CMU MHCII NASA Project > Summer 2005

Rover Planning and In-Situ Re-Tasking Interface

Alpha Prototype Functionality Specification > V 1.0
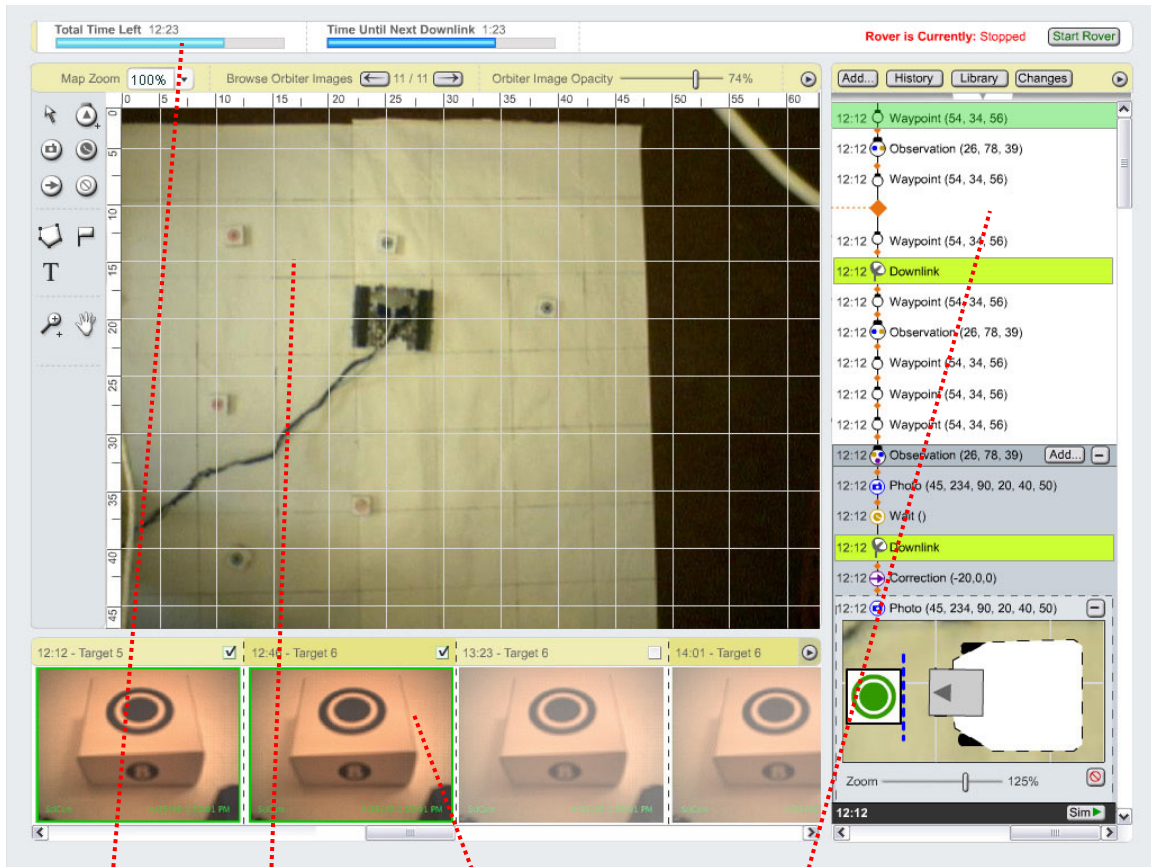
1 > Overview

Status Bar   Map   Science Viewer   Activity Planner

2 > Status Bar

Total Time Left Indicator   **Time Until Next Downlink Indicator**   **Rover Status**

2.1 > Purpose

The Status Bar gives the user important feedback about the status of the game context and any information about the Rover that isn't appropriately represented in other areas of the interface. It is placed prominently at the top of the screen because it contains crucial information about the user's task.

2.2 > Total Time Left Indicator

2.2.1 > Purpose

The Total Time Left Indicator gives the user feedback about how much time is left in the game.

2.2.2 > Functionality & Interactions

Before the game begins, the Total Time Left text reads "30:00" (thirty minutes), or however long a game is. The blue indicator bar is 'full', which means it is completely covering up the light grey background behind it. Once the game starts, the time ticks down backwards, and the progress bar gets smaller relative to how much time is left.

The Total Time Left Indicator is a purely system feedback widget. The user does not interact with it directly, as it is only meant to provide feedback.

2.3 > Time Until Next Downlink Indicator

Time Until Next Downlink 1:23
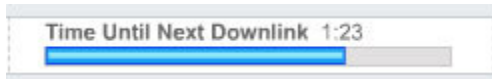
2.3.1 > Purpose

The Time Until Next Downlink Indicator gives the user feedback about how much time is left before the next downlink will occur.

2.3.2 > Functionality & Interactions

The Time Until Next Downlink text starts out at 2:00 (two minutes), with the progress bar 'full' (completely covering up the light grey background behind it). The time ticks down backwards, and the progress bar gets smaller relative to how much time is left. At the end of two minutes, the indicator resets to 2:00, with the progress bar 'full', and begins it's countdown again.

The Time Until Next Downlink Indicator is a purely system feedback widget. The user does not interact with it directly, as it is only meant to provide feedback.

2.4 > Rover Status

Active State:

Rover is Currently: Driving   Stop Rover

Stopped State:

Rover is Currently: Stopped   Start Rover

2.4.1 > Purpose

The Rover Status area gives the user feedback about what the system thinks the Rover is currently doing, as well as a way to start and stop the Rover.

2.4.2 > Functionality & Interactions

The text label tells the user what the system thinks the Rover is currently doing. If it is currently executing a drive, the 'Rover is Currently' text label reads 'Driving'. Other possibilities include 'Taking a Picture', 'Turning', 'Waiting', or 'Stopped'. If the Rover status is stopped, the text appears in red to draw the user's attention.

The button toggles between 'Stop Rover' and 'Start Rover.' If the Rover is currently active, the button reads 'Stop Rover', and pressing it will tell the Rover to stop executing the plan, but don't delete the rest of the plan (like a Pause button on a CD player). If the Rover is currently stopped, the button reads 'Start Rover', and pressing it will tell the Rover to resume executing the plan (like a Play button on a CD player).

3 > Map
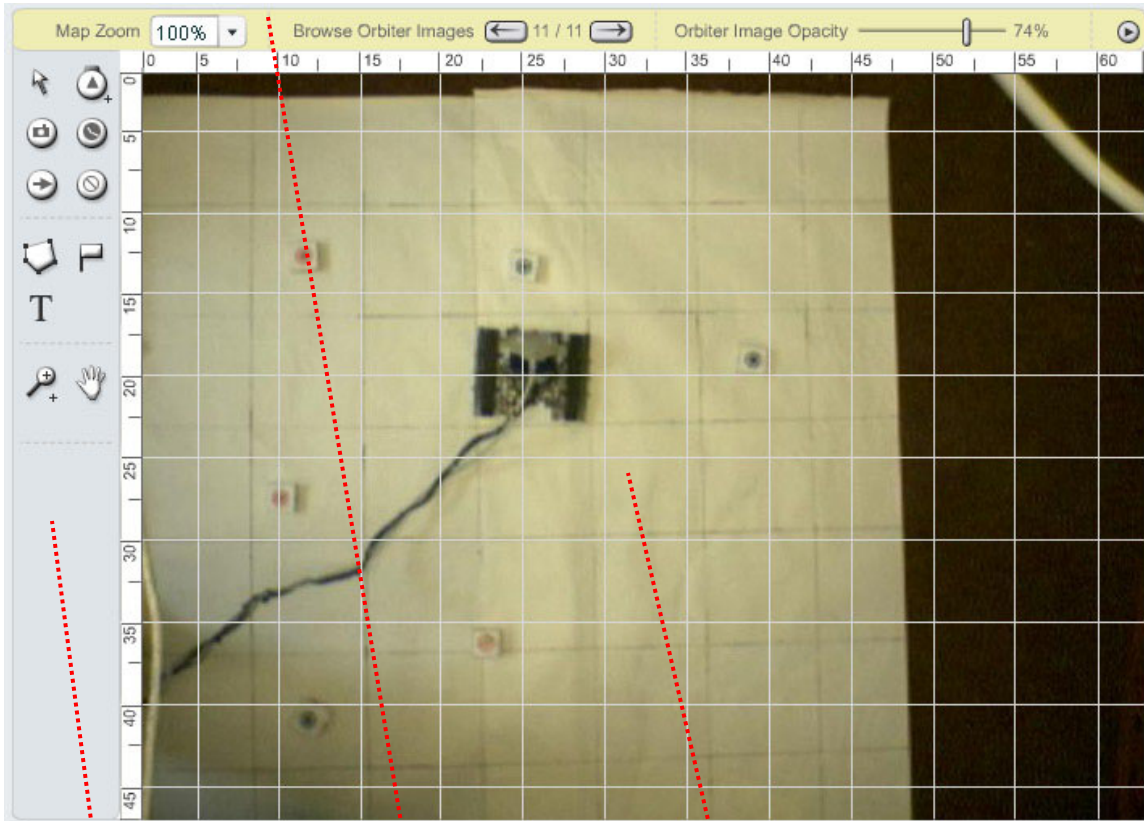
Map Toolbar   **Map Options Bar**   **Map Main Area**

3.1 > Map Options Bar
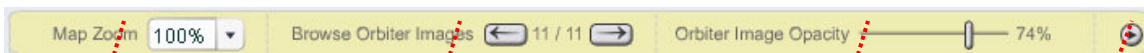
Map Zoom   **Orbiter Image Browser**   **Orbiter Image Opacity**

Map Options Button

3.1.1 > Map Zoom
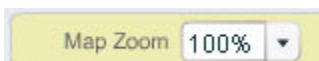
3.1.1.1 > Purpose

The Map Zoom tool allows the user to zoom in and out on the Map Main Area in order to establish the most appropriate map size for the current situation.

3.1.1.2 > Functionality & Interactions

The user clicks on the Map Zoom combo box and selects from one of the following options: 10%, 25%, 50%, 75%, 100%, 150%, 200%, 500%. The Map Main Area then zooms in or out based on the user's selection. If the Map Main Area Ruler is currently visible, the scale of the ruler adjusts accordingly, so that for example, when zooming in, the same number of pixels on the screen will represent less physical space, and the ruler scale will be 'stretched out.'

If the Zoom level is set to less than 100%, the Map is centered in the Main Map Area, and is surrounded by a grey background color (#999999), such as represented in the following screen shot:
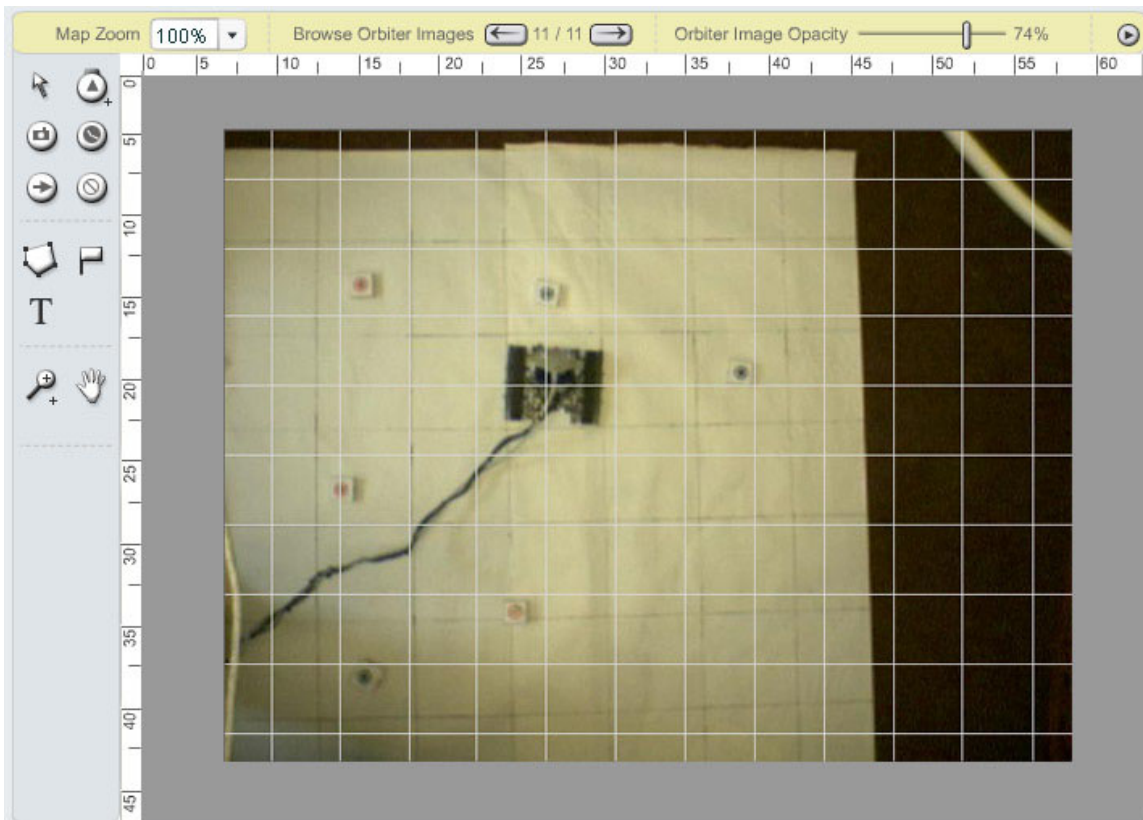
3.1.2 > Orbiter Image Browser
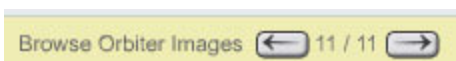
3.1.2.1 > Purpose

The Orbiter Image Browser tool allows the user to quickly access past orbiter images. By quickly browsing through each of the orbiter images, the user should be able to establish a solid mental model of the Rover's actual traversed path.

3.1.2.2 > Functionality & Interactions
At each downlink, the new orbiter image received from the orbiter replaces the current orbiter image in the Map Main Area. The orbiter image number feedback increases by one, so that if it previously read "7 / 7", at the next downlink it would read "8 / 8".

Clicking the left arrow button changes the orbiter image in the Map Main Area to the previously acquired orbiter image, and the orbiter image number feedback changes accordingly (so instead of reading " 8/ 8" it would read "7/ 8"). If the current orbiter image is the first one that was taken, the left arrow button is grayed out and not clickable.

