Lapidary Reference Manual

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Abstract

This document describes the features and operations provided by Lapidary, a graphical interface builder that allows a user to pictorially specify all graphical aspects of an application and interactively create much of the behavior. Lapidary allows a user to draw most of Opal's objects, combine them into aggregadgets, align them using iconic constraint menus or custom constraints, and create behaviors by entering appropriate parameters in dialog boxes representing each of Garnet's interactors, or by demonstrating the appropriate behavior for feedback objects.

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1. Getting Started

To load Lapidary, type `(load garnet-lapidary-loader)` after Garnet has been loaded, or type `(defvar load-lapidary-p t)` before Garnet is loaded, and Garnet will automatically load Lapidary when the Garnet loader file is invoked. To start Lapidary, type `(lapidary:do-go)`. This will cause Lapidary to come up in its initial state with the following windows:

- editor-menu: This menu contains a set of functions that deal with aggregadgets, constraints, saving and restoring objects, deleting objects, and setting properties of objects.
- shapes menu: This menu allows the designer to create opal graphical objects and windows.
- box-constraint menu: This menu allows the designer to attach constraints to an object that control its left, top, width, and height.
- drawing window: This window allows the designer to create new objects or load objects from existing files.

1.1. Object Creation

Lapidary allows new objects to be created from scratch, loaded from pre-defined gadgets files, or created directly in Garnet and then linked to a Lapidary window. The shapes menu displays the primitive graphical objects that can be created in Lapidary.

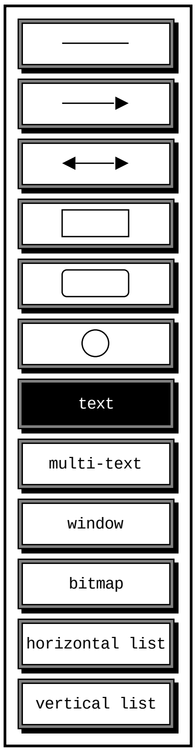


Figure 1-1: Shapes menu

The first six geometric shapes can be created by selecting the appropriate menu-item and sweeping out the item in a drawing window with the right mouse button down. Feedback corresponding to the selected shape will be shown as the object is swept out. Properties such as line-style, filling-style, and draw-function can be set from the corresponding property menus (see section 2.3).

To create a single line of text, select text and then click where you want the text to start. A cursor will appear and one line of text can be entered from the keyboard. For more than one line of text use multi-text. Single-line text can be terminated with either a mouse click or by hitting RETURN but, multi-line text can only be terminated by a mouse click.

To create a window, select the `window` menu-item and Lapidary will create a new window. Since, new windows initially have the same size and location as the draw window, they must be moved in order to expose the original draw window.

Bitmaps can be loaded by selecting the `bitmap` menu-item. Lapidary brings up a dialog box that allows the user to enter the name of an image file and the window that the bitmap should be placed in. The window name is obtained from the title border that surrounds a window or the name that appears in the icon for the window.

To create a horizontal or vertical list, first select a prototype object. Then select horizontal or vertical list and sweep out the list. A property sheet will appear that can be used to set parameters that control the list's appearance. A description of the parameters can be found in the chapter on aggregadgets and aggrelists.

1.2. Selecting Objects

Lapidary permits two types of selections: primary selections and secondary selections. Primary selections are denoted by black grow boxes that sprout around the perimeter of an object; secondary selections are denoted by white grow boxes. Most operations do not distinguish between these two types of selections and will operate in the same way on both types of selections. However, two operations, attaching a constraint to an object and defining parameters for an object, do make this distinction.

Lapidary provides two types of selection modes (Figure 1-2): a ‘‘leaves’’ mode which causes Lapidary to select leaf elements of an aggregate, and a ‘‘top-level objects’’ mode which causes Lapidary to select top-level aggregates (objects that do not belong to an aggregate will be selected in either mode). To aid the user in determining whether they have selected a leaf or aggregate element, Lapidary uses different types of selection handles—rectangular handles for leaf elements and circular handles for aggregates (Figure 1-5). If the object is too small to accomodate 8 selection handles, either a thin or thick-lined arrow is used to highlight the selection, depending on whether the object is a leaf or aggregate object (Figure 1-5).

In either mode, additional clicks over the selected object will cause Lapidary to cycle through the aggregate hierarchy. For example, when the user clicks on the label shown in Figure 1-3.a, and Lapidary is in ‘‘top-level objects’’ mode, the entire list element is selected (Figure 1-4.a). If the user clicks on the label again, the label is selected (Figure 1-4.b). Clicking once more with the mouse causes the key-box to become selected (Figure 1-4.c). Finally, one more click causes the list element to be selected, at which point the cycle repeats itself. In ‘‘leaves’’ mode, the label would be the first object selected, then the key box, and finally the list element.

