed webcam was formerly known as "Bluebeard", but has been renamed by the same IES Las Veredillas students as "Hermes". The way I remember the new names, is that the male god, Hermes, could have had a blue beard, and that the female god, Atenea, could have had blue hair.
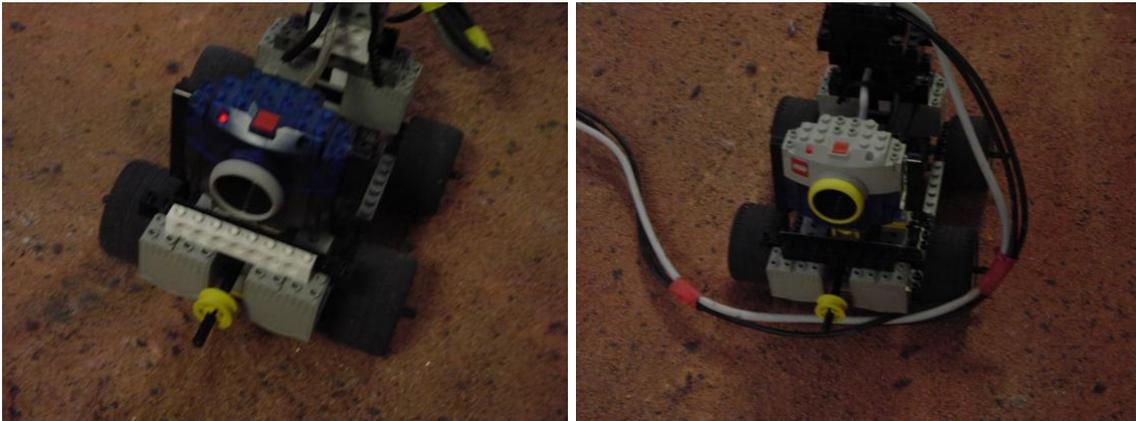
Figure 2)

Close-ups of *Atenea (*Bluehair) on the left. Atenea is more than a year older than her clone, *Hermes* (Bluebeard), shown on the right.

Hermes still has some things to learn, since he has his tether cable in an awkward position in this image. This is a bad position for Hermes' tether cable, since if the remote driver does not realize that the tether cable is in this position, and if the remote driver drives forward, then the remote driver will probably drive Hermes over his tether cable. When the tether cable has been driven over, the tether cable under Hermes could then cause Hermes to get stuck.

Both rovers have gray blocks in the front, which serve as counterweights to try to prevent the Rover from getting tipped over. The rover often tips over backwards, so that its camera is pointing straight up. Such backward tip-overs are normally caused by the tether cable dragging too much, which gives some torque that pulls the top part of the rover backwards.

The Yellow disk on the black rod sticking out of the rover is not part of a jousting stick, but rather it is a knob. This yellow knob allows the Mars Station Administrator to control the tip angle of the cameras. Changing the tip angle of the cameras is useful, if the drivers or the Administrator want to change the Crater Gusev Mars Station experience, from being a heads-up experience, sensing the distant environment, to being a heads-down experience, trying to explore the nearby "geological" environment.
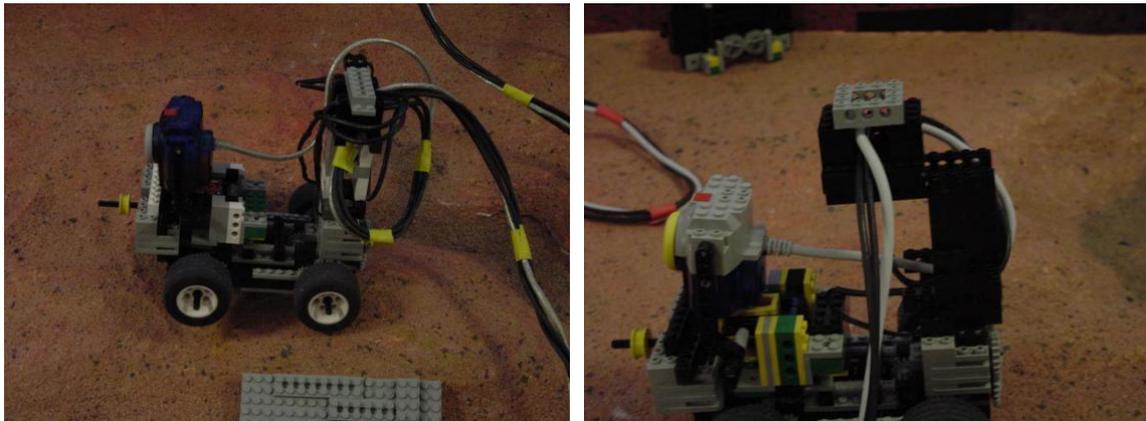
Figure 3)

Side views of Atenea (on the left) and Hermes (on the right). The current configuration of the tether cable for each rover is shown. A tower supports the tether cable, so that it leaves the rover at some distance above the ground. If the tether cable left the rover at a position that was closer to the ground, then the rover would run over the tether cable much more frequently.

I personally prefer that the tether cables would exit the top of the tower in a direction to the left or right of the rover (not in a frontwards or backwards direction). In the images above, Rover Atenea in her current configuration has her tether cable leaving the rover in the non-preferred backwards direction from the top of the tower; and Rover Hermes in his current configuration has his tether leaving the rover in the preferred leftwards direction from the top of the tower. I prefer left or right exits of the tether cable from the top of the tower, because I believe that the rover runs over its tether cable less frequently when it exits the tower from left or right, than when it leaves the tower from the front or back.
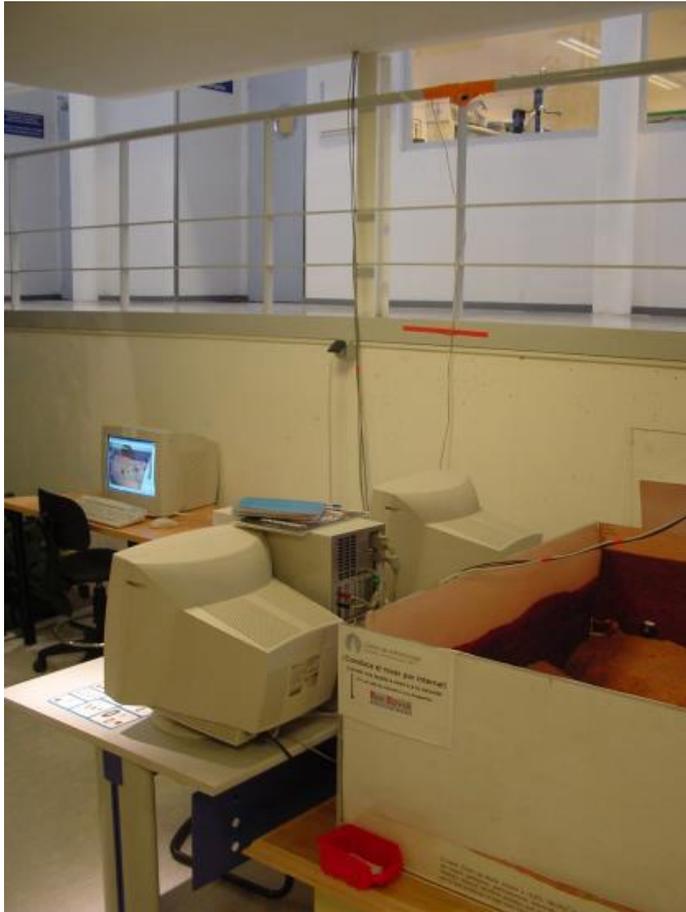
Figure 4)

This image shows the "Gusev East" portion of the diorama, together with the 3 PC workstations which comprise the control stations for the Crater Gusev internet-capable MarsStation. Also visible are the "Skyview" webcam, supported by orange masking tape at the top of the image, and the red box of internet-address cards at the bottom of the image.