Clicking the right arrow button changes the orbiter image in the Map Main Area to the next acquired orbiter image, and the orbiter image number feedback changes accordingly (so instead of reading " 7/ 8" it would read "8/ 8"). If the current orbiter image is the last one that was taken, the right arrow button is grayed out and not clickable.

3.1.3 > Orbiter Image Opacity
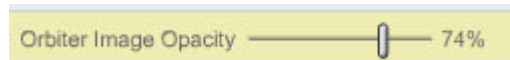
3.1.3.1 > Purpose
The Orbiter Image Opacity tool allows the user to specify the opacity of the currently displayed orbiter image in the Map Main Area. The orbiter image at 100% opacity may be too visually powerful and make it difficult to read and understand the other elements on the map, and so the user may want to lessen it's opacity. This would still give the user the awareness provided by the orbiter image, but without it being so dominant that it makes other elements difficult to discern.

3.1.3.2 > Functionality & Interactions
The user slides the slider widget (by clicking, holding, and dragging) to the left to increase the orbiter image's opacity and to the left the decrease the orbiter image's opacity. The orbiter image's opacity changes in real-time, as the user is sliding the bar. The scale goes from 0% to 100%. The number to the right of the slider widget gives the user real-time feedback as to the current orbiter image opacity.

3.1.4 > Map Options Button

3.1.4.1 > Purpose

The Map Options button allows the user to specify various options that affect the appearance of the Map Main Area.

3.1.4.2 > Functionality & Interactions

Clicking the Map Options Button displays the Map Options Menu. The right edge of the menu is aligned with the right-edge of the Map Options Button and the top edge of the menu is aligned with the bottom edge of the Map Options Button. Clicking the Map Options Button when the Map Options Menu is currently displayed hides the Map Options Menu. The Map Options Menu contains the following items (note the position of the menu dividers):

Hide Orbiter Image
Hide Grid
Hide Ruler
Hide Scale
Hide Downlink Points
Hide Text Notes
Hide Targets
Hide Worksites

Hide All Past
Hide Past Path
Hide Past Waypoints
Hide Past Observations
Hide Past Options

Hide All Future
Hide Future Path
Hide Future Waypoints
Hide Future Observations
Hide Future Options

Grid Size...

All of the menu items with "Hide" as the first word act as visibility toggles. For example, clicking "Hide Past Waypoints" will hide the past waypoints on the Map Main Area, and the menu will disappear. Clicking on the Menu Options Button again would display the menu again, and the user would see "Show Past Waypoints", and clicking this will display the past waypoints on the Map Main Area again. The same principle applies to the other "Hide/ Show" menu items.

There are two related accelerator menu items: "Hide All Past" and "Hide All Future." These menu items act as shortcuts for toggling the visibility of all past or future symbols on the Map Main Area. For example, clicking "Hide All Past" will hide all past symbols on the Map Main Area, and the menu will disappear. Clicking on the Menu Options Button again would display the menu again, and the user would see "Show All Past", "Show Past Waypoints", "Show Past Path", "Show Past Waypoints", "Show Past Observations", and "Show Past Options".

Clicking the "Grid Size..." menu item would bring up a dialog box and make the Map Options Menu disappear. The Grid Size Dialog Box contains up and down arrow widgets for increasing or decreasing the grid size, and two feedback widgets: a textual and visual description of the grid size. The details of the grid size scale and options, and the exact layout of the Grid Size Dialog Box, are to be designed for the next version of this Specification.

3.2 > Map Toolbar

Pointer Tool   **Waypoint Tool**
Camera Tool   **Wait Tool**
Correction Tool   **Delete Tool**

Worksite Tool   **Target Tool**
Text Tool

Zoom Tool   **Drag Tool**
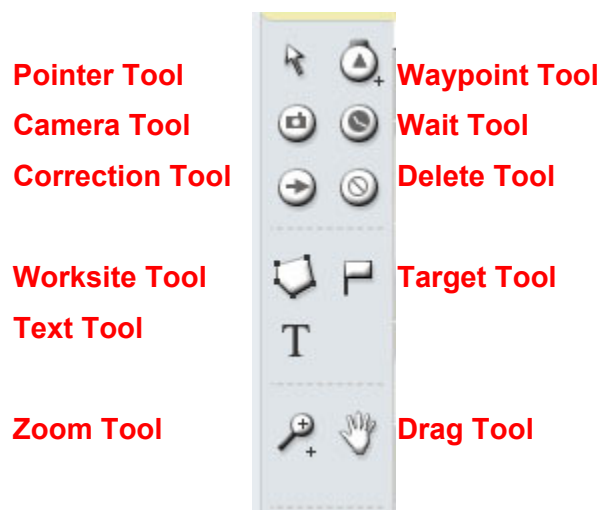
3.2.1 > Pointer Tool

3.2.1.1 > Purpose

The Pointer Tool allows the user to manipulate –move, rotate, select, delete, etc. - existing objects in the Main Map Area.

3.2.1.2 > Functionality & Interactions

Visual States

The Pointer Tool has three visual states in the Map Toolbar:

On (displayed when the Pointer Tool is the currently selected tool)

Off (displayed when the Pointer Tool is not the currently selected tool)

Over (displayed when the Pointer Tool is not the currently selected tool and the mouse is over the Pointer Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Pointer Tool icon in the Map Toolbar, a tool tip is displayed with the text "Selection Tool".

Cursor

When the Pointer Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursors:

Move Mode (the cursor is over the moveable area of a Waypoint or Observation Icon)

Rotate Mode (the cursor is over the rotatable area of a Waypoint or Observation Icon)

Default Mode (the cursor is not over a moveable or rotatable area of a Waypoint or Observation Icon)

Interactions with Waypoint and Observation Icons

Waypoint and Observation Icons – Tool Tip
Moving the mouse over a Waypoint or Observation Icon displays a tool tip with:

1. The Name of the Waypoint or Observation
2. The Start Time of the Waypoint or Observation
3. The Duration of the Waypoint or Observation

Waypoint and Observation Icons – Move Mode
When the cursor is over the moveable area of a Waypoint or Observation Icon, the cursor changes to Move Mode. If the user clicks, holds, and drags, the Waypoint or Observation Icon will move with the cursor until the user releases the mouse button. While a Waypoint or Observation Icon is being moved it changes appearance to the Selected Waypoint or Observation Icon (which is representative of the Rover's actual size):

and the drive paths immediately before and after the moving icon change appearance to the Live Path (which is representative of the width of the Rover's actual drive path):

The Activity Planner automatically scrolls to the selected Waypoint or Observation, so that the selected Waypoint or Observation is vertically located around the center of the Activity Planner. The selected Waypoint or Observation is automatically selected in the Activity Planner.

When the user releases the mouse button, the Waypoint or Observation Icon is still selected.

Waypoint and Observation Icons – Rotate Mode

When the cursor is over the rotatable area of a Waypoint or Observation Icon, the cursor changes to Rotate Mode. If the user clicks, holds, and drags, the Waypoint or Observation Icon (as well as the Rotate Mode cursor) will in real-time re-orient itself based on the cursor's relative position to the waypoint, until the user releases the mouse button. While a Waypoint or Observation Icon is being rotated it changes appearance to the Selected Waypoint or Observation Icon (which is representative of the Rover's actual size):

and the drive paths immediately before and after the moving icon change appearance to the Live Path (which is representative of the width of the Rover's actual drive path):

The Activity Planner automatically scrolls to the selected Waypoint or Observation, so that the selected Waypoint or Observation is vertically located around the center of the Activity Planner. The selected Waypoint or Observation is automatically selected in the Activity Planner.

When the user releases the mouse button, the Waypoint or Observation Icon is still selected.

Waypoint and Observation Icons –Single Selection Mode

After a user has either moved or rotated (or just clicked and quickly released) a Waypoint or Observation Icon, that icon is then selected and changes appearance to the Selected Waypoint or Observation Icon (which is representative of the Rover's actual size):

When a Waypoint or Observation Icon is in Single Selection Mode, but is not being dragged or rotated, the Live Path is not displayed.

The Activity Planner automatically scrolls to the selected Waypoint or Observation, so that the selected Waypoint or Observation is vertically located around the center of the Activity Planner. The selected Waypoint or Observation is automatically selected in the Activity Planner.

Waypoint and Observation Icons –Multiple Selection Mode

The user can perform the standard Shift-Click and Ctrl-Click in order to select multiple Waypoints or Observations. Nothing changes in the Activity Planner upon a multi-select.

Waypoint and Observation Icons –Single Selection Context Menu
Right-clicking a Waypoint or Observation Icon produces the following context menu:

Delete (Waypoint or Observation)
Delete Entire Plan After This Point
Add >
        Photo
        Wait
        Correction

Selecting either of the Delete menu items produces a confirmation dialog box. Upon confirmation, the appropriate delete action occurs.

Selecting a sub-menu item beneath 'Add' adds an Activity to a Waypoint (making it an Observation) or an existing Observation. The Activity Planner automatically scrolls to the selected Waypoint or Observation, so that the selected Waypoint or Observation is vertically located around the center of the Activity Planner. The selected Waypoint or Observation is automatically selected in the Activity Planner, and the selected Activity is added after the last existing Activity within that Observation. The newly added Activity is automatically in Edit Mode so that the user can quickly specify the Activity's parameters.

Waypoint and Observation Icons –Multiple Selection Context Menu
Right-clicking a Waypoint or Observation Icon produces the following context menu:

Delete

Selecting the Delete menu item produces a confirmation dialog box. Upon confirmation, the appropriate delete action occurs.

Waypoint and Observation Icons –Deselect
To deselect an Icon or Observation, the user clicks somewhere else in the Map Main Area, or else selects a different tool from the Map Toolbar.

Interactions with Downlink Icons

Downlink Icons – Tool Tip

Moving the mouse over a Downlink Icon displays a tool tip with:

1.   The Downlink time

Interactions – Other

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.2 > Waypoint Tool

3.2.2.1 > Purpose

The Waypoint Tool allows the user to add Waypoints and Optional Waypoints to the Map Main Area.

3.2.2.2 > Functionality & Interactions

Visual States

The Waypoint Tool has three visual states in the Map Toolbar:

On (displayed when the Waypoint Tool is the currently selected tool)

Off (displayed when the Waypoint Tool is not the currently selected tool)

Over (displayed when the Waypoint Tool is not the currently selected tool and the mouse is over the Waypoint Tool icon in the Map Toolbar)

Expanded States

When the user clicks and holds the Waypoint Tool in the Map Toolbar, sub-tools are displayed for the user to choose from (by clicking). There are four total Waypoint Tools to choose from:

Waypoint Forward

Waypoint Reverse

Waypoint Option Forward

Waypoint Option Reverse

Tool tip

When the mouse is over the Waypoint Tool icon in the Map Toolbar, a tool tip is displayed with the appropriate text (based on which sub-tool is currently selected): "Waypoint Forward Tool", "Waypoint Reverse Tool", "Optional Waypoint Forward Tool", "Optional Waypoint Reverse Tool".

Cursor

When the Waypoint Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursors (based on which sub-tool is currently selected):

Waypoint Forward – Mindstorm and Per

Waypoint Reverse – Mindstorm and Per

Waypoint Option Forward – Mindstorm and Per
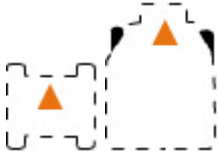
Waypoint Option Reverse – Mindstorm and Per

Interactions

Placing a New Waypoint After the Last Planted Waypoint or Observation

As the user moves the cursor around the Map Main Area, a Live Path (which is representative of the width of the Rover's actual drive path) is drawn in real-time from the last Planted Waypoint or Observation Icon to the custom cursor. The Live Path appears as follows:

Live Path

Live Path Option Mode

Both the last Planted Waypoint or Observation Icon and the custom cursor rotate in real time to match the direction from the last Planted Waypoint or Observation Icon to the custom cursor.

The user clicks to confirm the placement of the Waypoint. A Planted Waypoint Icon appears below the cursor, and the appropriate Planted Path (regular or optional) is displayed from the last Planted Waypoint or Observation Icon to the newly Planted Waypoint Icon. The newly Planted Waypoint Icon then becomes the last Planted Waypoint Icon, and the Live Path is then drawn from that Planted Waypoint Icon to the custom cursor.

Downlinks

As the user drags the cursor around the screen, Downlink Icons are automatically placed along the Live Path, at the points where the system estimates Downlinks will occur (based on the length of the Live Path). Since the Live Paths are sized to represented the Rover's actual drive path, the Downlink Icons should automatically re-size to cover the entire width of the Live Path.

Restrictions

A Waypoint placed on the Map must be placed at a distance equal to or greater than the size of the custom cursor away from the last Planted Waypoint or Observation Icon. Essentially, the Map is used only for "drives". Small movements, or Corrections, are handled in the Activity Planner.

Reverse

When the user plants a Reverse Waypoint (or Optional Reverse Waypoint), the last Planted Waypoint or Observation Icon automatically reverses its direction. The assumption is that the user intended for the Rover to drive in reverse from the last Planted Waypoint or Observation to the newly Planted Waypoint.

Placing a New Waypoint Along a Planted Path

Users can also place a Waypoint along a Planted Path. When the user moves the cursor within a reasonable range of a Planted Path and stops moving the mouse for a given period of time (around a second or two), the customer cursor snaps to the Planted Path. It's orientation – as well as the orientation of the Planted Path's starting Planted Waypoint or Observation Icon – are automatically adjusted. If the user moves the mouse slowly, the custom cursor remains attached to the Planted Path. The Planted Path is essentially split into two, divided by the custom cursor. The two Planted Paths (one before the custom cursor and one after) are displayed as Live Paths.

If the user moves the mouse quickly, the custom cursor detaches itself from the Planted Path, and operates as described in '*Placing a New Waypoint After the Last Planted Waypoint or Observation*' above.

Optional Waypoints can only be attached to Optional Planted Paths, and Regular Waypoints can only be attached to Regular Planted Paths.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.3 > Camera Tool

3.2.3.1 > Purpose

The Camera Tool allows the user to add a Photo Activity to Planted Waypoints or Observations.

3.2.3.2 > Functionality & Interactions

Visual States

The Camera Tool has three visual states in the Map Toolbar:

On (displayed when the Camera Tool is the currently selected tool)

Off (displayed when the Camera Tool is not the currently selected tool)

Over (displayed when the Camera Tool is not the currently selected tool and the mouse is over the Camera Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Camera Tool icon in the Map Toolbar, a tool tip is displayed with the text "Camera Tool".