Lapidary provides the usual range of selection operations found in drawing editors—select, add to selection, deselect, remove from selection, select/deselect in region. These operations are supported for both primary and secondary selections. In addition, Lapidary allows the user to select covered objects by pointing at an already selected object and requesting that the object directly covered by the selected object be selected.

Section 1.3 provides specific details on each of the selection operations.

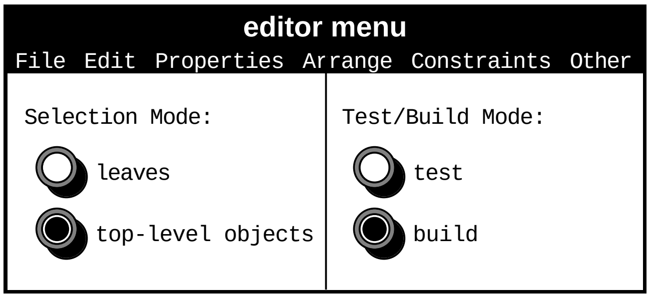


Figure 1-2: The user can cause Lapidary to select leaves of aggregates or top-level aggregates by choosing the appropriate selection mode in the editor menu window.

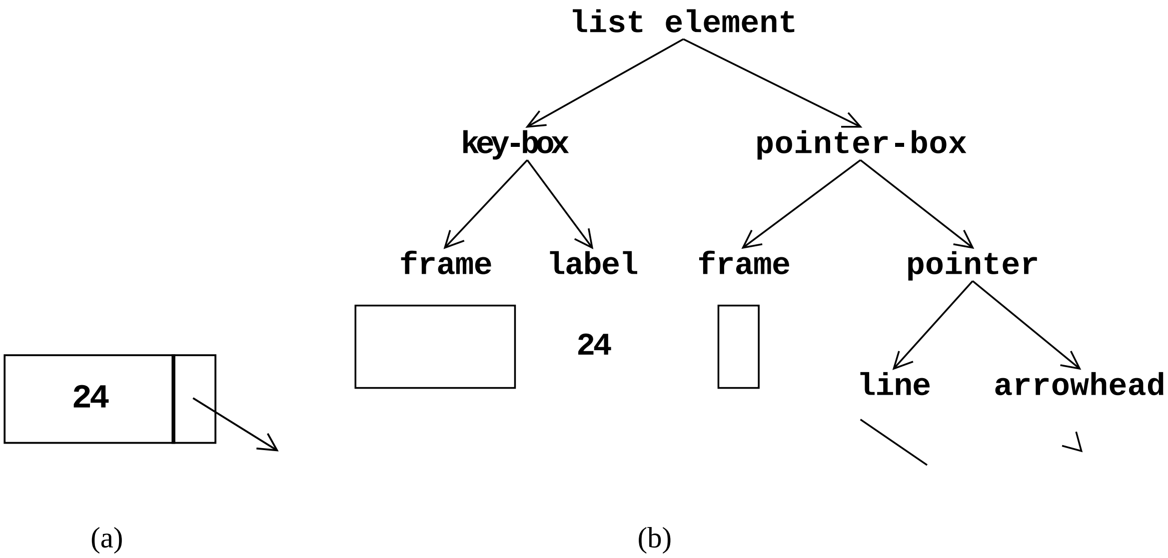


Figure 1-3: A list element (a) and the objects used to build this list element (b).

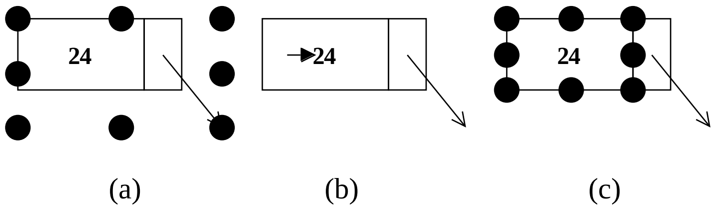


Figure 1-4: As the user repeatedly clicks the mouse button over an object, the selection cycles through the aggregate hierarchy shown in Figure 1-3. If Lapidary is in ‘‘top-level objects’’ mode, then the list element is initially selected (a). A second click selects the label (b), and a third click selects the key-box (c).

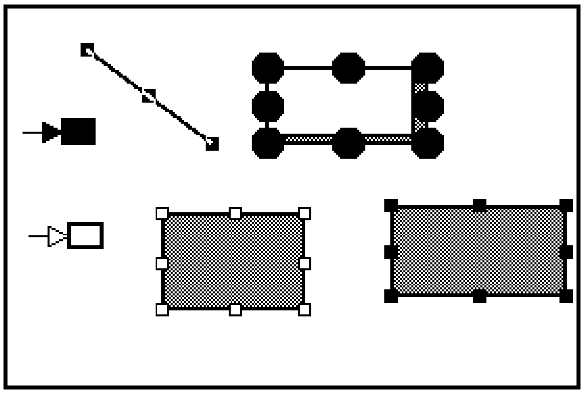


Figure 1-5: Different types of selection objects. Squares are for primitive graphical objects, circles are for aggregadgets, and arrows are for objects too small to accommodate grow boxes.