The computer to the far left, whose screen is visible in this image, is the computer which controls the Skyview webcam, and which transmits the Skyview webcams over the internet to remote drivers. This skyview perspective can be very useful to the drivers, so that they have some bearings for their Gusev explorations, and so that they can avoid accidents (which means less time fixing accidents for us at CAB).

The computer, whose monitor is to the right, is the computer which controls the Rover Atenea. And the computer in the middle, whose CPU and monitor are both together on the table, and which is closest to the person who took this picture, is the computer which controls Rover Hermes.

Figure 5)

The computers for the two rovers Atenea and Hermes (on the left and right, respectively). The homepage for the Redrover software is in the state in which it should be , when it is waiting for users. Normally, there should be two chairs here, to accommodate two drivers. Between the CPU for Hermes (to the left of the right-most monitor) and the monitor for Atenea (the left-most monitor) is the IR communication channel for Hermes.

This IR communication channel for Hermes transmits information from Hermes' CPU through the IR transmitter in a black and brown box (to the right side, masked with green tape) to the RCX yellow box (to the left side of the IR transmitter). The IR transmitter should always face the yellow RCX, for otherwise the motor-control signals would not reach the rover in the diorama.

There is another IR transmitter box and yellow RCX box for Atenea, on the top of Atenea's CPU. Atenea's CPU is on the floor, to the far left.

Figure 6)

Here is a close-up of the IR commlink for Hermes, as discussed in the caption to Figure 5. The black and brown box on the right sends IR signals (originally from the serial port on Hermes' CPU) to the yellow RCX box on the left. The yellow RCX box then converts these signals to motor commands, which are then sent over cables to the rovers.

Significant system complexity could be eliminated if this IR link could be replaced by another device, called an interface box. But I have not done this. Both of these two boxes require external power of different types, and the power cables are shown connecting to each of these two boxes in this figure.

Figure 7)
   One of the two existing power strips for the system, which is currently located to the left of the CPU for Atenea. The black converter on the left-hand side is one of the two power converters for the two sets of two IR/RCX boxes. The other black power converter is currently just to the right of this power strip. Sometimes (but very rarely), both of these two black power converters need to be unplugged and plugged-back-in, in order to get the IR/RCX transmission to function.

MANAGEMENT of the MECHANICAL ASPECTS of the ROVERS
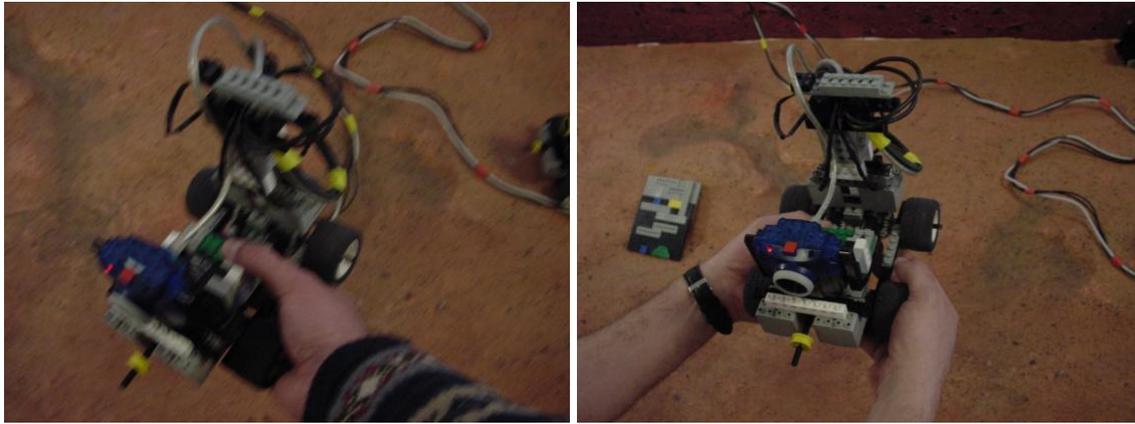
BAD
(1 HAND)

GOOD
(2 HANDS)

Figure 8)

The image on the left side shows the wrong way to pick up a rover. The image on the rght side is the right way. The rovers are *fragile*!
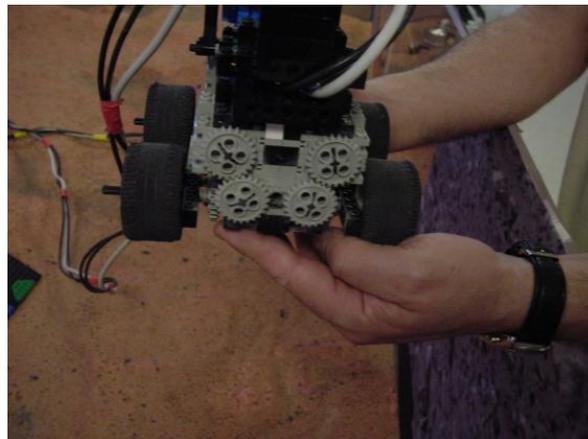
Figure 9)

The back side of one of the rovers, showing the proper interlocking of the gears of the motors of the rover. Sometimes the motors fall apart, and the manager needs to put them back together.
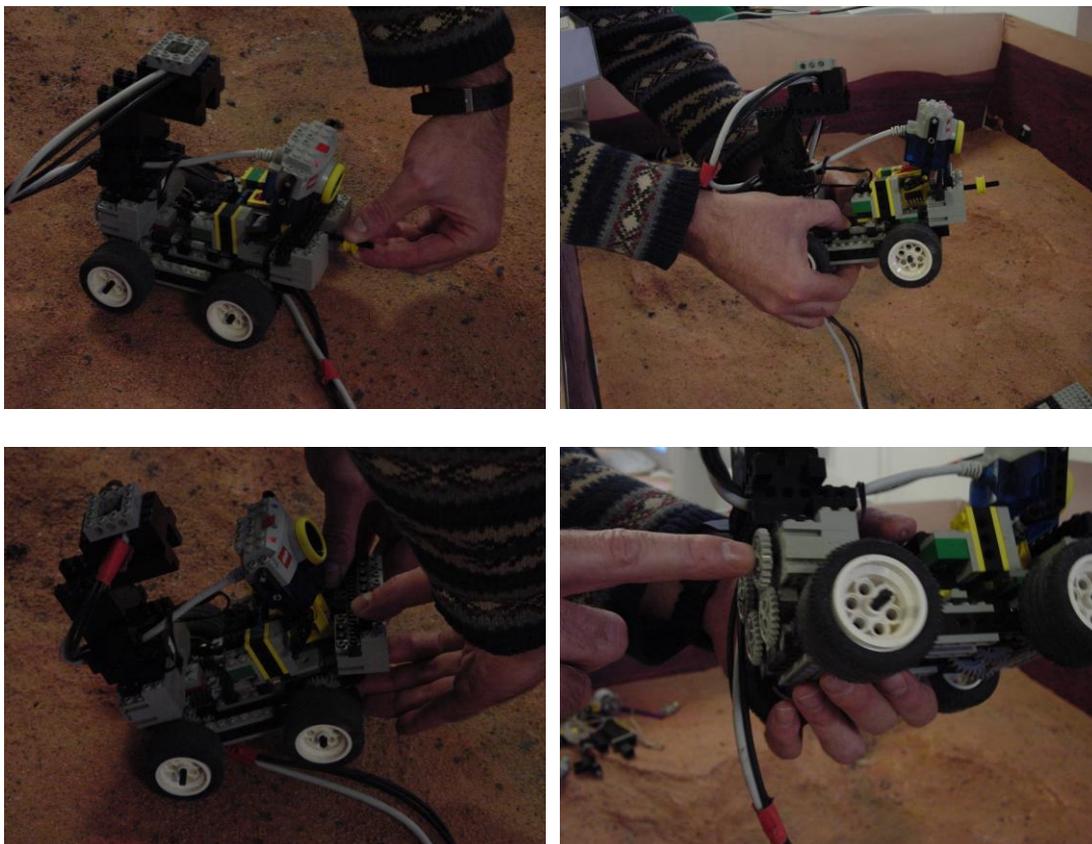
Figure 10)

Four figures showing some common adjustments or fixes that need to be a applied to a rover. It's always good to take a test drive of the rover, after changes like these.