Cursor

When the Camera Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:

Interactions with Waypoint and Observation Icons

When the user moves the cursor within an acceptable range of a Planted Waypoint or Observation Icon, the Planted Waypoint or Observation Icon grows to 125% of its normal size. When the user moves the cursor away from the icon, the icon shrinks back to it's original size. The user clicks in order to add a Photo Activity to the Waypoint or Observation. The following events occur:

- The Activity Planner automatically scrolls to the selected Waypoint or Observation, so that the selected Waypoint or Observation is vertically located around the center of the Activity Planner.
- The selected Waypoint or Observation is automatically selected in the Activity Planner.
- If the user clicked on a Waypoint, that Waypoint is automatically turned into an Observation, both in the Map Main Area and the Activity Planner.
- A Photo Activity is automatically added to the end of the Observation's Activities.
- The newly added Photo Activity is automatically placed in Edit mode so that the user can specify the appropriate parameters.
- The selected Waypoint or Observation is placed in Selected Mode (see 3.2.1.2 above for details).

Clicking when the cursor is not within an acceptable range of a Planted Waypoint or Observation Icon has no effect.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.4 > Wait Tool

3.2.4.1 > Purpose

The Wait Tool allows the user to add a Wait Activity to Planted Waypoints or Observations.

3.2.4.2 > Functionality & Interactions

Visual States

The Wait Tool has three visual states in the Map Toolbar:

On (displayed when the Wait Tool is the currently selected tool)

Off (displayed when the Wait Tool is not the currently selected tool)

Over (displayed when the Wait Tool is not the currently selected tool and the mouse is over the Wait Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Wait Tool icon in the Map Toolbar, a tool tip is displayed with the text "Wait Tool".

Cursor

When the Wait Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:

Interactions with Waypoint and Observation Icons

When the user moves the cursor within an acceptable range of a Planted Waypoint or Observation Icon, the Planted Waypoint or Observation Icon grows to 125% of its normal size. When the user moves the cursor away from the icon, the icon shrinks back to it's original size.

The user clicks in order to add a Wait Activity to the Waypoint or Observation. The following events occur:

- The Activity Planner automatically scrolls to the selected Waypoint or Observation, so that the selected Waypoint or Observation is vertically located around the center of the Activity Planner.
- The selected Waypoint or Observation is automatically selected in the Activity Planner.
- If the user clicked on a Waypoint, that Waypoint is automatically turned into an Observation, both in the Map Main Area and the Activity Planner.
- A Wait Activity is automatically added to the end of the Observation's Activities.
- The newly added Wait Activity is automatically placed in Edit mode so that the user can specify the appropriate parameters.
- The selected Waypoint or Observation is placed in Selected Mode (see 3.2.1.2 above for details).

Clicking when the cursor is not within an acceptable range of a Planted Waypoint or Observation Icon has no effect.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.5 > Correction Tool

3.2.5.1 > Purpose
The Correction Tool allows the user to add a Correction Activity to Planted Waypoints or Observations.

3.2.5.2 > Functionality & Interactions

Visual States
The Correction Tool has three visual states in the Map Toolbar:

On (displayed when the Correction Tool is the currently selected tool)

Off (displayed when the Correction Tool is not the currently selected tool)

Over (displayed when the Correction Tool is not the currently selected tool and the mouse is over the Correction Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Correction Tool icon in the Map Toolbar, a tool tip is displayed with the text "Correction Tool".

Cursor

When the Correction Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:

Interactions with Waypoint and Observation Icons

When the user moves the cursor within an acceptable range of a Planted Waypoint or Observation Icon, the Planted Waypoint or Observation Icon grows to 125% of its normal size. When the user moves the cursor away from the icon, the icon shrinks back to it's original size. The user clicks in order to add a Wait Activity to the Waypoint or Observation. The following events occur:

- The Activity Planner automatically scrolls to the selected Waypoint or Observation, so that the selected Waypoint or Observation is vertically located around the center of the Activity Planner.
- The selected Waypoint or Observation is automatically selected in the Activity Planner.
- If the user clicked on a Waypoint, that Waypoint is automatically turned into an Observation, both in the Map Main Area and the Activity Planner.
- A Correction Activity is automatically added to the end of the Observation's Activities.
- The newly added Correction Activity is automatically placed in Edit mode so that the user can specify the appropriate parameters.

- The selected Waypoint or Observation is placed in Selected Mode (see 3.2.1.2 above for details).

Clicking when the cursor is not within an acceptable range of a Planted Waypoint or Observation Icon has no effect.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.6 > Delete Tool

3.2.6.1 > Purpose

The Delete Tool allows the user to delete Planted Waypoints or Observations.

3.2.6.2 > Functionality & Interactions

Visual States

The Delete Tool has three visual states in the Map Toolbar:

On (displayed when the Delete Tool is the currently selected tool)

Off (displayed when the Delete Tool is not the currently selected tool)

Over (displayed when the Delete Tool is not the currently selected tool and the mouse is over the Delete Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Delete Tool icon in the Map Toolbar, a tool tip is displayed with the text "Delete Tool".

Cursor

When the Delete Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:

Interactions with Waypoint and Observation Icons

When the user moves the cursor within an acceptable range of a Planted Waypoint or Observation Icon, the Planted Waypoint or Observation Icon grows to 125% of its normal size. When the user moves the cursor away from the icon, the icon shrinks back to it's original size. The user clicks in order to delete the Waypoint or Observation. They are first shown a confirmation dialog box before the delete action occurs. Deleting a Waypoint or Observation causes a new path to be drawn from the Waypoint or Observation directly before the deleted icon to the Waypoint or Observation directly after the deleted icon (with obvious differences when deleting the first or the last icon).

Clicking when the cursor is not within an acceptable range of a Planted Waypoint or Observation Icon has no effect.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.7 > Worksite Tool

3.2.7.1 > Purpose

The Worksite Tool allows the user to visually define Worksites on the Map Main Area. In our limited domain, the Worksite serves mainly as an organizational and communication aid, and has no programmatic significance. However, for more advanced and autonomous robotic platforms, such as K9, the Worksite could serve as way to define areas that the user could directly command the Rover to explore.

3.2.7.2 > Functionality & Interactions

Visual States

The Worksite Tool has three visual states in the Map Toolbar:

On (displayed when the Worksite Tool is the currently selected tool)

Off (displayed when the Worksite Tool is not the currently selected tool)

Over (displayed when the Worksite Tool is not the currently selected tool and the mouse is over the Worksite Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Worksite Tool icon in the Map Toolbar, a tool tip is displayed with the text "Worksite Tool".

Cursor

When the Worksite Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:

Interactions

To be determined in a future version of this Specification.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.8 > Target Tool

3.2.8.1 > Purpose

The Target Tool allows the user to visually define Targets on the Map Main Area. In our limited domain, the Target serves mainly as an organizational and communication aid, and has no programmatic significance. However, for more advanced and autonomous robotic platforms, such as K9, the Target could serve as way to define specific targets that the user could directly command the Rover to explore.

3.2.8.2 > Functionality & Interactions

Visual States

The Target Tool has three visual states in the Map Toolbar:

On (displayed when the Target Tool is the currently selected tool)

Off (displayed when the Target Tool is not the currently selected tool)

Over (displayed when the Target Tool is not the currently selected tool and the mouse is over the Target Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Target Tool icon in the Map Toolbar, a tool tip is displayed with the text "Target Tool".

Cursor

When the Target Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:

Interactions

To be determined in a future version of this Specification.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.9 > Text Tool

3.2.9.1 > Purpose

The Text Tool allows the user to add textual notes to the Map Main Area. For our specific task, a key use of these text notes is to annotate the Map with the discovered point values of the target sides.

3.2.9.2 > Functionality & Interactions

Visual States

The Text Tool has three visual states in the Map Toolbar:

On (displayed when the Text Tool is the currently selected tool)

Off (displayed when the Text Tool is not the currently selected tool)

Over (displayed when the Text Tool is not the currently selected tool and the mouse is over the Text Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Text Tool icon in the Map Toolbar, a tool tip is displayed with the text "Text Tool".

Cursor

When the Text Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:

Interactions

Adding Text

The user clicks anywhere on the Map Main Area and a standard blinking text cursor appears in the spot where they clicked. The user can then type freely. The text will extend horizontally unless the user presses the Enter key, which acts as a carriage return.

To exit from this mode, the user presses the Escape key, or else activates another Tool on the Map Toolbar.

Editing Text

To edit existing text, the user places the cursor over existing text and clicks. A standard blinking text cursor appears within the text string where the user clicked. The text string is now in Edit mode, and the system behaves in the same way as described above in *Adding Text*. To delete text, the user simply deletes all the characters in a text string.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.10 > Zoom Tool

3.2.10.1 > Purpose

The Zoom Tool allows the user to zoom in and out on the Map Main Area in order to establish the most appropriate map size for the current situation.

3.2.10.2 > Functionality & Interactions

Visual States

The Zoom Tool has three visual states in the Map Toolbar:

On (displayed when the Zoom Tool is the currently selected tool)

Off (displayed when the Zoom Tool is not the currently selected tool)

Over (displayed when the Zoom Tool is not the currently selected tool and the mouse is over the Zoom Tool icon in the Map Toolbar)

Expanded States

When the user clicks and holds the Zoom Tool in the Map Toolbar, sub-tools are displayed for the user to choose from (by clicking). There are two total Zoom Tools to choose from:

Zoom In

Zoom Out

Tool tip

When the mouse is over the Zoom Tool icon in the Map Toolbar, a tool tip is displayed with the appropriate text (based on which sub-tool is currently selected): "Zoom In Tool", "Zoom Out Tool".

Cursor

When the Zoom Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursors (based on which sub-tool is currently selected):

Zoom In

Zoom Out

Interactions

The user clicks anywhere on the Map Main Area, and the Map zooms in or out, depending on which sub-tool is selected.

If the Map Main Area Ruler is currently visible, the scale of the ruler adjusts accordingly, so that for example, when zooming in, the same number of pixels on the screen will represent less physical space, and the ruler scale will be 'stretched out.'

If the Zoom level is set to less than 100%, the Map is centered in the Main Map Area, and is surrounded by a grey background color (#999999), such as represented in the following screen shot:
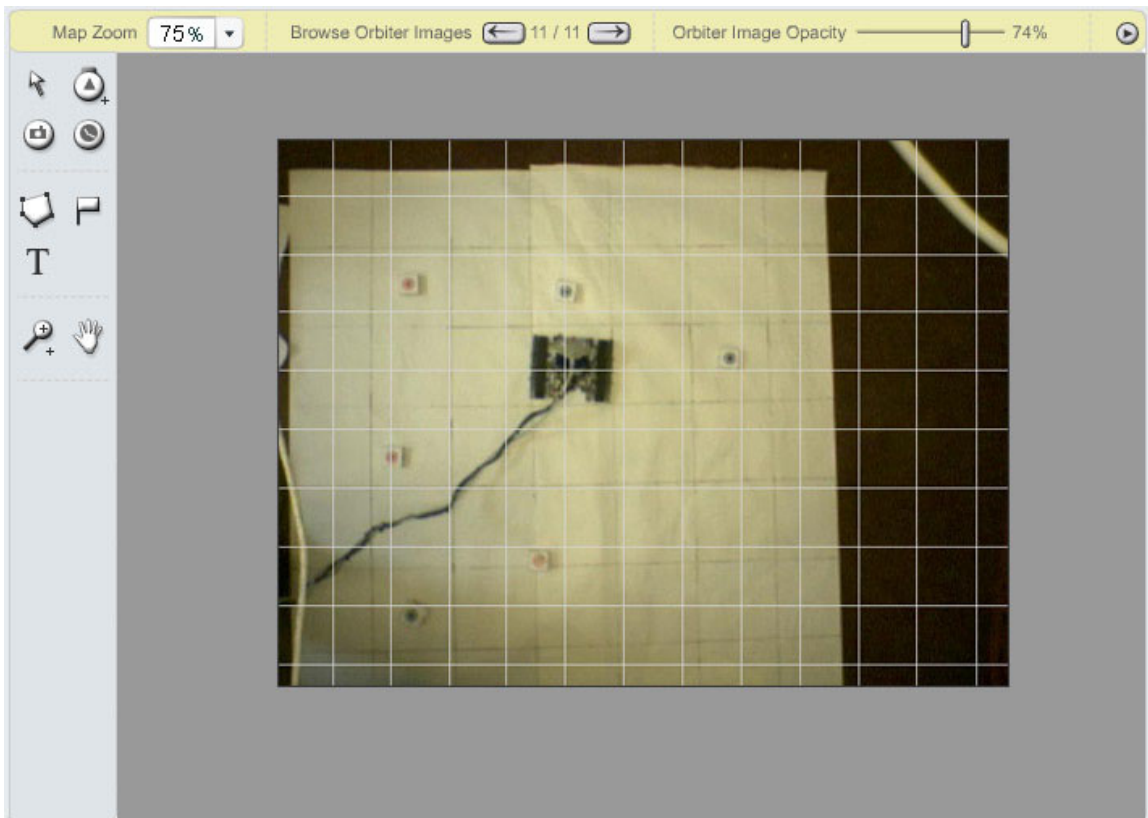
As the user zooms in or out with the Zoom Tool, the text in the Map Zoom tool in the Map Options Area changes to reflect the new zoom level.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.2.11 > Drag Tool

3.2.11.1 > Purpose

The Drag Tool allows the user to drag around the visible Map Main Area when the Map is zoomed in more than 100%.

3.2.11.2 > Functionality & Interactions

Visual States

The Drag Tool has three visual states in the Map Toolbar:

On (displayed when the Drag Tool is the currently selected tool)

Off (displayed when the Drag Tool is not the currently selected tool)

Over (displayed when the Drag Tool is not the currently selected tool and the mouse is over the Drag Tool icon in the Map Toolbar)

Tool tip

When the mouse is over the Drag Tool icon in the Map Toolbar, a tool tip is displayed with the text "Drag Tool".

Cursor

When the Drag Tool is the currently selected tool and the cursor is hovered over the Map Main Area, the cursor changes to the following custom cursor:


Interactions

The user clicks, holds, and drags anywhere on the Map Main Area, and as they do so the entire Map moves with the cursor. The Ruler stays in place but the units adjust accordingly. This dragging action is ceased by releasing the mouse button.

The Drag Tool has no effect if the Map is not zoomed in more than 100%.

Effect on the Map Ruler

As the user moves the cursor around the Map Main Area, a faint but visible dotted line appears on the Map Ruler at the exact position of the cursor, on both the horizontal and vertical axis. This helps the user gain a solid understanding of exactly where they have their cursor positioned.