1.3. Mouse-Based Commands

Lapidary is primarily a mouse-based system so it is important to know which mouse buttons correspond to which operation. These bindings are set in the file mouse-bindings.lisp and may be edited. Currently the following operations can be bound to mouse buttons (the pair following each entry shows the default and the variable that must be changed to modify the default):

- Primary Selection (leftdown, *prim-select-one-obj*): The user can either point at a particular object and make it the primary selection, or sweep out a rectangular region of the screen and make all objects that *intersect* the region be primary selections. This operation causes the previous primary selections to be deselected. If the mouse is not pointing at any objects, all primary selections are deselected. Each successive mouse click over the same object moves the selection one level higher in the aggregate hierarchy, until the top-most level is reached, at which point the selection process cycles back to a leaf (if the selection is initially a top-level object, the next click cycles to the leaf).

- Secondary Selection (middledown, *sec-select-one-obj*): Same as primary selection but makes a secondary selection.

- Deselect Primary Selection (control-leftdown, *primary-deselection-button*): This operation allows the user to deselect primary selections. The user can either point at a specific object or sweep out a rectangular region, in which case all objects that intersect this region will be deselected (if they are primary selections).

- Deselect Secondary Selection (control-middledown, *secondary-deselection-button*): Same as Deselect Primary Selection except secondary selections are deselected.

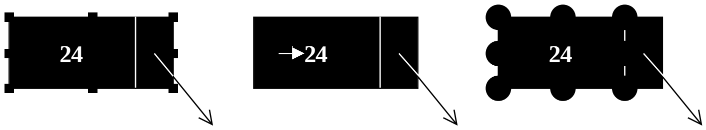
- Primary Select Covered Object (shift-control-leftdown, *prim-push-sel-under-button*): This operation allows the user to select covered objects. When the user points at a particular area of the screen, Lapidary determines which object is currently selected, and then deselects it and primary selects the first object that it covers. If no object under the mouse is selected, Lapidary primary selects the top object. If multiple objects under the mouse are selected, Lapidary finds the first unselected object which is under a selected object, selects the unselected object, and deselects the topmost selected object.

- Secondary Select Covered Object (shift-control-middledown, *sec-push-sel-under-button*): Same as Primary Select Covered Object except a secondary selection is made.

- Add to Primary Selection (shift-leftdown, *prim-add-to-select*): Same as Primary Selection except previously selected objects remain selected. Covered objects that are selected are automatically added to a selection, rather than causing previously selected objects to be deselected. Multiple clicks with the `Add to Primary Selection` button over the *selection handles* of a covered object will cause the selection to cycle through the aggregate hierarchy (Figure 1-6).