Upper Left: Changing the tilt of the webcam with the yellow knob.

Upper Right: Pressing the bricks of the under-chassis together with thumbs and fingers.

Lower Left: Reattaching the forward weights (this takes some practice and thinking).

Lower Right: Pushing one of the gears back, so that it interlocks with the other gear.
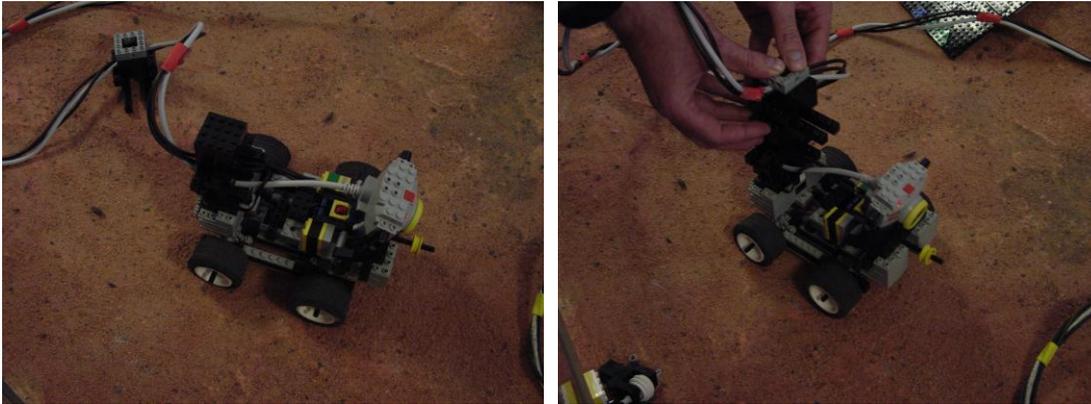
Figure 11)

On the left, the tower for the tether cable has fallen off of Hermes. On the right, the manager is reattaching the tower to the tether cable. This takes some practice and some care.

After this change, the manager should try to make sure the rover drives OK, by driving the rover with the Microsoft Internet Explorer Browser interface to the Redrover program.
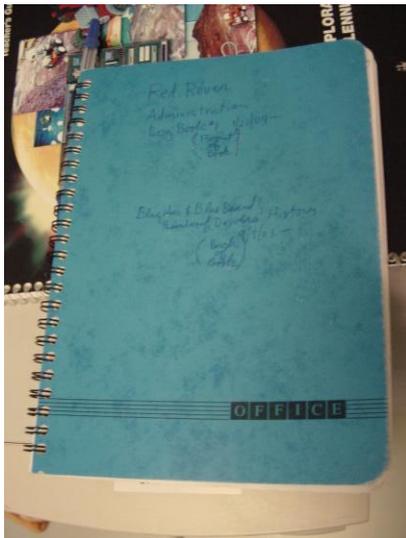
Figure 12)

It's a good idea to write down everything that the manager does to the Mars Station, whether it be mechanical, software, artistic or philosophical. That way the same manager or the next manager can remember what has been done previously. Sometimes things that the manager tries one day or one week will work, and sometimes they won't. It's good to write this stuff down, so that we learn from experience.

Management of Software Aspects of Mars Station Crater Gusev

For a brief version of some for the more important aspects of software management, see the 1st section "Daily Checklist" of this document.
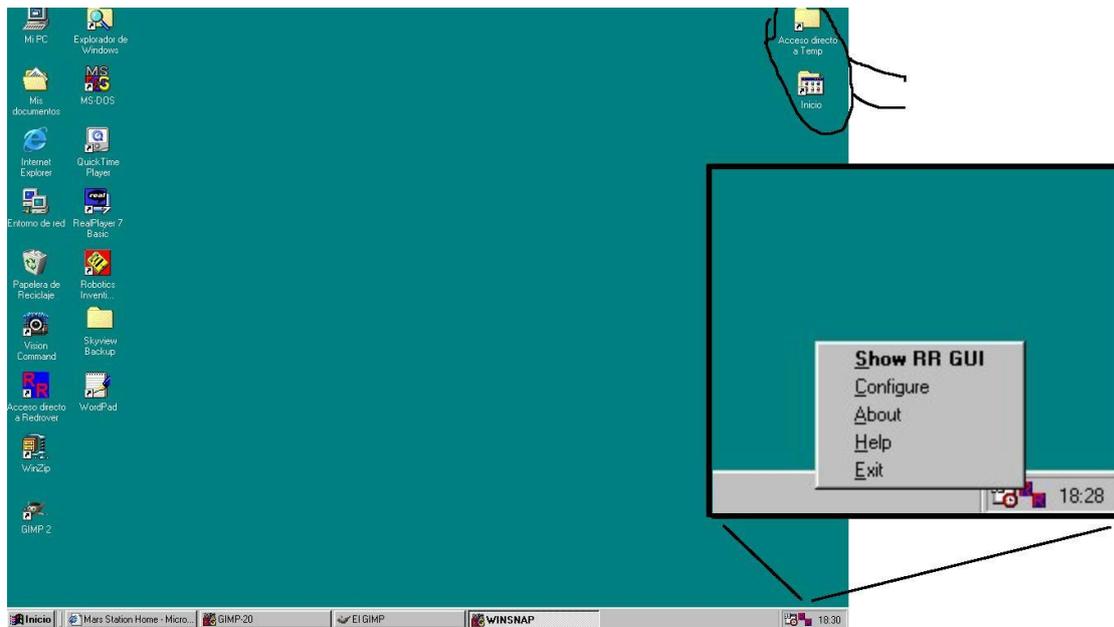
Figure 13)

The initial screen for the computer console of either Atenea or Hermes. In the lower right hand corner of the console should have a Red & Blue Redrover icon in it. If you right click with your mouse on this Redrover icon, then the small dialog should pop up, as shown in the inset of this figure. This dialog allows you to:

1) Show the console Redrover GUI (a.k.a. "RRGUI");
2) Configure the settings for the Redrover server program;
3) Exit the program.

Also shown (in the hand-drawn circle in the upper right hand corner of the console) are the two folders which give access to two important aspects of the Redrover system:

1) A shortcut to the 'c:\Archivos de programa\redrover4.531\temp directory, which gives the redrover administrator access to the HTML+Javascript *.htm source code files for modification (by right clicking on the *.htm file and select edit with Microsoft interdev studio), as well as access to the message.txt & log.txt files (which can be edited with a text editor). The Redrover administrator sometimes needs to look in these directories as well:

'c:\Archivos de programa\redrover4.531\'
'c:\Archivos de programa\redrover4.531\SIRWDOCS\'.