3.3 > Map Main Area

Map Ruler   **Map Grid Lines**
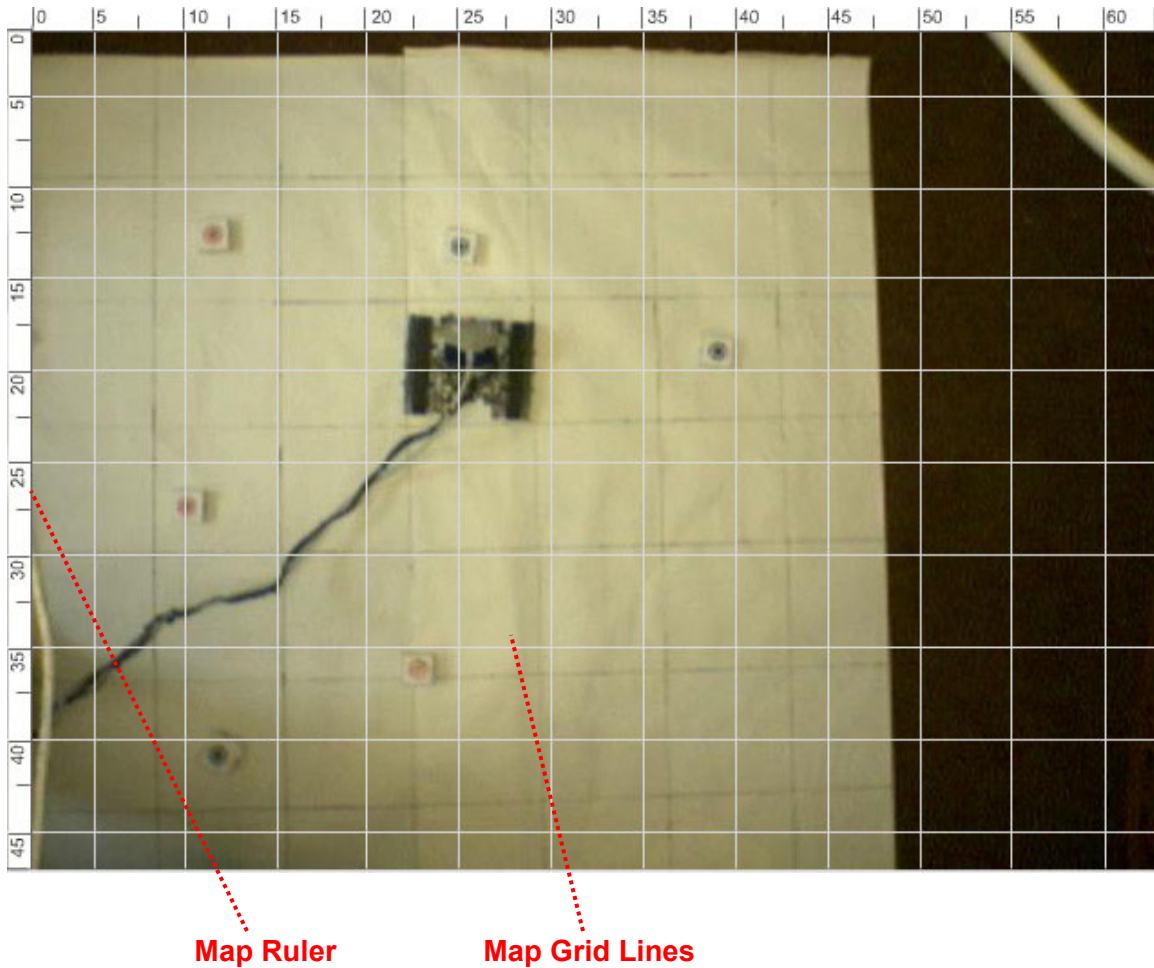
3.3.1 > Map Ruler

3.3.1.1 > Purpose

The Map Ruler gives the user an understanding of the scale being represented on the map. The tick marks on the Ruler should be aligned with the Map Grid Lines. The numbers on the Ruler should tell the user how far the corresponding area on the orbiter image is from an imaginary starting point in the upper left-hand corner. For example, if a tick mark is labeled as "40", the user would know that the corresponding area on the orbiter image is 40 Meters (or whatever unit is appropriate) away from the top of the playing field.

3.3.1.2 > Functionality & Interactions

The user mouses over the Ruler and a tool tip is displayed telling the user exactly where the cursor is located along the Ruler, including the units (for example: "41.56 M").

3.3.2 > Map Grid Lines

3.3.2.1 > Purpose

The Map Grid Lines provide a visual aid for the user to gain a solid understanding of the distances involved in the environment, and how those distances relate to each other.

3.3.2.2 > Functionality & Interactions

The user does not directly interact with the Map Grid Lines.

3.3.3 > Map Icons

The following is a visual definition of all icon types used on the Map:
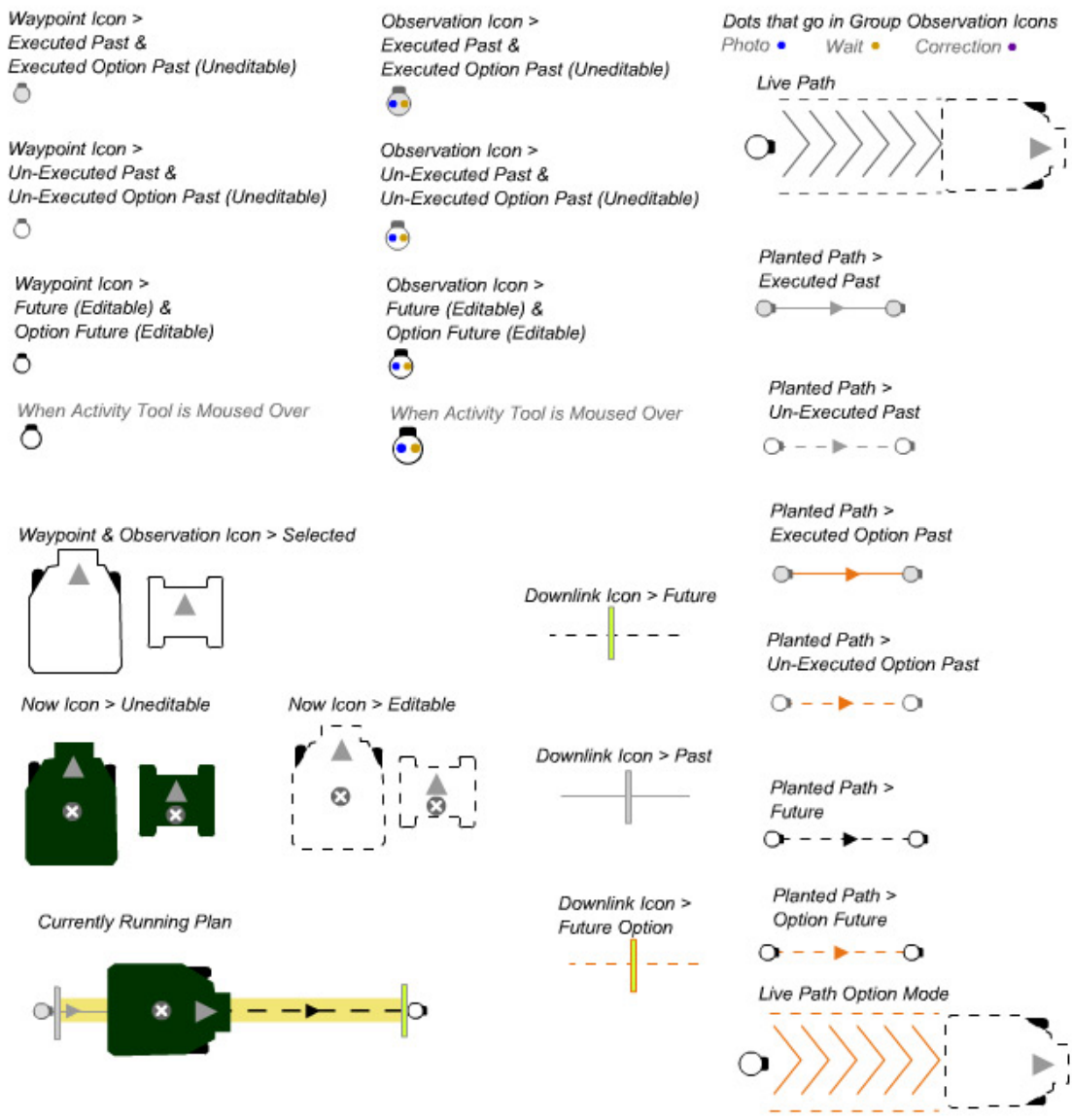
All the Icons above should be self-explanatory, but the Now Icon does warrant special mention. The Now Icon represents where the system thinks the Rover currently is along the planned path. As the Plan executes, the Now Icon animates in real-time along the planned path, and is not editable. At each Downlink point, the Uneditable Now Icon turns into the Editable Now Icon, so that the user can calibrate the system's model of ground truth (where the Rover currently is). This is explained further under the Activity Planner section in Calibration.
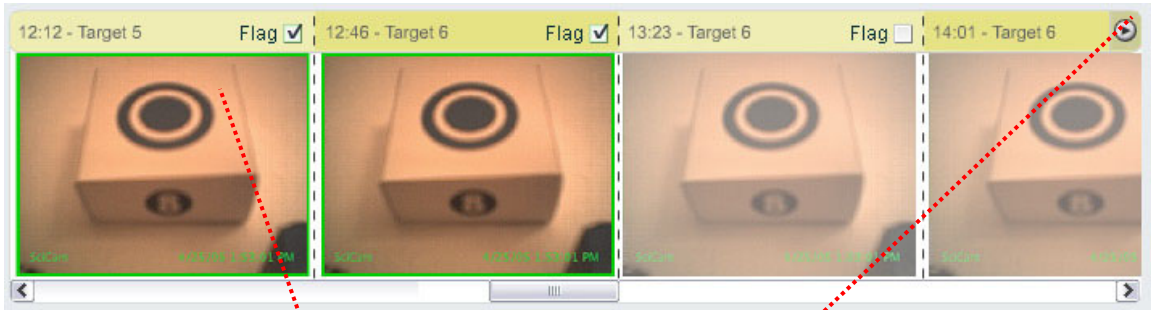
4 > Science Viewer

Photo Cell   **Science Viewer Options Button**

Note: the current design of the Science Viewer is geared towards our specific domain, in which Photos taken by the Rover's on-board camera are the only science data. It could, however, be easily modified to allow for the integration of other types of science data in future versions. Since our focus was not in viewing and organizing science data, we didn't fully explore the extensibility of this design.

4.1 > Photo Cell
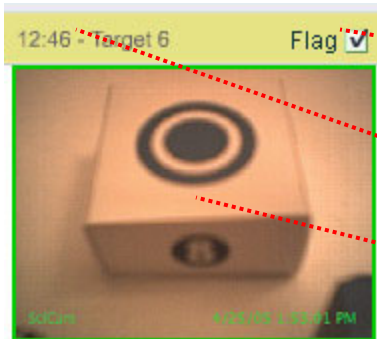
Flag Checkbox

Label

Photo

4.1.1 > Purpose

The Photo Cell allows users to view the Photographs taken by the Rover's on-board camera, and to flag the photos they want to count towards their official score.

4.1.2 > Functionality & Interactions

Label

The Label at the top of the Photo Cell gives the user the time the photo was taken, and the name of the photo's parent Observation. If the parent Observation name is too long to fit in the Label area, the end of the parent Observation name is appended with ellipses. For example: "12:46 – Long Observation Na...". Mousing over the Label displays a tool tip with the entire parent Observation name.

The Label area alternates background color to make it easier to distinguish between each individual Photo Cell.

Flag Checkbox
The Flag Checkbox is used to flag the photos the user wants to count towards their official score. A checked Flag Checkbox signifies a Flagged Photo, and an unchecked Flag Checkbox signifies an Unflagged Photo.

Photo
A Flagged Photo is displayed at 100% opacity and with a thick green stroke around the photo. An Unflagged Photo is displayed at 65% opacity and with a thin light grey stroke.

Viewing Associated Observation Icon, Orbiter Image, and Activity
When the user mouses over anywhere on the Photo Cell, the Map and Activity Planner areas of the interface display information associated with that Photo:

- The Map displays the last Orbiter Image taken before the Photo was taken.
- The orbiter image number feedback in the Orbiter Image Browser displays the associated orbiter image number (such as "4 / 7").
- The Observation Icon in the Map Main Area associated with the Photo changes appearance to the Selected Waypoint or Observation Icon (which is representative of the Rover's actual size):
  .
- The Activity Planner automatically scrolls to the associated Observation, so that the associated Observation is vertically located around the center of the Activity Planner. The associated Observation is automatically selected in the Activity Planner, and the associated Activity within that Observation is also selected.

When the user moves the mouse away from the Photo Cell, the Map and Activity Planner revert back to their previous states.

4.2 > Science Viewer Options Button

4.2.1 > Purpose

The Science Viewer Options button allows the user to specify various options that affect the appearance of the Science Viewer.

4.2.2 > Functionality & Interactions

Clicking the Science Viewer Button displays the Science Viewer Options Menu. The right edge of the menu is aligned with the right-edge of the Science Viewer Options Button and the bottom edge of the menu is aligned with the bottom edge of the Science Viewer Options Button. Clicking the Science Viewer Options Button when the Science Viewer Options Menu is currently displayed hides the Science Viewer Options Menu. The Science Viewer Options Menu contains the following items (note the position of the menu dividers):

Hide Flagged Photos
Hide Unflagged Photos
───────────────────

Photo Size >

<div style="text-align:center">

Large
✔ Medium
Small

</div>

All of the menu items with "Hide" as the first word act as visibility toggles. For example, clicking "Hide Flagged Photos" will hide the Flagged Photos in the Science Viewer, and the menu will disappear. Clicking on the Menu Options Button again would display the menu again, and the user would see "Show Flagged Photos", and clicking this will display the Flagged Photos in the Science Viewer again. The same principle applies to the other "Hide/ Show" menu items.

The Photo Size menu item and sub-menu items allow the user to specify the relative size of the photos as displayed in the Science Viewer.