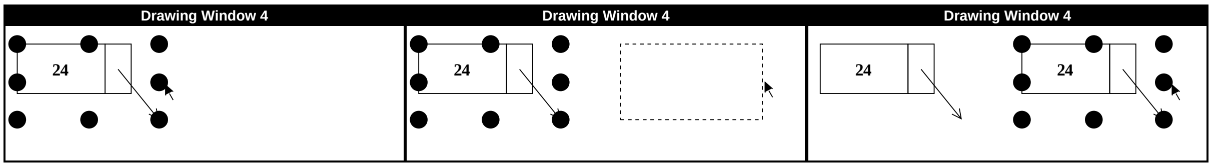
- Add to Secondary Selection (shift-middledown, *sec-add-to-select*): Same as add to primary selection but adds to secondary selection.
- Move Object (leftdown, *move-button*): This operation allows the user to move an object around the window. The user must point at one of the eight ‘‘grow’’ boxes around the perimeter of box objects, or one of the three ‘‘grow’’ boxes attached to line objects or the arrow if the object is too small to contain grow boxes. If the object is a box object and the user points at one of the corner boxes, the object can move in any direction, if the user points at one of the side boxes, the object can move in only one direction (along the x-axis if the left or right side is chosen and along the y-axis if the top or bottom side is chosen). If the object is a line object, Lapidary will attach the mouse cursor to the point designated by the grow box (either an endpoint of the line or its midpoint) and move the line in any direction. If the object is undersized so that the object does not have grow boxes but instead is pointed at by an arrow, then pointing at the arrow will cause the cursor to be attached to the northwest corner of the object and the object can be moved in any direction.
- Grow Object (middledown, *grow-button*): This operation allows the user to resize an object. The user must point at one of the eight ‘‘grow’’ boxes around the perimeter of the object if the object is a box, one of the endpoint ‘‘grow’’ boxes attached to the object if the object is a line, or the arrow that points at the object if the object is too small to contain the grow boxes. If the object is a box object and the user points at one of the corner boxes, both the object’s width and height can change, if the user points at one of the side boxes, only one of the object’s dimensions will change (the width if the left or right side is chosen, the height if the top or bottom side is chosen). If the object is a line object, Lapidary will attach the mouse cursor to the point designated by the grow box and move that endpoint while holding the other endpoint fixed. If the object is undersized so that the object does not have grow boxes but instead is pointed at by an arrow, then pointing at the arrow will cause the cursor to be attached to the northwest corner of the object and the object’s width and height will both change.
- Object Creation (rightdown, *obj-creation-button*): The user sweeps out a region of the screen and Lapidary creates the object selected in the shapes menu.
- Copy Object (shift-rightdown, *copy-button*): This operation allows the user to create a copy of an object and position it in a window (copies of an object can also be created using the `make copy` command in the editor menu window—see Section 2.2 for details). The user must point at one of the eight ‘‘grow’’ boxes around the perimeter of box objects, or one of the three ‘‘grow’’ boxes attached to line objects or the arrow if the object is too small to contain grow boxes. The selected ‘‘grow’’ box constrains the initial movement of the new object (see `Move Object` for a description of how the ‘‘grow’’ boxes constrain movement).
- Instance Object (control-rightdown, *instance-button*): This operation allows the user to create an instance of an object and position it in a window (instances of an object can also be created using the `make instance` command in the editor menu window—see Section 2.2 for details). The user must point at one of the eight ‘‘grow’’ boxes around the perimeter of box objects, or one of the three ‘‘grow’’ boxes attached to line objects or the arrow if the object is too small to contain grow boxes. The selected ‘‘grow’’ box constrains the initial movement of the new object (see `Move Object` for a description of how the ‘‘grow’’ boxes constrain movement).
- Text Editing (rightdown, *obj-creation-button*): The user can edit a selected text object by pointing at it and clicking with the object creation button. The user can use any text editing

command described in the interactors manual and clicks down on the mouse button to indicate that editing is complete.



(a) (b) (c)

Figure 1-6: Selecting a covered object in ‘‘leaves’’ mode. The label is covered by an xor feedback object, so the feedback object is the initial selection (a). Clicking the `shift-control-leftdown` mouse button pushes the selection down to the covered label (b). Clicking the add to selection button (`shift-leftdown` over the feedback arrow causes the selection to cycle up to the next level in the aggregate hierarchy, in this case, the key-box (c).



(a) (b) (c)

Figure 1-7: Objects can be duplicated or instanced by clicking on one of the selection handles (a), dragging the new object to the appropriate location (b), and dropping it (c).

2. Editor Menu Commands

The commands in Lapidary's pull down menu (Figure 1-2) provide a set of commands for saving and restoring objects, manipulating aggregadgets, applying constraints, and editing properties.

2.1. File

- `Save Gadget:` Objects are written out using `opal:write-gadget`, so the file contains a series of create-instance calls. The value in the object's `:known-as` slot is passed as the name parameter to create-instance. For example, if the object's `:known-as` slot is `:white-rect` and the object is a rectangle, the first line of the create-instance would be

```
(create-instance 'white-rect opal:rectangle)
```

  Primary selections are saved before secondary selections, so it is best to make prototypes primary selections and instances of these prototypes secondary selections. The user can also save an entire window by having no objects selected and typing in the string that appears in a window's title bar or icon in the corresponding area of the dialog box.

  Lapidary looks at each saved object to determine if the object has any links which Lapidary thinks should be parameters. If Lapidary finds any such links, it pops up the link parameters dialog box and asks the user if these links should be made into parameters (see Section 2.3). Pressing either the `OK` or `CANCEL` buttons in the link parameters dialog box allows Lapidary to continue. The `CANCEL` button in the link parameters dialog box will not cause Lapidary to discontinue the save operation, it will simply cause Lapidary to proceed to the next object.

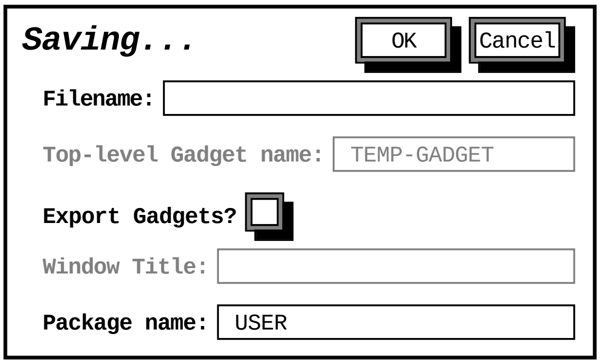


Figure 2-1: Save file dialog box

- `Load Gadget:` Requests the name of a file and then loads it (Figure 2-2). Lapidary expects a variable named *Garnet-Objects-Just-Created* to be initialized in the user package which contains the names of the created objects. If the user selects the option `Replace existing objects`, then the objects in the loaded file will replace the current objects in the drawing window. If the user selects the option `Add to existing objects`, then the objects in the file will be added to the existing objects in the window.