2) A shortcut to the 'Inicio' folder, in case the user wants to restart one of the programs that is run when the computer is restarted (i.e. Redrover and/or Microsoft Internet Explorer.
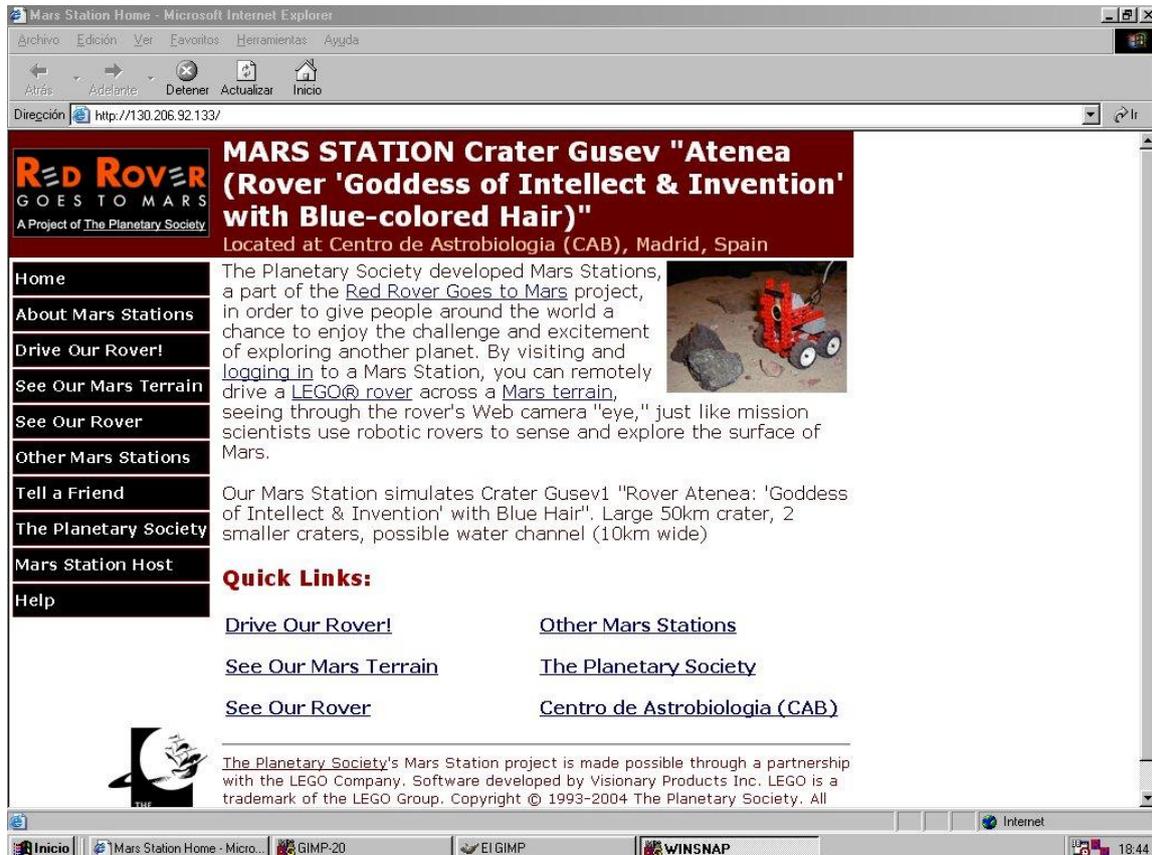
Figure 14)

This is the initial screen for the Redrover console. This is the homepage for Microsoft Internet Explorer on the computers for Atenea (and also Hermes, with small modifications).

In order to drive one of the rovers, then the user just needs to click on the hyperlink "Drive Our Rover", and then enter a *screenname* and a *country* (the user should not in general need to enter a *username*, which requires a password), and then press the 'login' button.

Note the address http://130.206.92.133 . This is the internet address for Atenea.
Hermes has the internet address of http://130.206.92.149 , and
the Skyview computer has the internet address of http://130.206.92.150 .
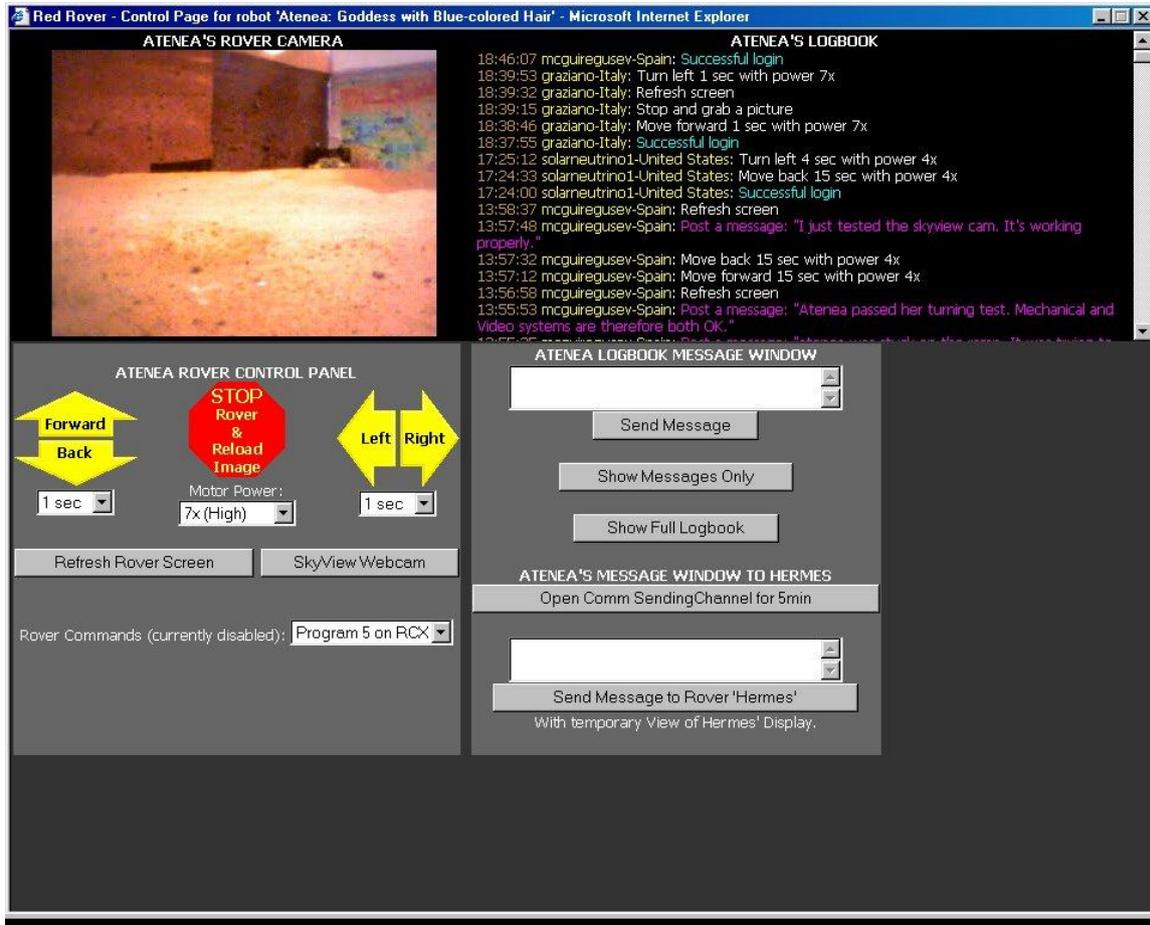
Figure 15)
   After the user has entered a screenname, the system should pop up with this window.

The user should be able to see all parts of it. Sometimes, in order to see all parts of the
window above, the user needs to hit the 'Refresh Rover Screen' button, or with the
keyboard hit 'Control-R'. These commands are not exactly equivalent, as 'Control-R'
seems to have success more often than the 'Refresh Rover Screen' button. If both of these
fail, the user should be able to log in again in the 'Drive Our Rover' page.