5 > Activity Planner

Activity Planner Options Button

Changes Button

Library Button

History Button

Add Activity Button

Activity Planner Main Area

5.1 > Activity Planner Main Area

Label	
12:12 ◯ Waypoint (54, 34, 56)	.... Past and Future Split Pane Widget
12:12 ◉ Observation (26, 78, 39)	
12:12 ◯ Waypoint (54, 34, 56)	.... Runtime Marker
◆	.... Options
12:12 ◯ Waypoint (54, 34, 56)	
12:12 ◯ Downlink	.... Waypoints
12:12 ◯ Waypoint (54, 34, 56)	
12:12 ◉ Observation (26, 78, 39)	.... Downlink Marker
12:12 ◯ Waypoint (54, 34, 56)	
12:12 ◯ Waypoint (54, 34, 56)	.... Observations
12:12 ◯ Waypoint (54, 34, 56)	
12:12 ◉ Observation (26, 78, 39) [Add...] [−]	.... Photo Activities
12:12 ◉ Photo (45, 234, 90, 20, 40, 50)	
12:12 ◉ Wait ()	.... Wait Activities
12:12 ◯ Downlink	
12:12 ◉ Correction (-20,0,0)	.... Correction Activities
12:12 ◉ Photo (45, 234, 90, 20, 40, 50) [−]	

Zoom ——————— 125% .... Resource Monitor

12:12 [Sim ▶] .... Simulate Button

5.1.1 > Waypoints

12:12 ⟷ Waypoint (54, 34, 56)

5.1.1.1 > Purpose

Adding Waypoints to a Plan allows the user to specify specific points in the environment that they want the Rover to travel to. The system then figures out the low-level drive commands to send the Rover in order to reach those Waypoints.

5.1.1.2 > Functionality & Interactions

Adding a Waypoint to a Plan

Using the Add Activity Button
The user can click the Add Activity Button at the top of the Activity Planner and select "Waypoint". A new Waypoint will be added to the bottom of the Plan, and will automatically be placed in Edit Mode.

Using Text Entry
The user can type "Waypoint (" in the Activity Planner and the system will automatically recognize that they are entering a Waypoint Activity. A Waypoint Icon is then automatically displayed to the left of the text, and a time estimate (either Start Time or Duration) is displayed to the left of the Waypoint Icon. The Waypoint Edit Mode is automatically expanded below the Waypoint Activity. The user can then type the Waypoint Activity parameters, according to the following function signature:

Waypoint (X Position, Y Position, Drive Angle, Name)

Name is an optional parameter. If the user does enter a string for the Name parameter, that name is then displayed in the Activity Planner instead of the word "Waypoint". When the user is not editing this line of code, they wouldn't see the Name parameter. For example:
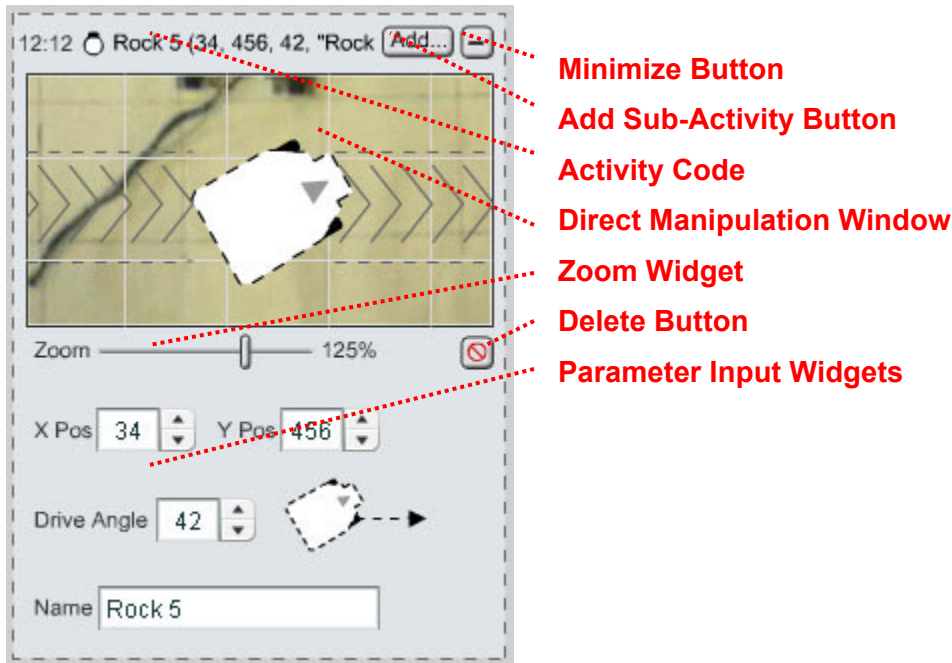Turning Corner (45, 235, 34)
But if they were editing this line of code, the Name parameter is visible:
Turning Corner (45, 235, 34, "Turning Corner")

Editing a Waypoint

The following is a screen shot of a Waypoint in Edit Mode:

Minimize Button

Add Sub-Activity Button

Activity Code

Direct Manipulation Window

Zoom Widget
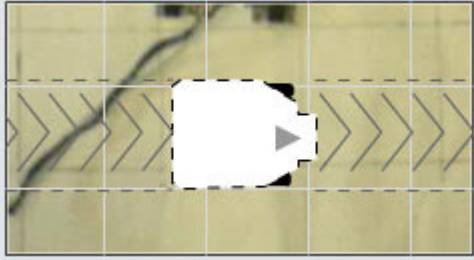
Delete Button

Parameter Input Widgets

Users can click on a Waypoint in the Activity Planner or the Map Main Area to bring it into Edit Mode. When a Waypoint is in Edit Mode, the corresponding Waypoint Icon in the Map Main Area is in Selection Mode.

Activity Code

Users can edit the Waypoint Activity's parameters by directly editing the Activity Code text. As they do so, the Direct Manipulation Window, the Parameter Input Widgets, the graphical parameter representations (Drive Angle), and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters. If the Activity Code is too long to fit in the designated area, it acts like a standard Text Box, in which only a specific amount of text is visible at any one time, and the user has to use the arrow keys to move through the text.

Direct Manipulation Window

Users can edit the Waypoint Activity's parameters by moving and rotating the Rover in the Direct Manipulation Window. As they do so, the Activity Code, the Parameter Input Widgets, the graphical parameter representations (Drive Angle), and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters.

As the user moves the Rover Icon to the edges of the Direct Manipulation Window, the background moves in the direction of the edge (left, right, up, down, etc.), acting like a joystick, so that the user can effectively move the Rover Icon anywhere in the environment.

When the cursor is hovered over the Direct Manipulation Window, the cursor changes to the following custom cursors:

Move Mode (the cursor is over the moveable area of the Rover Icon)

Moving the Rover Icon around modifies the Waypoint's X Pos and Y Pos parameters.

Rotate Mode (the cursor is over the rotatable area of the Rover Icon)
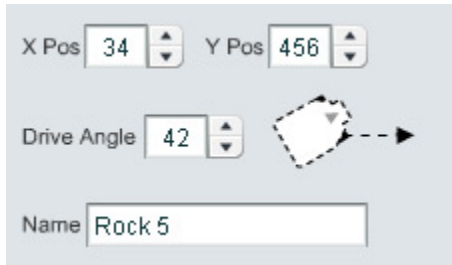

Rotating the Rover Icon modifies the Waypoint's Drive Angle parameter.

Zoom Widget

The Zoom Widget allows the user to zoom in and out of the image in the Direct Manipulation Window.

Parameter Input Widgets

Users can edit the Waypoint Activity's parameters by using the Parameter Input Widgets. As they do so, the Activity Code, the Direct Manipulation Window, the graphical parameter representations (Drive Angle), and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters.

- X Pos: The X Position of the Waypoint in relation to the Map.
- Y Pos: The Y Position of the Waypoint in relation to the Map.
- Drive Angle: The angle a which the Rover is oriented as it drives along the specified path. For the Mind Storm, the only possible options are 0 or 180 (since the Mind Storm can only drive forward or reverse). For PER, any angle from 0 to 360 is possible.
- Name: The default or user-specified name given to the Waypoint.
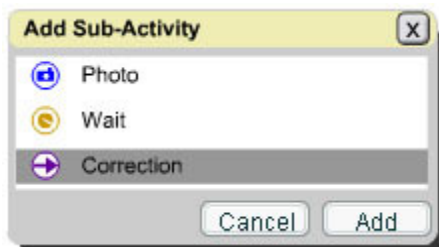
Delete Button

Pressing the Delete Button will remove the Activity from the plan, upon an 'OK' in a confirmation dialog box.

Add Sub-Activity Button

Users can add Sub-Activities to a Waypoint, at which point the Waypoint is changed into an Observation. Clicking the Add Sub-Activity Button results in the following dialog box:

Users click on a sub-activity and then the Add button to add a sub-activity to the Waypoint. The Add button is disabled until the user clicks on a sub-activity. Multiple selections are not allowed. After the user adds a sub-activity, the Add Sub-Activity dialog box is closed, the added sub-activity is in Edit Mode in the Activity Planner, and the Waypoint Icon is changed to an

Observation Icon. If the user hadn't renamed the default "Waypoint" Name, the Name of the Activity is changed to "Observation".

Minimize Button

To exit from Edit Mode, the user either presses the Minimize Button, or else clicks another Activity in the Plan.

5.1.2 > Observations

5.1.2.1 > Purpose

Observations are essentially Waypoints that have Sub-Activities. They serve as a Plan organizational tool. Observations represent a waypoint where the Rover has stopped to do anything other than a long drive, such as taking a photo, or executing a short correction drive.

5.1.2.2 > Functionality & Interactions

Adding an Observation to a Plan
Users add Observations to the Plan through the Activity Planner by first adding a Waypoint (as described above) and then adding a Sub-Activity to that Waypoint (also described above).

Editing an Observation
The following is a screen shot of an Observation in Edit Mode:
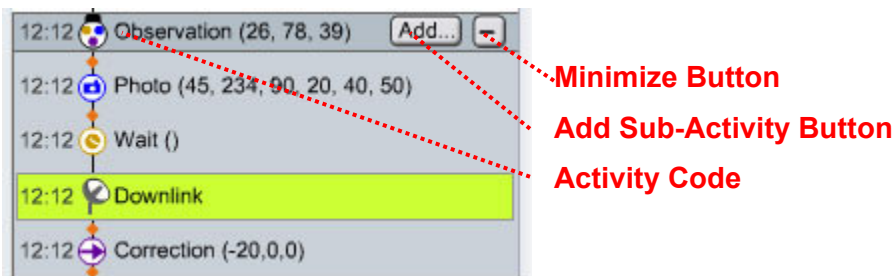
The user can click an Observation in the Activity Planner or the Map Main area to bring an Observation into Edit Mode. The Observation's Sub-Activities, which are normally hidden, and displayed. The user can click on any of the Sub-Activities to bring them into Edit Mode. When an

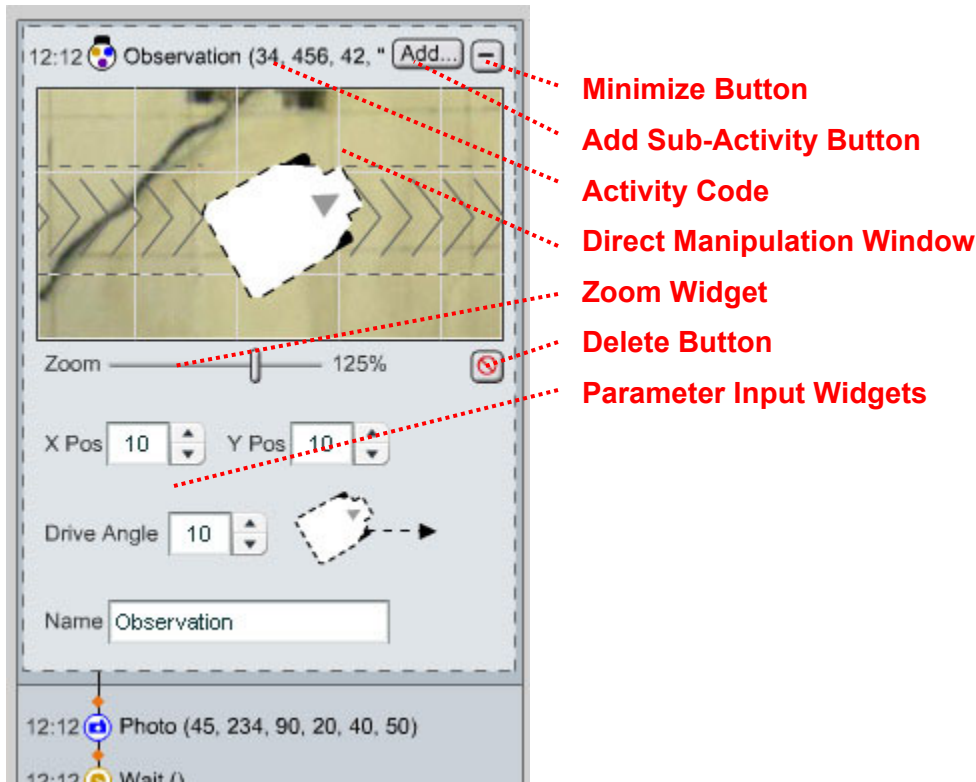Observation is in Edit Mode, the corresponding Observation Icon in the Map Main Area is in Selection Mode.

Observation Waypoint Edit Mode

To edit the Waypoint that makes up the first Activity of an Observation, the user clicks the Observation's Activity Code when it is in Edit Mode. This will bring up the Observation Waypoint Edit Mode, as seen in the screen shot below:

Activity Code

Users can edit the Observation Waypoint Activity's parameters by directly editing the Activity Code text. As they do so, the Direct Manipulation Window, the Parameter Input Widgets, the graphical parameter representations (Drive Angle), and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters. If the Activity Code is too long to fit in the designated area, it acts like a standard Text Box, in which only a specific amount of text is visible at any one time, and the user has to use the arrow keys to move through the text.

Direct Manipulation Window

Users can edit the Observation Waypoint Activity's parameters by moving and rotating the Rover in the Direct Manipulation Window. As they do so, the Activity Code, the Parameter Input Widgets, the graphical parameter representations (Drive Angle), and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters.

As the user moves the Rover Icon to the edges of the Direct Manipulation Window, the background moves in the direction of the edge (left, right, up, down, etc.), acting like a joystick, so that the user can effectively move the Rover Icon anywhere in the environment.

When the cursor is hovered over the Direct Manipulation Window, the cursor changes to the following custom cursors:

Move Mode (the cursor is over the moveable area of the Rover Icon)

Moving the Rover Icon around modifies the Observation Waypoint's X Pos and Y Pos parameters.