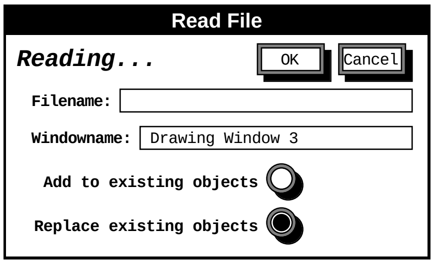


Figure 2-2: Load file dialog box

- `Add Gadget:` Users may create objects in the lisp listener and then link them to a Lapidary window. `add-gadget` pops up a dialog box that requests the name of the object to be added and the name of a window to place the object in (Figure 2-3). The name of the object should be the one used in the call to create-instance. For example, the object created by `(create-instance 'my-gadget opal:rectangle)` is named ‘‘my-gadget’’. The name of the window should be the name that appears in the window's title bar or in its icon.

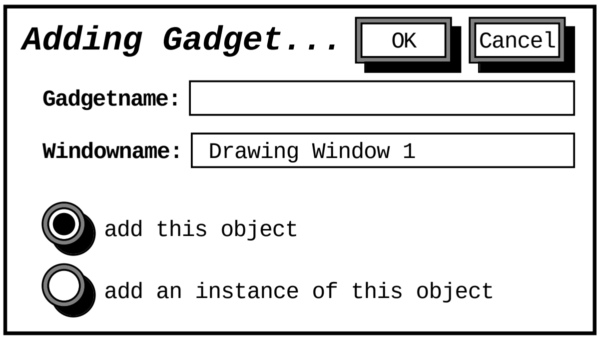


Figure 2-3: Add gadget dialog box

The user has the option of either adding the object itself or an instance of the object to Lapidary. If the user decides to add the object itself and the object has instances, Lapidary will pop up a warning box indicating that editing this object could have unintended consequences on other applications that use this object. For example, it is better to add an instance of a garnet gadgets text button rather than the actual button defined in the gadgets package, since editing the actual button is likely to cause Lapidary to fail (Lapidary uses garnet gadgets text buttons).

- `Quit:` Allows the user to exit Lapidary. It is suggested that before rebooting Lapidary, that the user create a new lisp listener and reload Garnet.

2.2. Edit

- `Make Instance:` Creates an instance of the selected object. The selected object is the new object's prototype.
- `Make Copy:` Creates a copy of the selected object. The value of each slot in the selected object will be copied to the new-object. The new object will have the same prototype as the selected object, and thus will inherit from the selected object's prototype rather than the selected object.
- `Delete Object:` Destroys all selected objects.
- `Delete Window:` Pops up a dialog box and asks the user to input the name of a window that appears in a window's title bar or icon. Lapidary then destroys the window.

2.3. Properties

Lapidary contains four property menus that control an object's line-style, filling-style, draw-function, and font. The line-style and filling-style menus (Figures 2-4 and 2-5) provide a set of commonly used styles, an ‘‘Other’’ option which prompts the user for the name of a style, and a ‘‘Constraint’’ option that allows the user to enter a custom constraint that defines the style (see Section 3 for information on how to enter a custom constraint). The color button pops up a color menu that allows the user to select a pre-defined color or create a new color by mixing hues of red, green, and blue.

- `Filling Style:` Allows the user to set the filling style of selected objects.

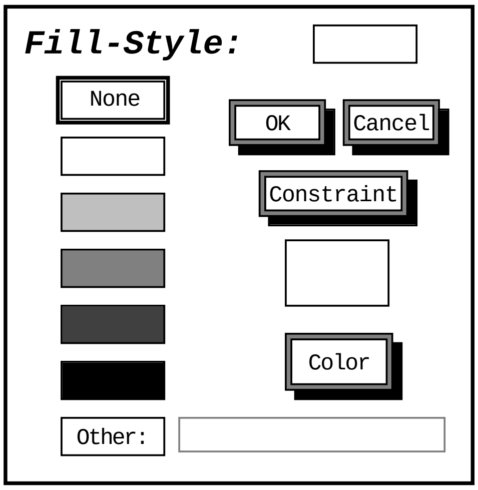


Figure 2-4: Filling styles that can be attached to objects in Lapidary

- `Line Style:` Allows the user to set the line style of selected objects.