   To drive, the user just needs to click on the yellow arrows with the mouse, and then wait
for the chosen time period (here:1 second) for the rover to move for that amount of time
and for the screen to refresh.
   The user can also change the power of the motors to lower power (max power = 7), in
order to navigate more carefully.
   Messages can also be passed to the logbook of the local rover (just type the message in
the upper white subwindow and then click "Send Message), or to the logbook of the other
rover in the diorama (click on 'Open Comm Channel', type the message in the lower white
subwindow, and then click 'Send Message to Rover Hermes').
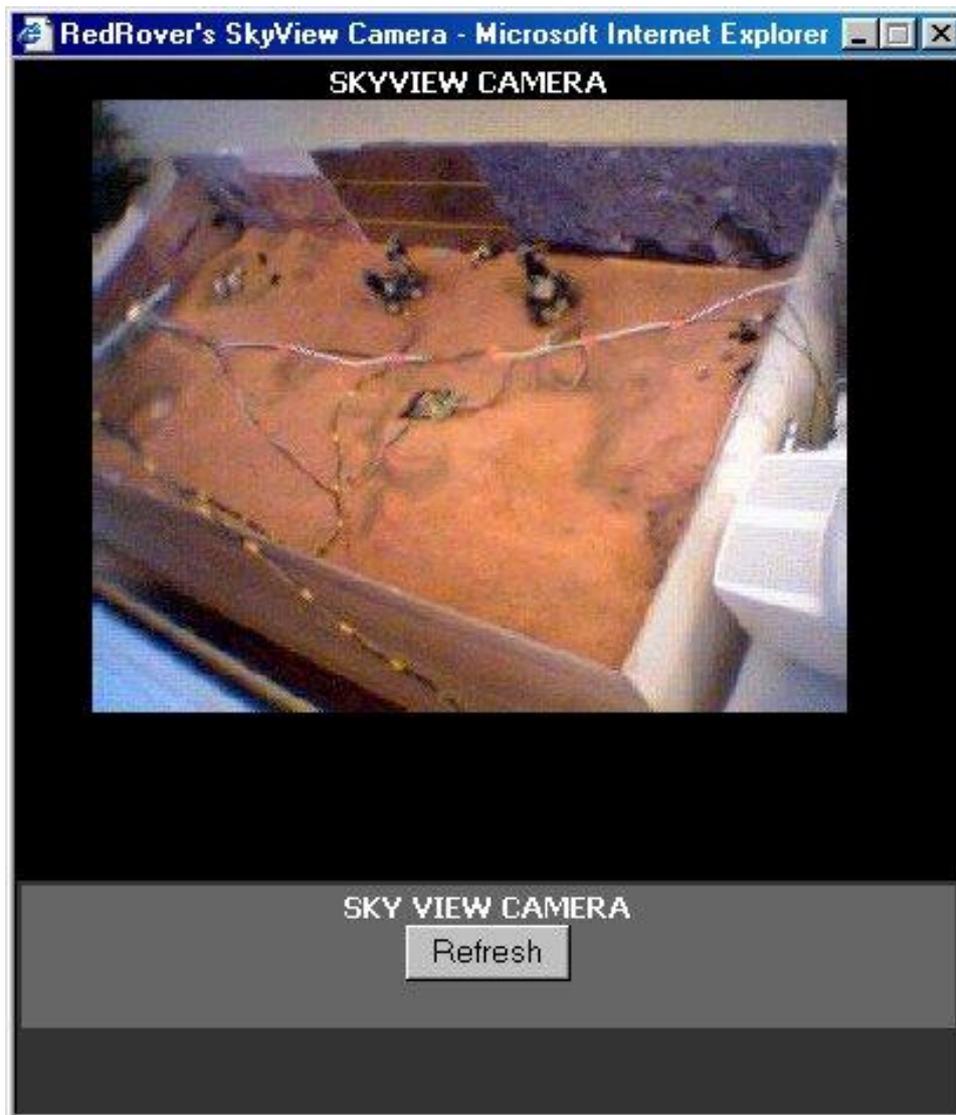
Figure 16)

   If the user clicks on the 'Skyview Webcam' button of the Control Page (Figure 15), then this window should pop up. If the user wants this image to be refreshed, then the user needs to click on the 'Refresh' button in the 'Skyview Camera' Window.

   There is an auto-refresh, large screen 'Skyview Camera' window (which was programmed for the Feria Madrid por la Ciencia, 2004). I choose not to give the user access to this auto-refresh version of the sky view, because I have some worries about bandwidth and about overloading the skyview computer. See the discussion below for more details about this Skyview Camera Window.

   This image from the skyview can be helpful for the user to figure out how to get out of a problem or how to avoid a problem, and also to get a general perspective as to where the rovers are situated in the diorama of Crater Gusev.

Figure 17)

If the user or manager selects the "Show RR GUI" in the dialog accessible from the Redrover Icon (see Figure 13), then the RRGUI window appears, as shown above. This gives more control over the rover:

8) The user can control the local rover, or go online to connect to another rover.
9) The user can check the camera settings, by pressing the "Advanced Settings Remote Reset" button, which should pop up the window shown in Figure 18. If the image is either black or does not update, then the first thing to do is either to reboot the computer or to select this camera-control button.
10) The user can drive the rover with the controls in the middle. The images should update much faster in this RRGUI than in the Internet Browser version of the Redrover program.
11) The user can check whether the IR transmitter can send commands to the RCX yellow box, or not. This can be checked by seeing if the "range status is "good" or "bad".
12) The adventurous administrator can install user programs. These programs can be made with such programming languages as LEGO Mindstorms Robotics Invention System.
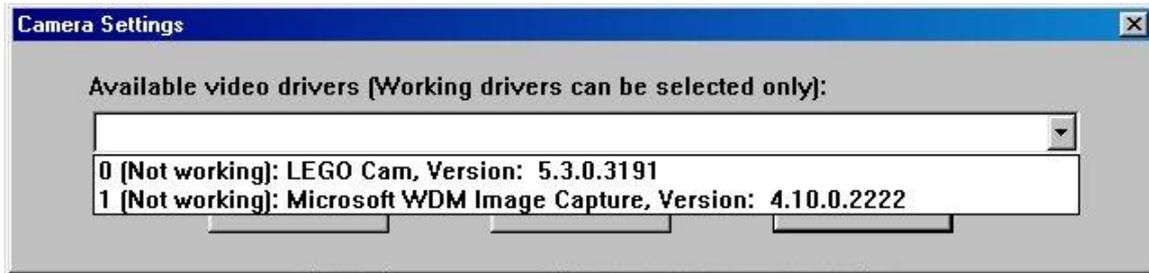
Figure 18)

This is the dialog window that pops up when the manager clicks on the "Advanced Settings Remote Reset" button, in the dialog window shown in Figure 17. If the user selects the small arrow on the right side of this "Camera Settings" dialog, then the user can select which camera driver that will be used. I don't know which one of the two camera drivers above is the best one, but in this case, neither of the drivers is working. The result of this failure is usually that the camera video display is black or does not change.

A solution to this problem is to reboot the computer and startup the Redrover program once again. Remember to turn the RCX on with its red switch.