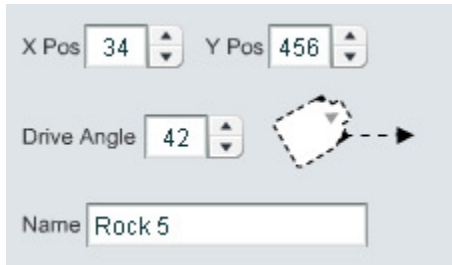*Rotate Mode* (the cursor is over the rotatable area of the Rover Icon)

Rotating the Rover Icon modifies the Observation Waypoint's Drive Angle parameter.

Zoom Widget

The Zoom Widget allows the user to zoom in and out of the image in the Direct Manipulation Window.

Parameter Input Widgets

Users can edit the Observation Waypoint Activity's parameters by using the Parameter Input Widgets. As they do so, the Activity Code, the Direct Manipulation Window, the graphical parameter representations (Drive Angle), and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters.

- X Pos: The X Position of the Observation Waypoint in relation to the Map.
- Y Pos: The Y Position of the Observation Waypoint in relation to the Map.
- Drive Angle: The angle a which the Rover is oriented as it drives along the specified path. For the Mind Storm, the only possible options are 0 or 180 (since the Mind Storm can only drive forward or reverse). For PER, any angle from 0 to 360 is possible.
- Name: The default or user-specified name given to the Observation.

Delete Button

Pressing the Delete Button will remove the Observation from the plan, upon an 'OK' in a confirmation dialog box.

Add Sub-Activity Button

Users can add Sub-Activities to an Observation clicking the Add Sub-Activity Button, which results in the following dialog box:
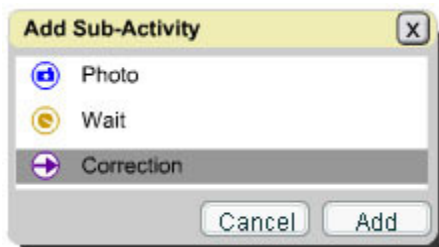
Users click on a sub-activity and then the Add button to add a sub-activity to the Observation. The Add button is disabled until the user clicks on a sub-activity. Multiple selections are not allowed. After the user adds a sub-activity, the Add Sub-Activity dialog box is closed, and the added sub-activity is in Edit Mode in the Activity Planner.

Minimize Button

When in Observation Waypoint Edit Mode, clicking the Minimize button collapses the Observation Waypoint Edit Screen. When in regular Observation Edit mode the user either presses the Minimize Button, or else clicks another Activity in the Plan to exit from Observation Edit Mode.

5.1.3 > Photo Activities

5.1.3.1 > Purpose
Adding a Photo Activity to a Plan allows the user to command the Rover to take a photograph.

5.1.3.2 > Functionality & Interactions

Adding a Photo to a Plan

Using the Add Activity Button
The user can click the Add Sub-Activity Button in either the Observation Edit Mode window or the Waypoint Edit Mode window and select "Photo". A new Photo activity will be added to the bottom of the Sub-Plan, and will automatically be placed in Edit Mode.

Using Text Entry
The user can type "Photo (" in the Activity Planner and the system will automatically recognize that they are entering a Photo Activity. A Photo Icon is then automatically displayed to the left of the text, and a time estimate (either Start Time or Duration) is displayed to the left of the Photo Icon. The user can then type the Photo Activity parameters, according to the following function signature:

Mind Storm:
Photo (X Offset, Y Offset, Angle)

PER:
Photo (X Offset, Y Offset, Rover Angle, Camera Angle, Image Distance, FOV)

The Photo Edit Mode is then automatically expanded below the Photo Activity.

If the user types a Photo Activity in the Activity Planner outside the scope of an Observation, the system will do one of two things:

1. If there is an Observation directly above the Photo Activity, that Observation will expand, and the Photo Activity will be placed as the last Sub-Activity within that Observation.
2. Otherwise, the Waypoint above the Photo Activity will turn into an Observation, expand, and the Photo Activity will be placed as a Sub-Activity within that Observation.

Editing a Photo

The following is a screen shot of a Photo Activity in Edit Mode:

Mind Storm:

PER:

Minimize Button

Activity Code

Direct Manipulation Window

Zoom Widget

Delete Button

Parameter Input Widgets
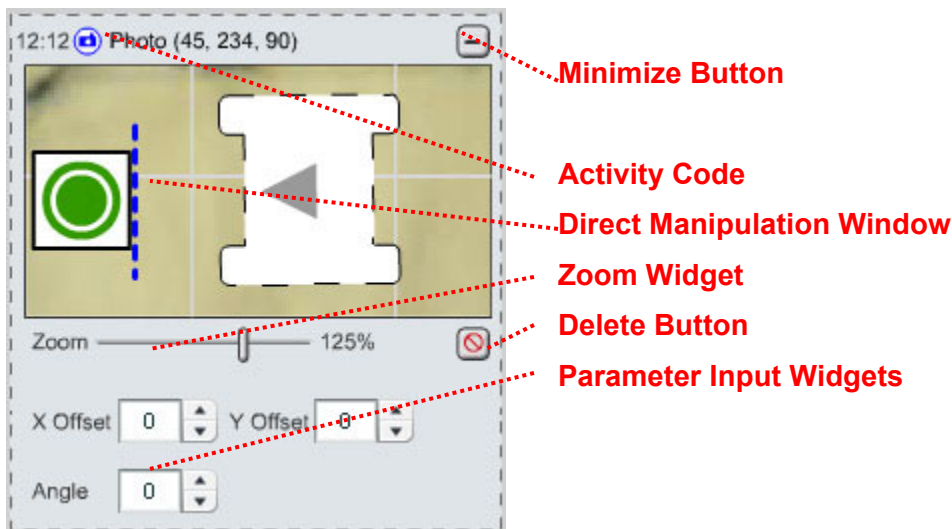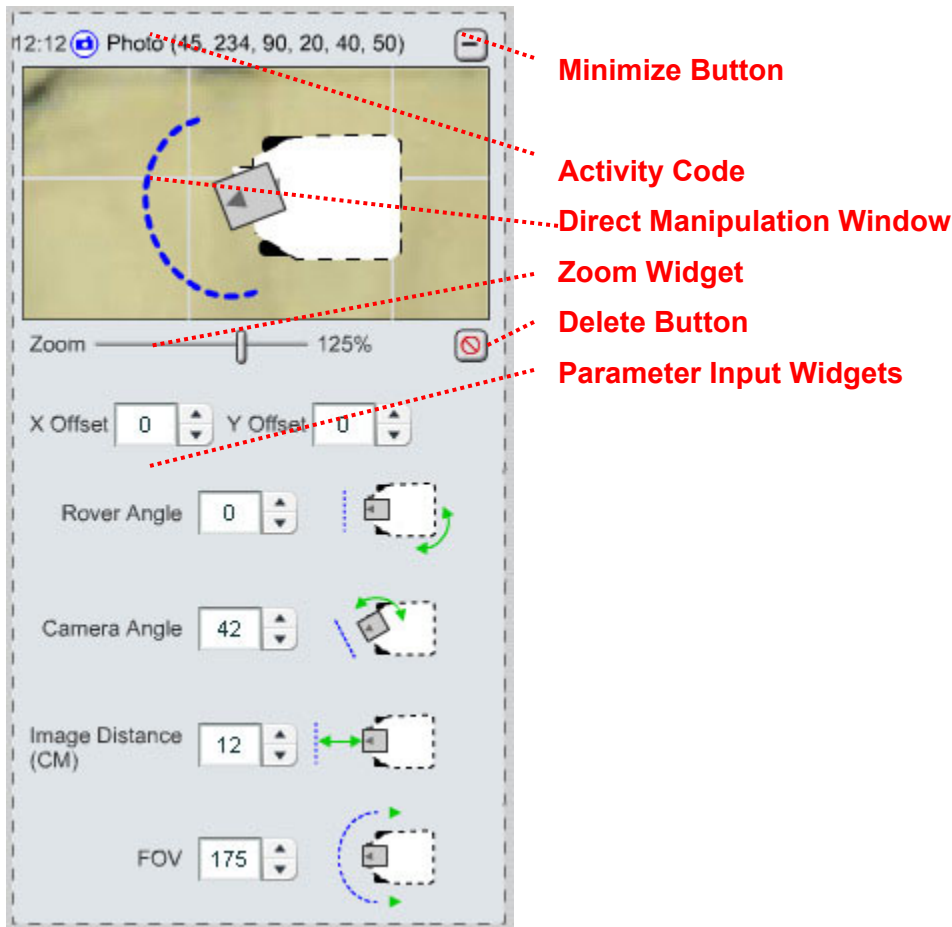
Science Viewer

When a Past Photo Activity is in Selected (Edit) Mode, the following events occur:

- The Science Viewer scrolls to the associated Photo, which is displayed in Selected Mode.
- The Map displays the last Orbiter Image taken before the Photo was taken.
- The orbiter image number feedback in the Orbiter Image Browser displays the associated orbiter image number (such as "4 / 7").

When the Past Photo Activity is no longer in Selected Mode, the above interface elements revert back to their previous state.

Activity Code

Users can edit the Photo Activity's parameters by directly editing the Activity Code text. As they do so, the Direct Manipulation Window, the Parameter Input Widgets, and the graphical

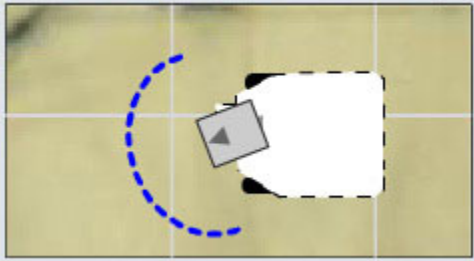parameter representations change in real-time to reflect the new parameters. If the Activity Code is too long to fit in the designated area, it acts like a standard Text Box, in which only a specific amount of text is visible at any one time, and the user has to use the arrow keys to move through the text.

Direct Manipulation Window

Users can edit the Photo Activity's parameters by moving and rotating the Rover in the Direct Manipulation Window. As they do so, the Activity Code, the Parameter Input Widgets, and the graphical parameter representations change in real-time to reflect the new parameters.

As the user moves the Rover Icon to the edges of the Direct Manipulation Window, the background moves in the direction of the edge (left, right, up, down, etc.), acting like a joystick, so that the user can effectively move the Rover Icon anywhere in the environment.

A dotted Photo Line is also displayed along with the Rover Icon in order to show an estimated surface plane of the photo that will be taken.

The user can directly manipulate:

- The Photo Line. For both Mindstorm and PER, the user can move and rotate the Photo Line, and the Rover Icon and the parameters will adjust automatically. For PER, the user can also directly manipulate the Field of View (FOV).
- The Rover. For both Mind Storm and PER, the user can move and rotate the Rover Icon, and the Photo Line and the parameters will adjust automatically.
- The Camera. For PER only, the user can independently move and rotate the camera, and the Photo Line and the parameters will adjust automatically.

When the cursor is hovered over the Direct Manipulation Window, the specific component (either the Photo Line, the Camera, or the Rover Icon) which would be modified – based on the cursor's position - is highlighted with a yellow halo around its representation. The cursor changes to the following custom cursors:

Move Mode (the cursor is over the moveable area of the Rover Icon or the Photo Line)

✛

Moving the Rover Icon around modifies the Photo's X Offset and Y Offset parameters. Moving the Photo Line around modifies the Photo's X Offset, Y Offset, and for PER only, the Image Distance parameters. The user cannot move the Camera Icon independently of the Rover Icon (at least for our current robotic platforms).

Rotate Mode (the cursor is over the rotatable area of the Rover Icon, the Camera Icon, or the Photo Line)

↶

Rotating the Rover Icon modifies the Photo's Rover Angle parameter. Rotating the Camera Icon (PER only) modifies the Photo's Camera Angle parameter. Rotating the Photo Line modifies the Photo's X Offset, Y Offset, and Rover Angle parameters.

*FOV Mode* (the cursor is over either end of the Photo Line – PER only)

⟫

Directly manipulating the FOV modifies the Photo's FOV parameter. The exact interaction for directly manipulating the FOV is to be determined in the next version of this specification.

Zoom Widget

Zoom ——————⬦—— 125%

The Zoom Widget allows the user to zoom in and out of the image in the Direct Manipulation Window.

Parameter Input Widgets
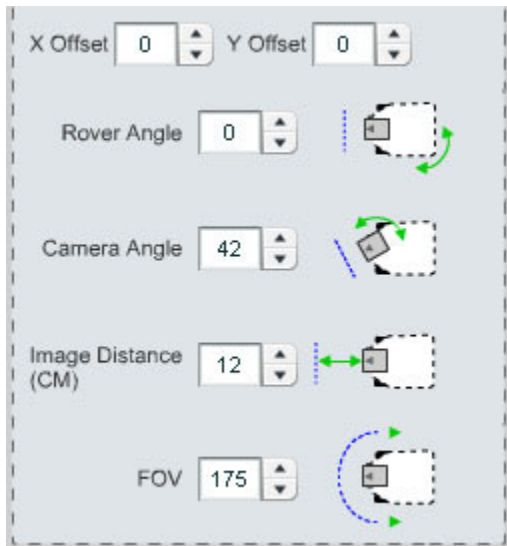
Users can edit the Photo Activity's parameters by using the Parameter Input Widgets. As they do so, the Activity Code, the Direct Manipulation Window, the graphical parameter representations, and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters.

- X Offset. The horizontal distance the Rover should move from the original Observation Waypoint's position before taking a picture.
- Y Offset. The vertical distance the Rover should move from the original Observation Waypoint's position before taking a picture.
- Rover Angle. The angle the Rover should turn from the original Observation Waypoint's position before taking a picture.
- Camera Angle (PER only). The angle the Camera should rotate in relation to the Rover body before taking a picture.
- Image Distance (PER only). The distance the image should be taken from the camera. This effects the tilt of the camera.
- Field of View (PER only). The desired field of view for the photo. PER is capable of taking multiple images and then stitching them together, which effectively translates to a FOV.

Delete Button

Pressing the Delete Button will remove the Activity from the plan, upon an 'OK' in a confirmation dialog box.

Minimize Button

To exit from Edit Mode, the user either presses the Minimize Button, or else clicks another Activity in the Plan.

5.1.4 > Correction Activities

12:12 ⊕ Correction (-20,0,0)

5.1.4.1 > Purpose

Adding Correction Activities to the Plan allows the user to fine-tune the position of the Rover. While Waypoints are placed on the Map Main Area generally for long drives, Correction Activities are added to the Plan to specify very short drives. The drive distance for a Correction Activity is restricted to no longer than the size of the Rover.