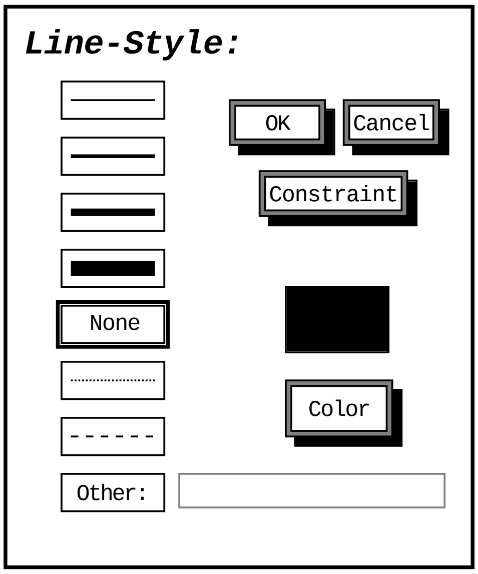


Figure 2-5: Line styles that can be attached to objects in Lapidary

- `Draw Function:` Allows the user to set the draw function of all selected objects. The Opal chapter describes draw functions in more detail.
- `Name Object:` Requests a name from the user (no quotes should be used), converts it to a keyword, and stores it in the :known-as slot of the selected object (if there is more than one selected object, Lapidary will rename the last object the user selected; name object does not distinguish between primary and secondary selections). Lapidary also creates a link with this name in the object's parent that points to this object. When an object is saved, it will be assigned this name.
- `List Properties:` Brings up a property list for horizontal and vertical lists. This property list allows the user to modify any of the customizable slots of an aggrelist. The list of customizable slots can be found in the Aggrelists chapter.

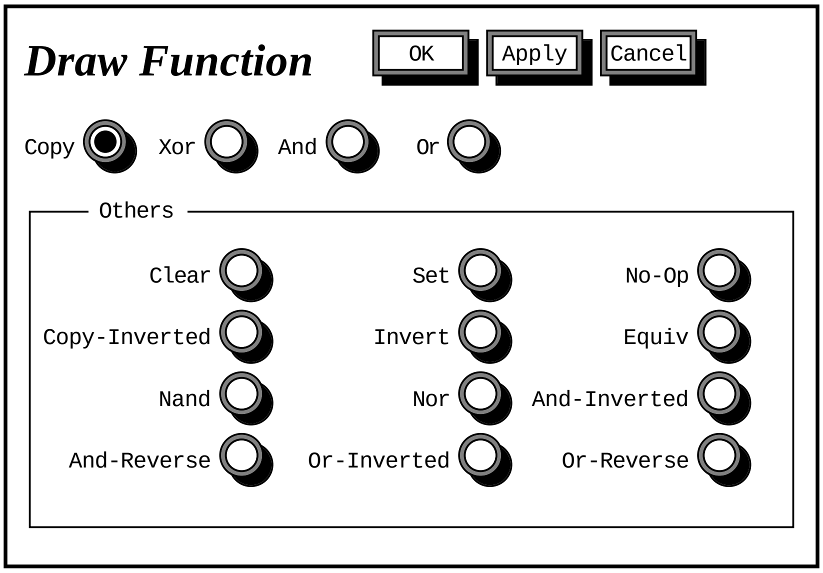


Figure 2-6: Draw functions that can be attached to objects in Lapidary

- `Text Properties:` Allows the user to choose a standard Opal font, to request a font from one of the directories on the user's font path, to request a font from an arbitrary directory, or to enter a custom constraint that determines the font (Figure 2-7). It also allows the user to enter a custom constraint that determines the string of a text object.