Hidden underneath the pop-down camera-driver selection window of the "Camera Settings" dialog above are three buttons, two of which give the user the ability to control the settings of the camera, for the chosen camera driver; these settings include the ability to change the exposure time of the cameras (useful when the lighting changes).
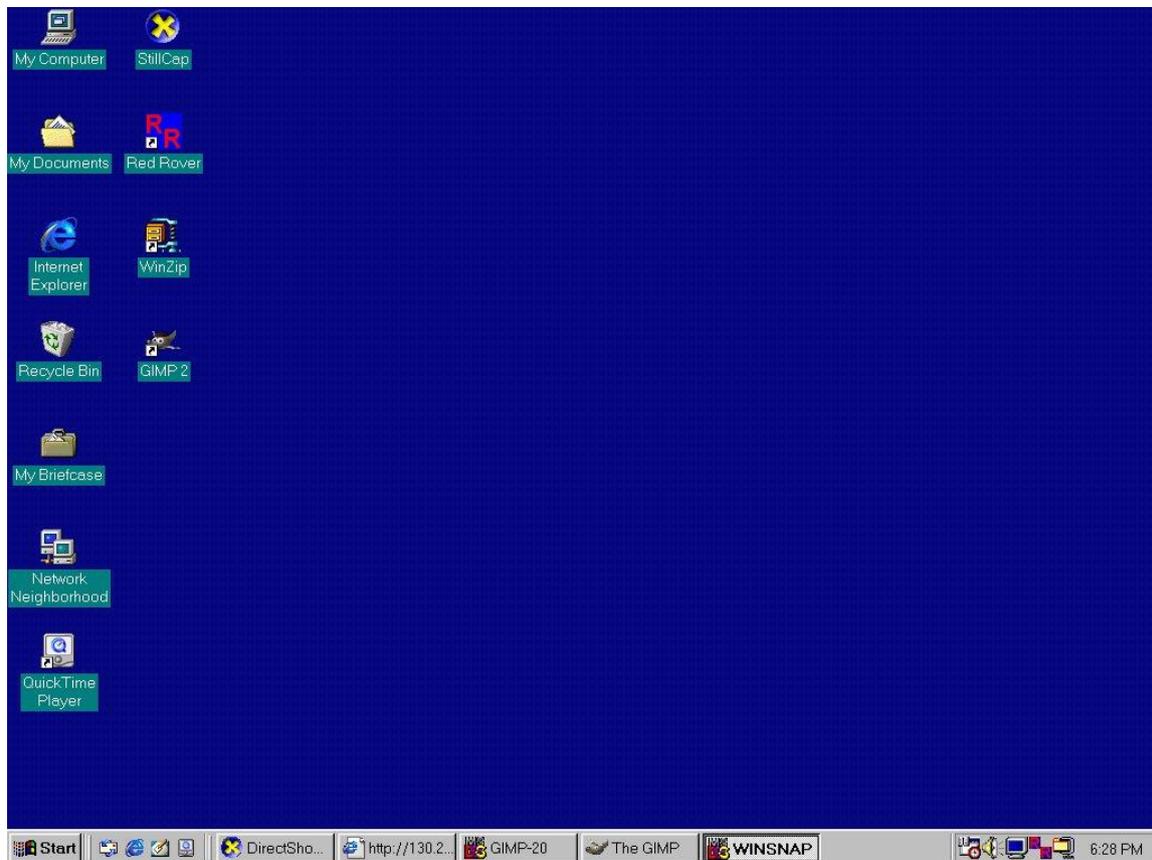
Figure 19)

This is the screen of the skyview computer. If this computer is rebooted or if the server programs need restarted, this is the order that they should be restarted:

1) StillCap (so that it can use the camera instead of Redrover);
2) Redrover, with these initialization-dialog window choices:
   a. selecting the "No Interface" option in the 1st dialog window that pops up (since there is no LEGO Mindstorms robot to control).
   b. Pressing cancel several times in the "camera selection" dialog window that pops up (StillCap is using he camera).
3) Microsoft Internet Explorer, which has its homepage set for:
   A fullscreen auto-refresh Skyview javascript program:
   http://130.206.92.150/skyview.htm
   For some reason, this skyview program only refreshes on the console, it does not refresh when viewed remotely. This should be fixed.
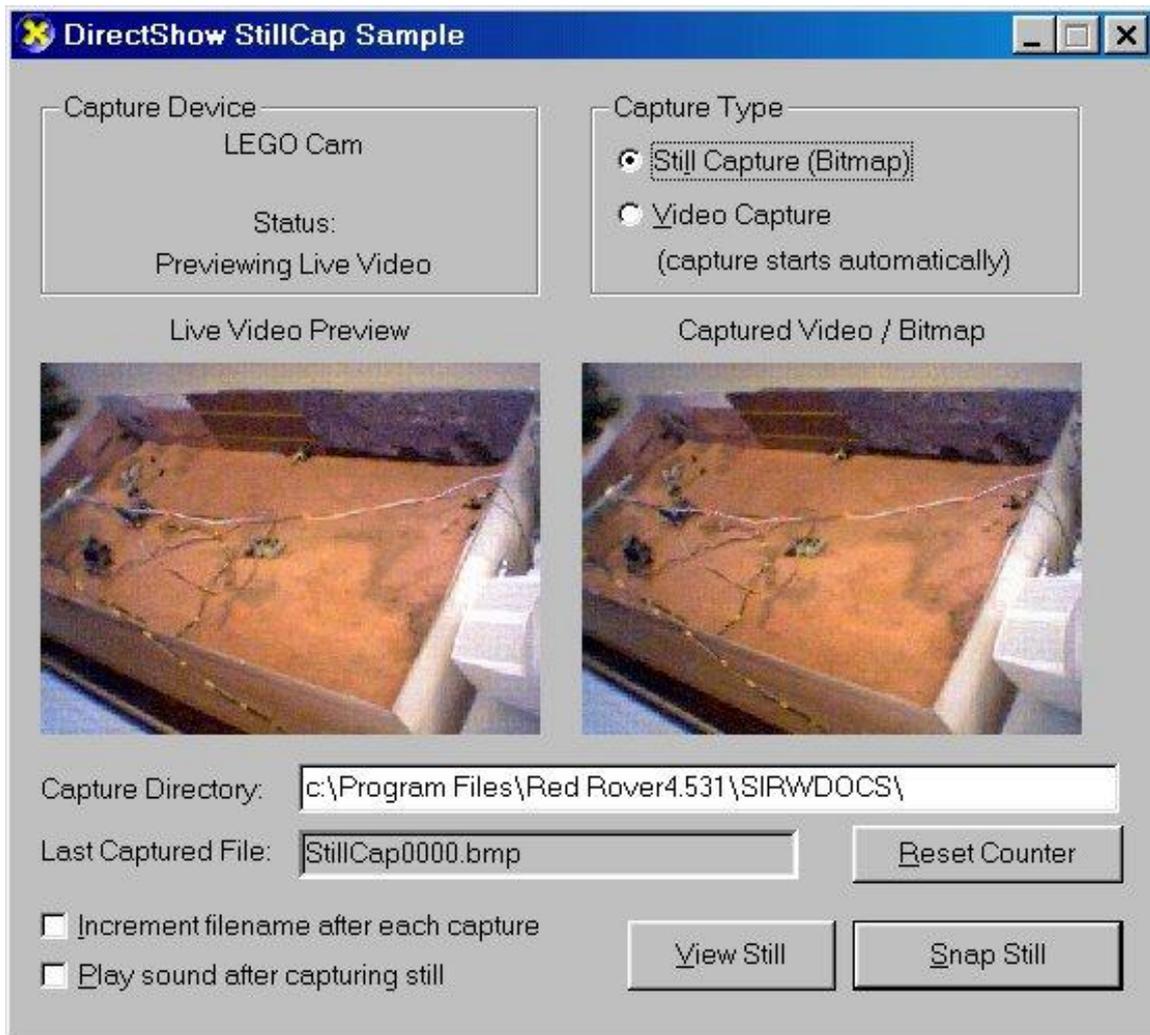
Figure 20)

  This is how the Stillcap program on the Skyview computer. should appear when maximized. The manager can minimize this program, if desired. The default Capture directory shown, and should not be changed. This default is hardwired into the modified DirectX9.0 Microsoft Visual C++ source code. Another modification to the StillCap source code made by McGuire was to automatically capture a new image and store it to hard disk every 5 seconds.

        This image on disk is the image which is visible to the outside world when the Redrover server program is running. In order to access this image from the outside world, the user should access: http://130.206.92.150/StillCap0000.jpg . This address is hardwired into the Skyview Camera buttons on Atenea and Hermes.