5.1.4.2 > Functionality & Interactions

Adding a Correction to a Plan

Using the Add Activity Button
The user can click the Add Sub-Activity Button in either the Observation Edit Mode window or the Waypoint Edit Mode window and select "Correction". A new Correction activity will be added to the bottom of the Sub-Plan, and will automatically be placed in Edit Mode.

Using Text Entry
The user can type "Correction (" in the Activity Planner and the system will automatically recognize that they are entering a Correction Activity. A Correction Icon is then automatically displayed to the left of the text, and a time estimate (either Start Time or Duration) is displayed to the left of the Correction Icon. The user can then type the Correction Activity parameters, according to the following function signature:

Correction (X Offset, Y Offset, Angle)

The Correction Edit Mode is then automatically expanded below the Correction Activity.

If the user types a Correction Activity in the Activity Planner outside the scope of an Observation, the system will do one of two things:

1. If there is an Observation directly above the Correction Activity, that Observation will expand, and the Correction Activity will be placed as the last Sub-Activity within that Observation.

2. Otherwise, the Waypoint above the Correction Activity will turn into an Observation, expand, and the Correction Activity will be placed as a Sub-Activity within that Observation.

Editing a Correction

The following is a screen shot of a Correction Activity in Edit Mode:
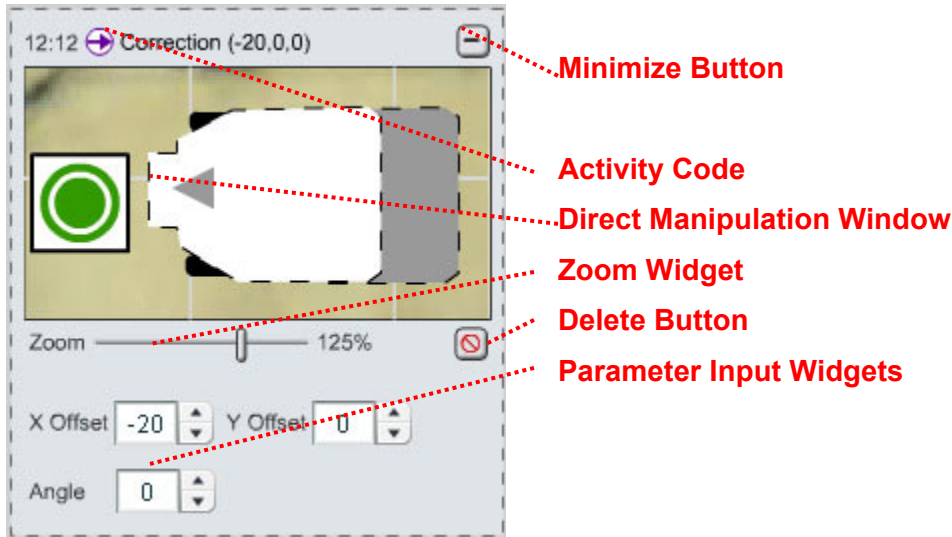
Activity Code

Users can edit the Correction Activity's parameters by directly editing the Activity Code text. As they do so, the Direct Manipulation Window and the Parameter Input Widgets change in real-time to reflect the new parameters. If the Activity Code is too long to fit in the designated area, it acts like a standard Text Box, in which only a specific amount of text is visible at any one time, and the user has to use the arrow keys to move through the text.

Direct Manipulation Window

Users can edit the Correction Activity's parameters by moving and rotating the Rover in the Direct Manipulation Window. As they do so, the Activity Code and the Parameter Input Widgets change in real-time to reflect the new parameters.

As the user moves the Rover Icon to the edges of the Direct Manipulation Window, the background moves in the direction of the edge (left, right, up, down, etc.), acting like a joystick.

The drive distance for a Correction Activity is restricted to no longer than the size of the Rover. The original Rover position icon is displayed behind the Correction Waypoint Rover icon in a dark grey.

When the cursor is hovered over the Direct Manipulation Window, the cursor changes to the following custom cursors:

Move Mode (the cursor is over the moveable area of the Rover Icon)

Moving the Rover Icon around modifies the Correction's X Offset and Y Offset parameters.

Rotate Mode (the cursor is over the rotatable area of the Rover Icon)

Rotating the Rover Icon modifies the Correction's Angle parameter.

Zoom Widget

The Zoom Widget allows the user to zoom in and out of the image in the Direct Manipulation Window.

Parameter Input Widgets

Users can edit the Correction Activity's parameters by using the Parameter Input Widgets. As they do so, the Activity Code, the Direct Manipulation Window, and the corresponding Waypoint Icon in the Map Main Area change in real-time to reflect the new parameters.

- X Offset. The horizontal distance the Rover should move from the Rover's previous position.
- Y Offset. The vertical distance the Rover should move from the Rover's previous position.
- Angle. The angle the Rover should turn from the Rover's previous position.

Delete Button

Pressing the Delete Button will remove the Activity from the plan, upon an 'OK' in a confirmation dialog box.

Minimize Button

To exit from Edit Mode, the user either presses the Minimize Button, or else clicks another Activity in the Plan.

5.1.5 > Wait Activities

5.1.5.1 > Purpose
Adding Wait Activities to the Plan allows the user to command the Rover to stop and do nothing for a specified amount of time before moving on to the next Activity in the Plan.

5.1.5.2 > Functionality & Interactions

Adding a Wait Activity to a Plan

Using the Add Activity Button
The user can click the Add Sub-Activity Button in either the Observation Edit Mode window or the Waypoint Edit Mode window and select "Wait". A new Wait activity will be added to the bottom of the Sub-Plan, and will automatically be placed in Edit Mode.

Using Text Entry
The user can type "Wait (" in the Activity Planner and the system will automatically recognize that they are entering a Wait Activity. A Wait Icon is then automatically displayed to the left of the text, and a time estimate (either Start Time or Duration) is displayed to the left of the Wait Icon. The user can then type the Wait Activity parameters, according to the following function signature:

Wait ()

(Note: In this version of the Functionality Specification, there is one type of Wait command: Wait Until Next Download. It is conceivable, however, that other Rover platforms may have tools on board that would require the user to specify a particular amount of time to wait, and so we've left this option open.)

The Wait Edit Mode is then automatically expanded below the Wait Activity.

If the user types a Wait Activity in the Activity Planner outside the scope of an Observation, the system will do one of two things:

1. If there is an Observation directly above the Wait Activity, that Observation will expand, and the Wait Activity will be placed as the last Sub-Activity within that Observation.
2. Otherwise, the Waypoint above the Wait Activity will turn into an Observation, expand, and the Wait Activity will be placed as a Sub-Activity within that Observation.

Editing a Wait Activity

The following is a screen shot of a Wait Activity in Edit Mode:

Activity Code

Users can edit the Wait Activity's parameters by directly editing the Activity Code text. As they do so, the Direct Manipulation Window and the Parameter Input Widgets change in real-time to reflect the new parameters. If the Activity Code is too long to fit in the designated area, it acts like a standard Text Box, in which only a specific amount of text is visible at any one time, and the user has to use the arrow keys to move through the text.

Direct Manipulation Window
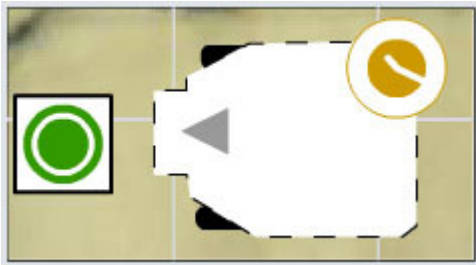
The user cannot interact with the Direct Manipulation Window for a Wait Activity. It is only displayed as feedback so the user knows where the Rover is located when the Wait command will execute. The user is made aware of this lack-of-affordance by the fact that the cursor does not change when being moved around the Direct Manipulation Window.
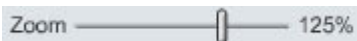
Zoom Widget

The Zoom Widget allows the user to zoom in and out of the image in the Direct Manipulation Window.

Parameter Input Widgets
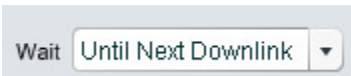
Users can edit the Wait Activity's parameters by using the Parameter Input Widgets. In this version of the Functionality Specification, there is one type of Wait command (and so only one item in the combo box): Wait Until Next Download. It is conceivable, however, that other Rover platforms may have tools on board that would require the user to specify a particular amount of time to wait, and so we've left this option open.

Delete Button

Pressing the Delete Button will remove the Activity from the plan, upon an 'OK' in a confirmation dialog box.

Minimize Button

To exit from Edit Mode, the user either presses the Minimize Button, or else clicks another Activity in the Plan.

5.1.6 > Downlink Marker

5.1.6.1 > Purpose

The Downlink Marker shows the user where in their Plan they will receive telemetry data.

5.1.6.2 > Functionality & Interactions

Downlink Markers are automatically added to the Plan as the user adds Activities. The user does not manipulate the Downlink Markers; they are only there to give the user feedback of what points in the Plan the user will receive telemetry data back from the Rover.

5.1.7 > Runtime Marker
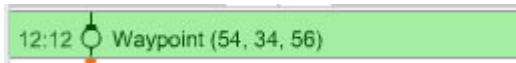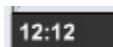

5.1.7.1 > Purpose

The Runtime Marker shows the user which Activity the system estimates is currently being executed on the Rover.

5.1.7.2 > Functionality & Interactions

The Runtime Marker always remains in the same place. As the Plan executes it scrolls upward, and the estimated currently running activity moves behind the Runtime Marker. The user does not manipulate the Runtime Marker; it is only there to give the user feedback of the system's estimate of which Activity is currently being executed by the Rover.

When an Observation arrives at the Runtime Marker, the Observation automatically expands to display it's Sub-Activities, so that the user can see when each of the Sub-Activities is being executed (estimated).

5.1.8 > Resource Monitor

5.1.8.1 > Purpose

The Resource Monitor gives the user feedback of the relevant total Resource consumption of a given plan (for both the Nominal or Optional Plans).

5.1.8.2 > Functionality & Interactions

The user does not manipulate the Resource Monitor; it is only there to give the user feedback of the relevant total Resource consumption of a given plan. When there is more than one Plan Option visible on the screen at once, a separate Resource Monitor is displayed for each of the Plans. This allows the user to compare the total Resource consumption of each Plan Option. In our limited Rover domain, the only crucial Resource is the total time taken to executed a Plan. For other, more complex Rover domains, the Resource Monitor would also display other relevant Resources, such as battery consumption or memory usage.

5.1.9 > Simulate Button

Play

Stop

5.1.9.1 > Purpose

The Simulate Button allows the user to visually simulate a Plan in the Map Main Area.

5.1.9.2 > Functionality & Interactions

The user presses the Simulate Play Button to simulate a Plan in the Map Main Area. The Now Icon moves along the Planned path at twice the normal speed. As it arrives at Observations, it rotates and waits according to the Sub-Activities within the Observation. As the Simulation plays, the Activities in the Activity Planner scroll up as if they were being executed in real-time (but at twice the speed).

When the Simulation is currently playing, the Simulate Play Button changes to the Simulate Stop Button. The user pressed the Simulate Stop Button in order to stop the Simulation, at which point all interface elements return to their previous states, and the Simulate Stop Button changes to the Simulate Start Button.

Each Plan Option has it's own Simulate Button.

5.1.10 > Options

5.1.10.1 > Purpose

Adding options to a Plan allow the user to specify optional Plan paths ahead of time. For example, they may want to linger and examine a target if they discover it is of high value, but otherwise they would just move on to the next target. Explicitly planning out these two options ahead of time allows the user to quickly choose between one of the two options when they reach their decision point, rather than having to spend time re-planning in real-time when they reach their decision point.

5.1.10.2 > Functionality & Interactions

Adding an Option

The Plan as represented in the Activity Planner includes Option Triggers, which are small orange diamonds:


12:12 Observation (26, 78, 39)

These represent points in the plan where the user can add Optional Plan paths. The user interacts with these Option Triggers to add Optional Plan paths. The details of this interaction are to be designed for the next version of this Specification.

Users can add up to two Optional Plan paths at any given Option Trigger, giving them a total of three possible Options at any given decision point (one nominal and two optional). This number is derived from user research, but should be verified with further user testing.

Option Representation in the Activity Planner

An Option is represented in the Activity Planner with a large orange diamond and a dotted orange line going off to the left or the right. The Optional Plan then proceeds down the screen in the same way as an Nominal Plan, except the line connecting the Activities is orange and dotted, the background color is a light gray, the detailed signature of each Activity is not displayed (unless selected), and the background color of the Resource Monitor is a light gray. See screen shot below:
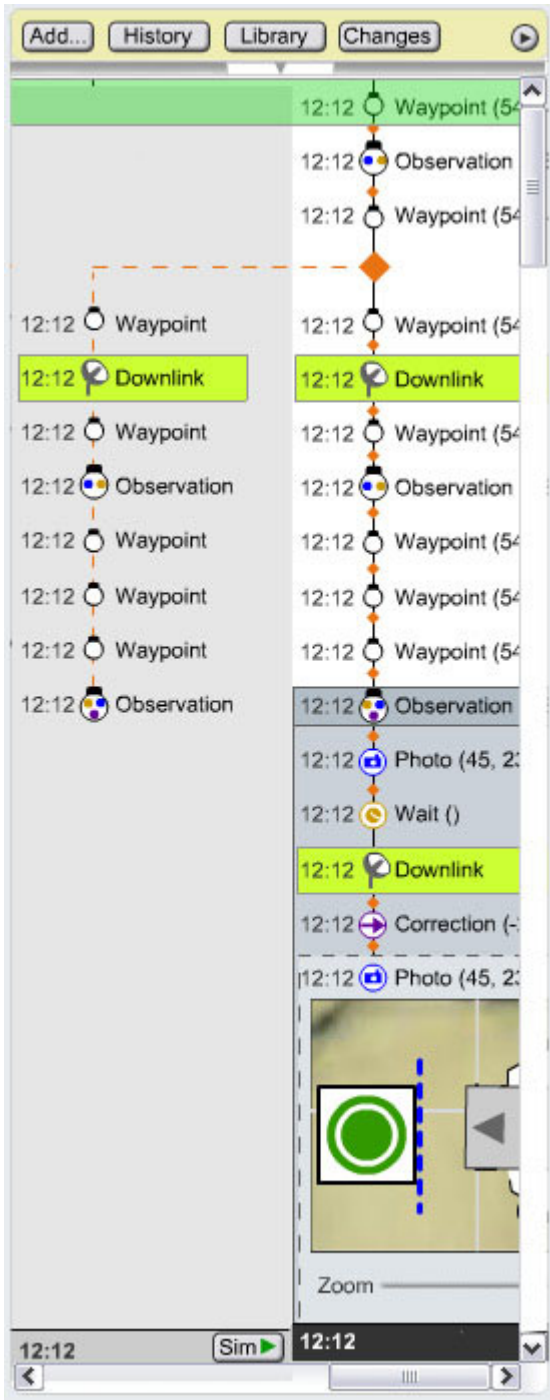
The Resource Monitor and Simulation Button are applicable to each specific Optional Plan path.