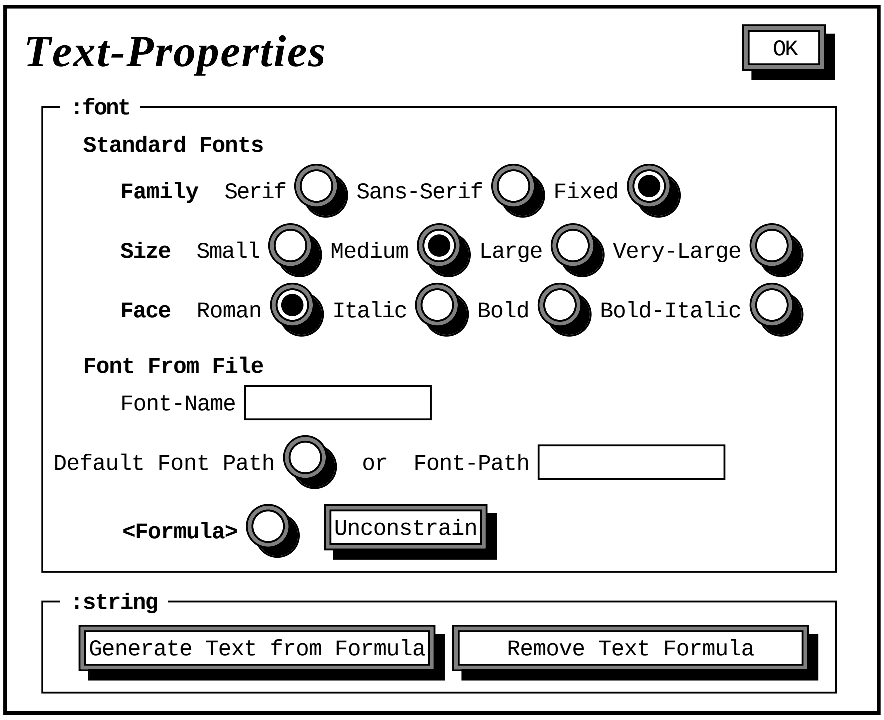


Figure 2-7: Lapidary's text properties menu

- `Parameters:` Allows the user to specify that one or more slots in an object should be parameters (Figure 2-8). A slot that is a parameter will have its value provided at run-time by the application. To create parameters, the user must make both a primary and a secondary selection. The primary selection is the object whose slots are being made into parameters and the secondary selection is the object that the parameters will retrieve their values from.

Typically the secondary selection will be the top-level aggregadget that contains the object, since the top-level aggregadget is the only object that the application should know about (an application should not be required to know the parts of an aggregadget). For example, if a label text object belongs to an aggregadget, the user might make the label the primary selection and the aggregadget the secondary selection. If the object is already at the top-level, then the object should be both the primary and secondary selection.

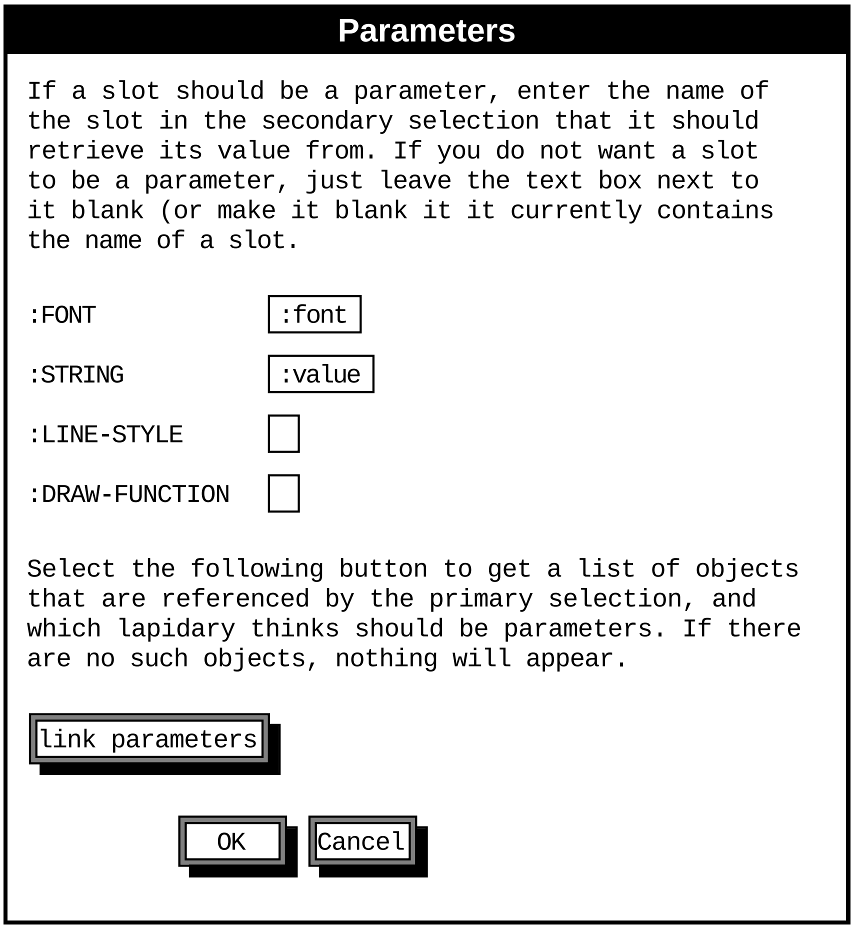


Figure 2-8: Parameters dialog box

To turn a slot into a parameter, select the text box next to the slot and enter the name of the slot in the secondary selection that the slot should retrieve its value from. In Figure 2-8, the label's `string` slot retrieves its value from list element's `value` slot, and the `font` slot retrieves its value from the list element's `font` slot. To make the slot no longer be a parameter, make the slot's text box be blank. Lapidary maintains a list of slots for each objects that can be turned into parameters. If the user wants to parameterize a slot that is not displayed in the parameters dialog box, the user can bring up C32 and place a formula in the desired slot that retrieves its value from the top-level aggregadget.