        We tried to run this program on one of the Redrover computers (Atenea or Hermes), but these computers seemed to crash much more frequently when this StillCap.exe program was running, in addition to the robot-driving Redrover programs.
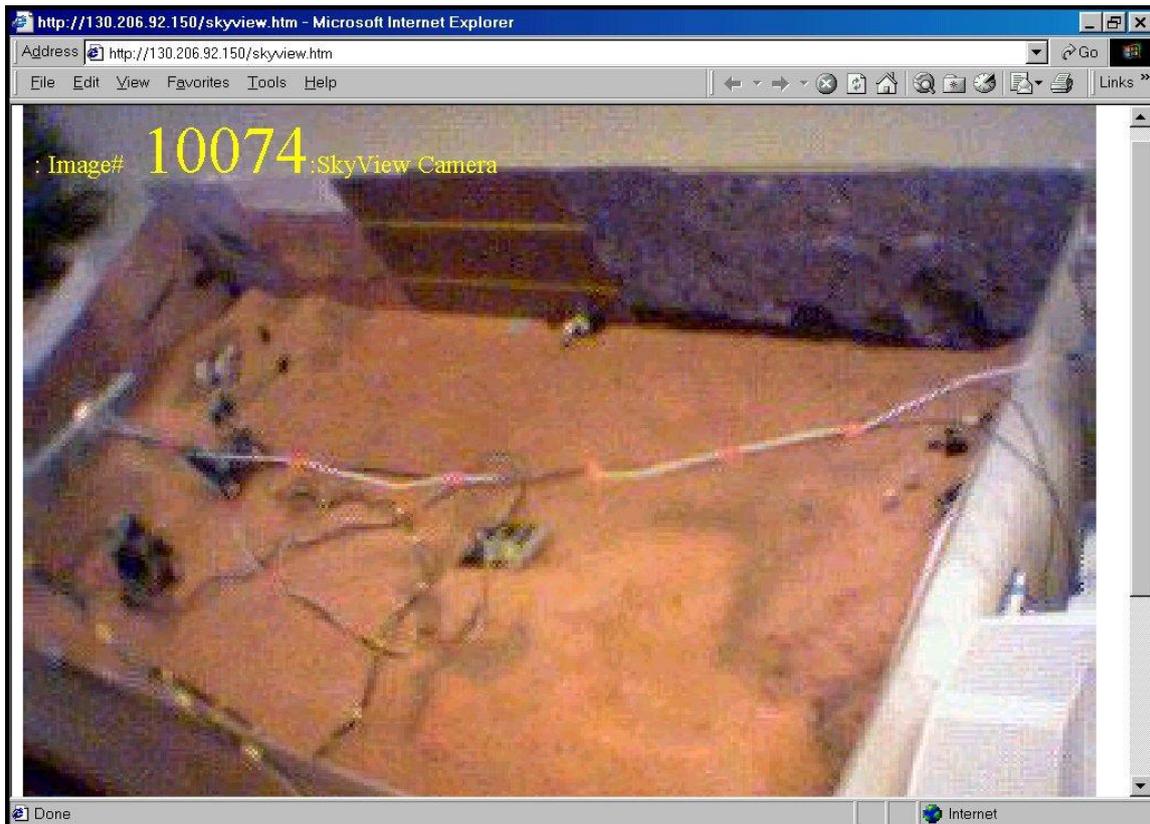
Figure 21)

This is the Microsoft Internet Explorer Window on the Skyview computer, with its default homepage of http://130.206.92.150/skyview.htm . This is an auto-refresh, large screen Javascript program that displays the http://130.206.92.150/StillCap0000.jpg image taken by the StillCap program; this image is made available to the network by the Redrover web server running on the Skyview camera.

The number shown is the number of image-refreshes that have been made since the skyview.htm Javascript program was initiated (usually when the browser is opened). The images should autorefresh every 8 seconds.

For some reason (i.e., a bug), the auto-refreshing only works on the console. It does not work on remote computers. This should be fixed.

Graphs of Historical Utilization of Mars Station
"Crater Gusev"

Usage of the MarsStation Crater Gusev
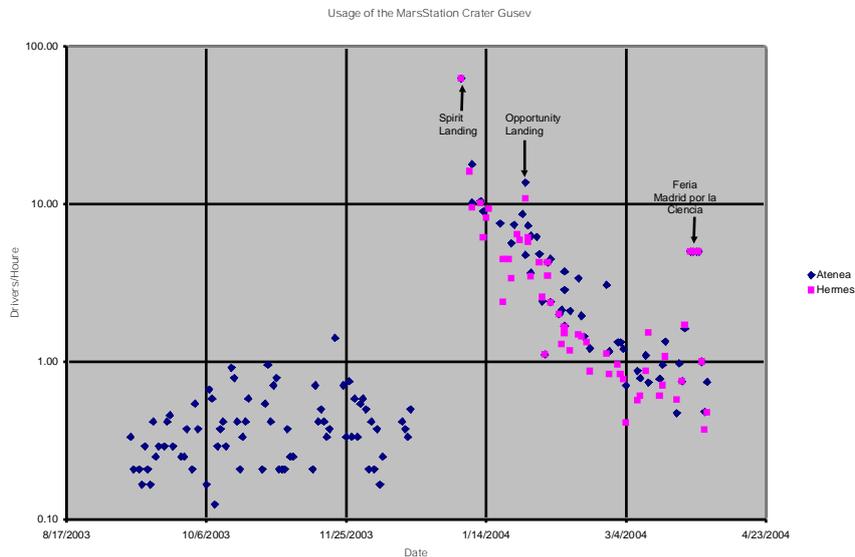
Graph 1)

Graph of the usage of the MarsStation Crater Gusev from September 2003 until March 2004, for the two rovers, Atenea and Hermes. Note the logarithmic scale.

Correlation of Usage of the 2 Rovers (Atenea & Hermes) of the MarsStation Crater Gusev
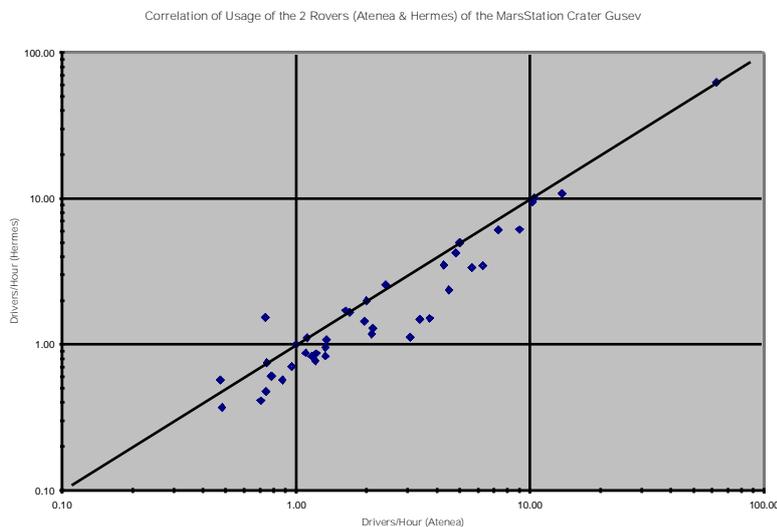
Graph 2)

Graph of the correlation of the usage of the MarsStation Crater Gusev from September 2003 until March 2004, for the two rovers, Atenea and Hermes. Note the logarithmic scales. Also note that Hermes is used less than Atenea, which is probably caused by Hermes being listed after Atenea at http://www.redrovergoestomars.org/drive.html

Technical Record of Developing the Mars Station Crater Gusev at the Centro de Astrobiologia (July 2002-March 2004)

1) *<March 2002:* LEGO Mindstorms kits acquired by the Centro de Astrobiologia for its participation in the "Redrover Goes To Mars" project.

2) *August 2002:* McGuire establishes e-mail contact with Emily Lakdawalla at the Planetary Society in Pasadena. Lakdawalla is the person responsible for the Redrover Mars Station program at the Planetary Society. McGuire builds Atenea and tests the "Redrover Goes to Mars" internet software.

3) *September 2002:* Martinez Frias, McGuire & Fernandez Remolar visit Avila twice in order to procure the services of the diorama artist, Pablo Ballesteros, for making the Mars Station diorama for CAB. Decision made at this time to make a diorama of the Gusev Crater.

4) *November 2002:* Ballesteros delivers the diorama of the Gusev Crater to CAB.

5) *January 2003:* The Advanced Computing group at CAB activates a network, partly for the MarsStation at CAB, with the firewall configured to allow outside access to CAB's Mars Station.

6) *January 2003:* During the inauguration of the new building for CAB, the Crater Gusev Mars Station makes its debut to the outside world.