Our original design ideas had separate representations for different types of Options (Fork, Delay, Rush, Delete, Insert, Skip, Detour). However, when we showed these representations to users at JPL, they had difficulty understanding the graphical representations of the different option types. They commented that they would rather see the Optional Plan path represented as a completely

separate line, even if it meant repeating Activities that were present in the Nominal Plan path. This streamlined representation also makes it very easy for users to compare the Resources used in each Optional Plan path. So for now, we are only representing the Optional Plan paths as single unique lines. This representation, however, needs to be fully flushed out and user tested, and should be further refined in the next version of this Specification (for example: how would you represent an Optional Delete?).

Interactions

The exact interactions involved with specifying, viewing, and then choosing an Optional Plan are to be designed for the next version of this Specification. Questions to be addressed:

- What is the exact interaction for adding an Optional Plan?
- Currently, the user has to horizontally scroll to see three Optional Plan side-by-side. Is this acceptable? Should more screen-real-estate be delegated to the Activity Planner?
- How and at what points can users turn an Optional Plan into a Nominal Plan?
- What if two Optional Plan paths visually overlap? Is there a way to hide and show individual Optional Plan paths?
- Are all types of Options (Fork, Delay, Rush, Delete, Insert, Skip, Detour) adequately representable using the simplified single line Optional Plan path representation?

5.1.11 > Calibration

Direct Manipulation Window

Zoom Widget

Parameter Input Widgets

Start Rover Button
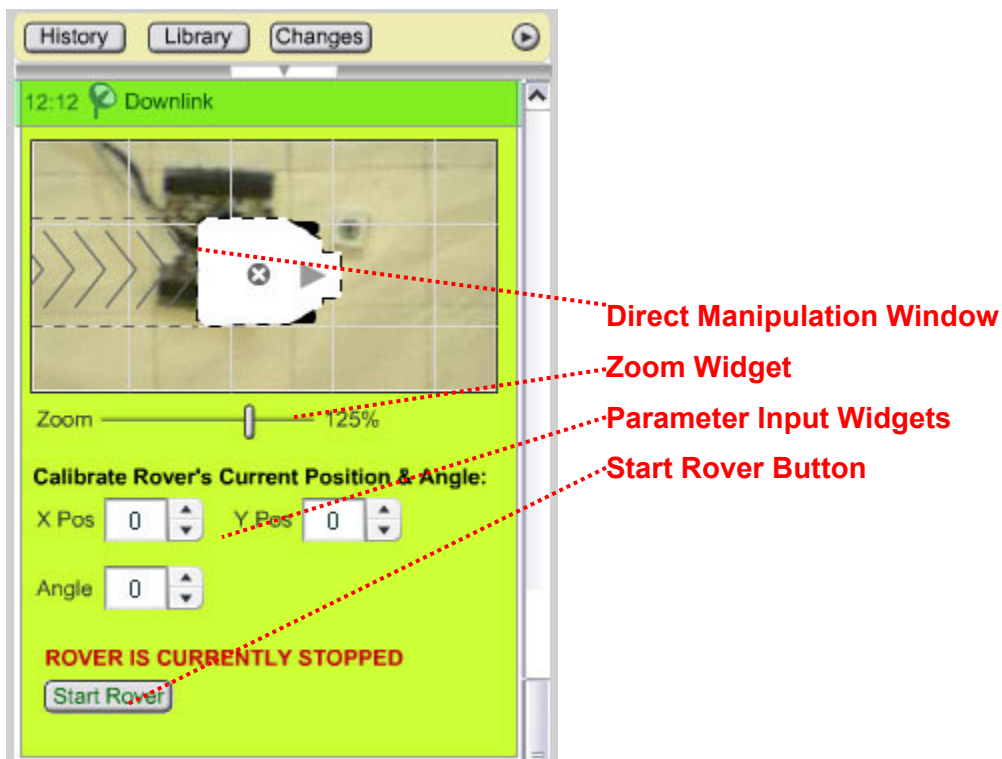
5.1.11.1 > Purpose

Calibration allows the user to update the system's model of ground truth (where the Rover currently and actually is) after each Downlink.

**5.1.11.2 > Functionality & Interactions**

Temporal Aspects

As the Plan executes in real-time, the Activities in the Activity Planner scroll up past the Runtime Marker. When the Plan gets to a Downlink point, the Rover automatically stop executing Activities. The Downlink Marker moves behind the Runtime Marker, and the Downlink Marker animates to expand and display the Calibration interface.

The user will see the Rover's actual position from the newly acquired Orbiter Image. They will then be given a chance to update the system's model of ground truth, or where the Rover currently is. This assures that the rest of the plan will be executed according to where the Rover actually is, as opposed to where the system thought the Rover would be.

The Now Icon is displayed in the Calibration interface in it's editable state so that the user can manipulate the Now Icon. After the user has corrected the position of the Now Icon, they press the Start Rover button to continue execution of the Plan.

Direct Manipulation Window
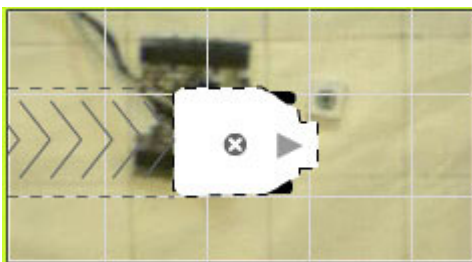
Users can edit the Calibration's parameters by moving and rotating the Rover in the Direct Manipulation Window. As they do so, the Parameter Input Widgets change in real-time to reflect the new parameters.

As the user moves the Rover Icon to the edges of the Direct Manipulation Window, the background moves in the direction of the edge (left, right, up, down, etc.), acting like a joystick, so that the user can effectively move the Rover Icon anywhere in the environment.

When the cursor is hovered over the Direct Manipulation Window, the cursor changes to the following custom cursors:

Move Mode (the cursor is over the moveable area of the Rover Icon)

Moving the Rover Icon around modifies the Calibration's X Pos and Y Pos parameters.

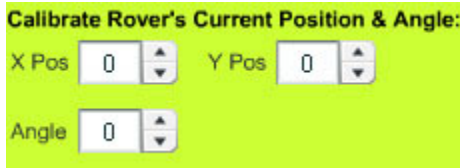*Rotate Mode* (the cursor is over the rotatable area of the Rover Icon)

Rotating the Rover Icon modifies the Calibration's Angle parameter.

Zoom Widget

The Zoom Widget allows the user to zoom in and out of the image in the Direct Manipulation Window.

Parameter Input Widgets

Users can edit the Calibration's parameters by using the Parameter Input Widgets. As they do so, the Direct Manipulation Window and the corresponding Now Icon in the Map Main Area change in real-time to reflect the new parameters.

- X Pos. The X position of the Now Icon.
- Y Pos. The Y position of the Now Icon.
- Angle. The angle of the Now Icon.

## 5.1.12 > Past and Future Split Pane Widget

5.1.12.1 > Purpose

The Past and Future Split Pane Widget allows the user to quickly hide and show Activities that have recently been executed. It is essentially a dividing line between Activities that have yet to execute or are currently executing and those Activities which have already executed.

5.1.12.2 > Functionality & Interactions

The Past and Future Split Pane Widget hides past Activities by default. To Display past Activities, the user clicks the Split Pane Widget, which then animates downward to reveal the most recent past Activities. The arrow in the center of the Split Pane Widget points upward when past Activities are visible. To hide visible past Activities, the user clicks the Split Pane widget, which then animates upward to hide the past Activities.

Past Activities are displayed in the Activity Planner with a grey background, and are not editable. All of the clickable behaviors of Observations, Waypoints, and Activities (such as clicking a Waypoint and having it's corresponding Waypoint in the Map Main Area turn highlighted) are still applicable to past Activities, but user cannot edit any of the parameters of past Activities. Visible past Activities appear as follows:
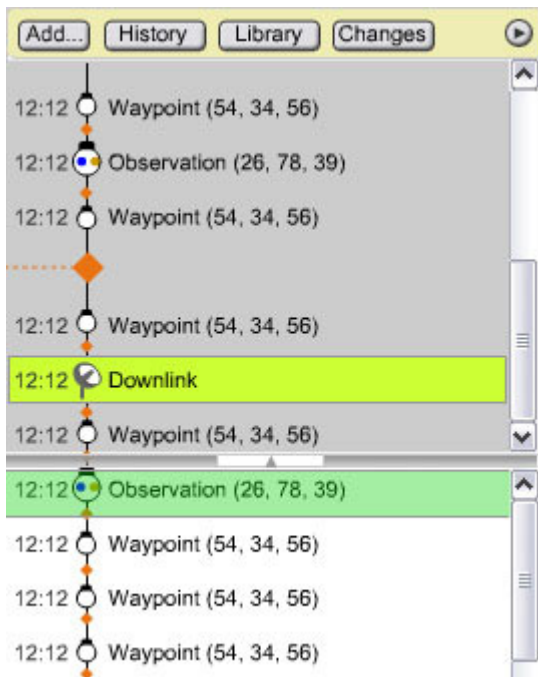
5.1.13 > Text Entry Behavior

Text entry in the Activity Planner Main Area should behavior similarly to any standard text editor, such Word or Note Pad. However, there are small nuances involved with the Activity Planner that need to be completely flushed out. This will be handled in the next version of this Specification.
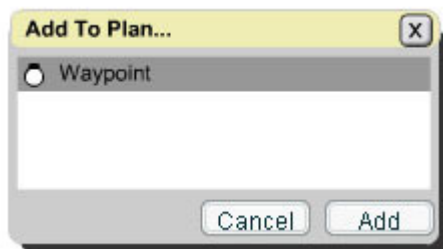
5.2 > Add Activity Button

5.2.1 > Purpose

The Add Activity Button allows the user to add Activities to the Plan without typing the code directly.

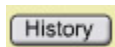### 5.2.2 > Functionality & Interactions

Users can add Activities to the Plan by clicking the Add Activity Button, which results in the following dialog box:

Users click on an Activity and then the Add button to add an Activity to the Plan. The Add button is disabled until the user clicks on an Activity. Multiple selections are not allowed. After the user adds an Activity, the Add Sub-Activity dialog box is closed, and the added Activity is in Edit Mode in the Activity Planner.

Note that currently the only type of Activity the user can add from the Add Activity Button is a Waypoint. (Of course they can add Sub-Activities, such as Photo, Wait, and Correction, to a Waypoint or Observation using the Add Sub-Activities Button within a Waypoint or Observation Edit Mode screen.) With our current domain and design, Waypoint is the only type of activity that can logically be added to the Plan at this level. However, we wanted the design to be flexible enough that that other types of Activities could be added in future versions of this Specification if need be.

5.3 > History Button

5.3.1 > Purpose

The History Button displays a pop-up window where the user can view, search, sort, and filter all executed Activities from the current and past sols (days).

5.3.2 > Functionality & Interactions

Although the user can use the Past and Future Split Pane Widget in the Activity Planner Main Area to quickly view recently executed Activities, we also think there is a need for a more detailed and isolated view of past Activities, or History. This isolated view, in it's own window, would allow the user to view Activities from the current as well as past sols. It would also offer more advanced interactive features that would be relevant to History but not present in the Activity Planner Main Area, such as searching, sorting, and filtering, and potentially other advanced features. The details of the History window need to be worked out in the next version of this Specification.

5.4 > Library Button

Library

5.4.1 > Purpose

The Library Button allows the user to access the Library in a separate window. The Library allows the user to create and store macros, so that they can quickly add commonly-used combinations of Activities to their Plan without having to create them from scratch.

5.4.2 > Functionality & Interactions

We think there is a strong need to have a Library area of the interface where users can create and access macros. These macros would be commonly-used combinations of Activities which the user could then easily add to their Plan, specifying each time the parameters required by the macro. The details of the Library – it's functionality and interactions – are to be designed for the next version of this Specification.

5.5 > Changes Button
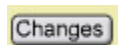
Changes

5.5.1 > Purpose

The Changes Button allows the user to access the Changes window, where they can review and revert back to specific edit points.

5.5.2 > Functionality & Interactions

The Changes window would work in a similar fashion to the PhotoShop History Palette. The exact functionality and interactions are to be designed for the next version of this Specification.

5.6 > Activity Planner Options Button

5.6.1 > Purpose

The Activity Planner Options button allows the user to specify various options that affect the appearance and behavior of the Activity Planner.

5.6.2 > Functionality & Interactions

Clicking the Activity Planner Options Button displays the Activity Planner Options Menu. The right edge of the menu is aligned with the right-edge of the Activity Planner Options Button and the top edge of the menu is aligned with the bottom edge of the Activity Planner Options Button. Clicking the Activity Planner Options Button when the Activity Planner Options Menu is currently displayed hides the Activity Options Menu. The Activity Planner Options Menu contains the following items (note the position of the menu dividers):

View Visual Mode
View Code Mode
————————————————

View Activity Start Times
View Activity Durations

View Visual Mode and View Code Mode act like radio buttons: only one can be selected at a time, and one of the options must always be selected. Whichever option is selected will have a checkmark graphic to the left of the text. When in Visual Mode, the Activity Planner displays all graphical representations, including Waypoint, Observation, and Activity icons, Direct Manipulation Windows, and Parameter Input Widgets. When in Code Mode, the Activity Planner displays text only. This is an expert mode in which the user is not slowed down by graphical representations and can essentially type code freely.

View Activity Start Times and View Activity Durations act like radio buttons: only one can be selected at a time, and one of the options must always be selected. Whichever option is selected will have a checkmark graphic to the left of the text. When View Activity Start Times is selected, the Activity start times are displayed next to each line in the Activity Planner. When View Activity Durations is selected, the Activity durations are displayed next to each line in the Activity Planner. This was designed this way because of limited screen space. This should be verified with user tests however, as it may turn out that users need to view both the Activity start times and the Activity durations at the same time.

There are many other possibly items that could be added to the Activity Planner Options Menu, and these possibilities will be explored in the next version of this Specification.