7) *February 2003:* Rodriguez Manfredi decides that the diorama for Crater Gusev should be taken to the Feria 'Madrid por la Ciencia' at IFEMA. He informs McGuire of this decision. The diorama is a big success at this Feria. During the transport of the diorama to this Feria, the diorama develops 2 cracks on the surface. These cracks have not been repaired.

8) *June 2003:* Lakdawalla asks McGuire to have CAB's Mars Station host a multiple-user debugging session for the "Redrover goes to Mars" software. McGuire and Rodriguez Manfredi host this debugging session.

9) *July 2003:* Jose Rodriguez Manfredi suggests to McGuire that he install a second rover in the diorama, in order to allow remote drivers to experience "cooperative" robotics. McGuire decides to do this, but he decided to that before the 2nd rover is installed, a "skyview" camera should be installed. McGuire asks the Advanced Computing group for 2 computers for the skyview camera and for the 2nd rover.

10) *October 2003:* Still waiting for the 2 computers, McGuire installs the skyview camera on the computer for Atenea. Having two programs at once on Atenea's computer often caused Atenea's computer to crash.

11) *November 2003:* Planetary Society has a debugging session by having many Mars Station administrators (and others) log into their Mars Station in Pasadena, in order to track down problems in the software.

12) *December 2003:* Skyview camera is moved to a 2nd computer, which had just been provided to McGuire; this works better. McGuire builds and tests Hermes, the second rover. McGuire decides to turn the skyview camera off, and move Hermes to the 2nd computer.

13) *January 2004:* A 3rd computer becomes available, and the skyview camera is moved to this computer. Now both rovers are operational, as well as the skyview.

14) *January 2004:* Spirit lands on Mars in Crater Gusev. The number of drivers per hour at our Mars Station increases suddenly from about 0.5/hour to more than 60 per hour. The "Redrover goes to Mars" software cannot handle this number of drivers, and it begins to crash more than 10-20 times per day.

15) *January 2004:* Csaba Gyulai, the programmer of the "Redrover goes to Mars" software, who works for Visionary Products, Inc. (in Utah), asks McGuire to help him find the bugs in the software. McGuire agrees, and starts running "tracefile" versions of the Redrover software on the two Crater Gusev Mars Station machines. McGuire watches the system carefully, noting system crashes and problems, and after each crash, sends the tracefiles to Gyulai.

16) *February 2004:*Gyulai & McGuire track down several of the bugs which cause webserver crashes or video crashes, and Gyulai fixes them. After each bug is fixed, Gyulai sends McGuire a new version of the trace-enabled Redrover program to install and test on the Crater Gusev Mars Station. The software is now much more stable than before.

17) *March 2004:* Federico Moran chooses the Mars Stations to be part of the Feria "Madrid por la Ciencia", and these Mars Stations are successfully used by about 5 internet drivers per hour, for 4 days at the Feria.

Known Buglist:

Software:

1) The auto-refresh version of the Skyview camera http://130.206.92.150/skyview.htm only auto-refreshes on the Skyview computer console. It does not refresh automatically on remote consoles.
2) After the installation of the release version of Redrover 4.541 on April 1, 2004, the message-passing between Hermes and Atenea does not work. Maybe the release version works more rapidly than the trace version. Have tried putting a pause after the Viewer-only window in the javascript code for frame3.htm, via a for loop of 100000 iterations. Will try a for loop of 1000000 interations to see if this helps.
3) If the Skyview computer is turned off, then the manager needs to restart the server programs by *hand*, in a certain order (first StillCap and then Redrover), since we want to make sure that StillCap is given access to the camera instead of Redrover.
4) When the power goes out, or when the redrover software is shut off, the yellow RCX brick loses its power. The user must manually turn the power back on with the red button on the yellow RCX brick.
5) Sometimes when the systems are first started up, the browser does not show the Welcome page. The manager should just reload the home page. This is caused by the browser opening too soon after starting up the Redrover program.
6) Sometimes a little window can pop up saying that there was an access violation or a page fault. Usually, the program will continue to run OK, as long as this window is not closed. The manager can restart the Redrover program, if desired.
7) Sometimes, there is "no server available", which results in error messages to this effect when the remote or local user tries to access the web page. The incidence of this serious problem has gone down dramatically in the past 2 months. If this happens again, wait 5 minutes for the program to try to self-repair itself. If there is still "no server available", then shut the Redrover program down, reboot the computer, and restore power to the yellow RCX brick.
8) The driving sessions time out after a few minutes, giving an error message of "oops…". This is part of the design of the program. Try pressing "Control-R" to log in again, or try entering a screen name once again and pressing the "login" button.
9) Sometimes the motors don't stop running after a motor command. This is probably due to RCX<->IR transmission problems. A temporary solution is to try stopping them with another motor command, or try rebooting the computer.

Mechanical:

1) The rovers often tip over backwards due to the tether cable dragging and/or when the rovers go uphill.
2) The forward counterweights often fall off.
3) The tether cable tower often falls off.
4) The gears of the rovers often lose engagement and need pressed back together.
5) The rover often gets stuck in the small crater to the southwest of the main crater.
6) The rovers often get stuck when they are trying to climb uphill

7) The rovers often get stuck when traversing the putative water channel to the southeast of the main crater.

System:

1) The users often run the rovers into the walls, which normally makes the image turn black. This is due to the "Truman Show" effect of the user thinking the posters on the wall are real.
2) The posters on the walls of the diorama need better organization and nicer mounting (better than scotch tape).
3) Sometimes the security guards turn the lights off at night, so the users cannot see anything. Maybe an extra light needs to be put over the diorama, which is always left on, or which turns on at night only.
4) The power cables on the floor need to be better organized.
5) Sometimes a parasitic oscillation occurs in the two power supplies for the RCX and infrared transmitter, which can cause both systems to lose their communications to the motors of the rovers. One solution is to unplug the power supplies for both the RCX and the infrared transmitter. This problem may be partially caused by sharing each of the power supplies between the 2 RCX's and the 2 infrared transmitters. Maybe this problem could be permanently solved by replacing the RCX and infrared transmitter system with an "interface box".
6) The supply of IP address business cards in the red box goes to zero. Look for more business cards on the table of the skyview computer.

Suggested Future Improvements

1) Make the system wireless.
    a. This would solve many of the problems of the system (especially the mechanical ones), but would add the requirement for the rovers to obtain power by batteries or by some other method.
    b. Wireless webcams are available from DECOM in Valencia (they can resupply http://X10.com webcams for under 300 € each).
    c. To carry batteries for the webcam and for the RCX for 24 hours, the batteries might need to weigh 1-4kg, which means the rovers will need to be mechanically redesigned to support this heavy load.
    d. The RCX for each rover would need to be carried by each rover.
    e. The infrared transmitter for the RCX would need to be placed on the ceiling above the diorama, and they would need to be parallelized, i.e. making two transmitters in order to cover the 1x3 m^2 diorama. To handle two rovers, there would need to be some sort of coding in order for the RCX and the infrared transmitter to correctly identify each of the rovers.
2) Professionally-arranged imagery on the sides of the walls of the diorama.
3) Placement of the posters from the Madrid Feria por la Ciencia in good locations around the diorama.
4) Fixing the skyview.htm auto-refesh mode so that it works on remote computers.
5) Fixing the inter-rover message passing, so that it works properly with the newly-installed version of Redrover (Redrover version 4.541, release version).
6) Proper advertising in Spain and in other countries, in order to increase traffic to the Mars Stations in Spain and around the world.
    a. There has not yet been a proper press release in Spain about the rovers. The system is working now, and deserves a proper Spanish press release.
    b. Also, The Planetary Society in Pasadena should consider another press release in the USA, now that the beta-testing phase of the "Redrover goes to Mars" software is complete. The Planetary Society last had a press release at the beginning of the beta-testing phase of the software (in late 2003), when the software still had some significant problems. The problems might have scared away many of the interested drivers.