The link parameters button in the parameters dialog box allows the user to specify links that should be parameters. Links are used by Lapidary-generated constraints to indirectly reference other objects. For example, when the user creates a constraint that attaches the endpoint of a line, say `arrow1` to a rectangle, say `rect1`, Lapidary generates a link in `arrow1` that points to `rect1`. When a link references an object that is not part of the primary selection's top-level aggregadget, Lapidary guesses that this link should be a parameter and displays it in the link parameters dialog box (Figure 2-9). For each such link, Lapidary displays the value of the link, the slots that reference the link, and a parameter

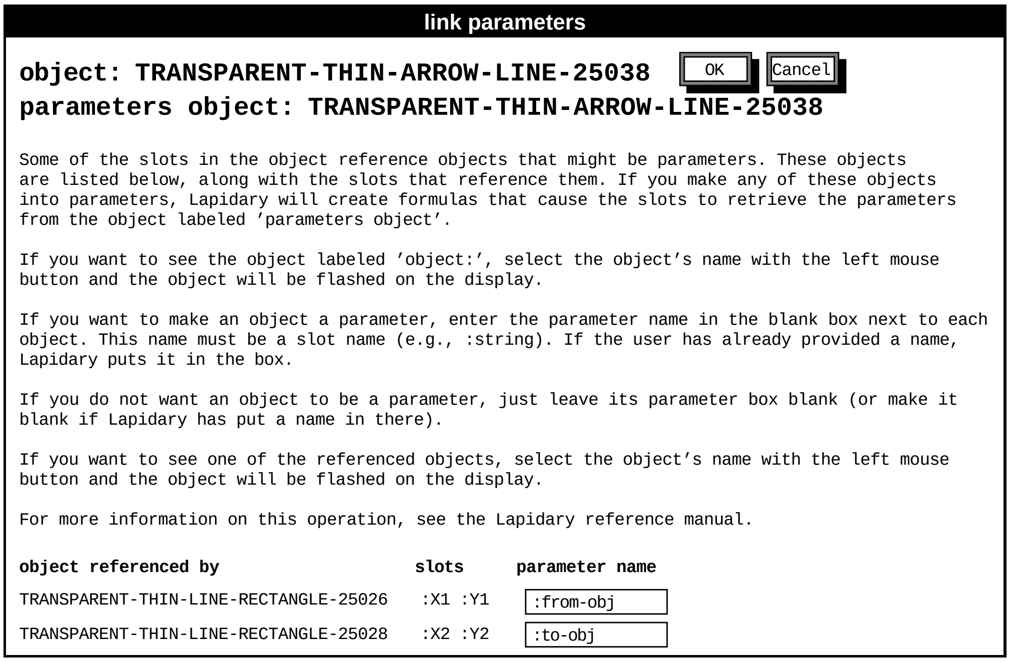


Figure 2-9: Link parameters dialog box

name, if any, that the user has assigned to this link. The user can change this parameter name by editing it, or can indicate that this link should not be a parameter by making the parameter name blank.

To make a slot depend on an :items list in an aggrelist, make any object in the aggrelist be a primary selection and make the aggrelist be the secondary selection. Then enter :items in the labeled box for any slot on the parameters menu that should get its value from :items. For example, suppose the prototype object for a list is a text object and the string and font slots of the text object should retrieve their values from the aggrelist's `:items` slot. To do this the user makes the aggrelist the secondary selection and one of the text objects in the aggrelist a primary selection. The user then selects the `parameters` option, which causes Lapidary to pop up the parameters menu. Typing :items in the type-in fields next to the `font` and `string` slots creates the necessary formulas that link these slots to the `:items` slot in the aggrelist (Figure 2-10). The :items slot of the aggrelist will now contain a list of the form ((string1 font1) (string2 font2)...(stringN fontN)).

If the prototype object is an aggregadget (such as a labeled box that contains a rectangle and a piece of text), then any of the parts of the aggregadget, and the aggregadget itself, can have slots that depend on the aggrelist's :items slot. This is done by parameterizing the parts one at a time. For example, if the string slot of the text object and the filling-style slot of the rectangle should be parameters, the user could first select the rectangle and parameterize it, then select the text object and parameterize it. Lapidary does not follow any easily described rules in constructing the :items list (e.g., the string and font values could easily have been reversed in the above list), so users should look at the :items list Lapidary constructs before writing their own.

If a slotname besides :items (e.g., :string) is entered in a type-in field, then the slot is treated as an ordinary parameter, and all items in the list will have a formula that accesses this slot in the aggrelist. For example, if a list consists of rectangles, and the rectangles should all have the line-style that is passed to the aggrelist, then the user would select one of the rectangles and enter the an appropriate name, such as `:line-style`, next to the :line-style slot of the rectangle.

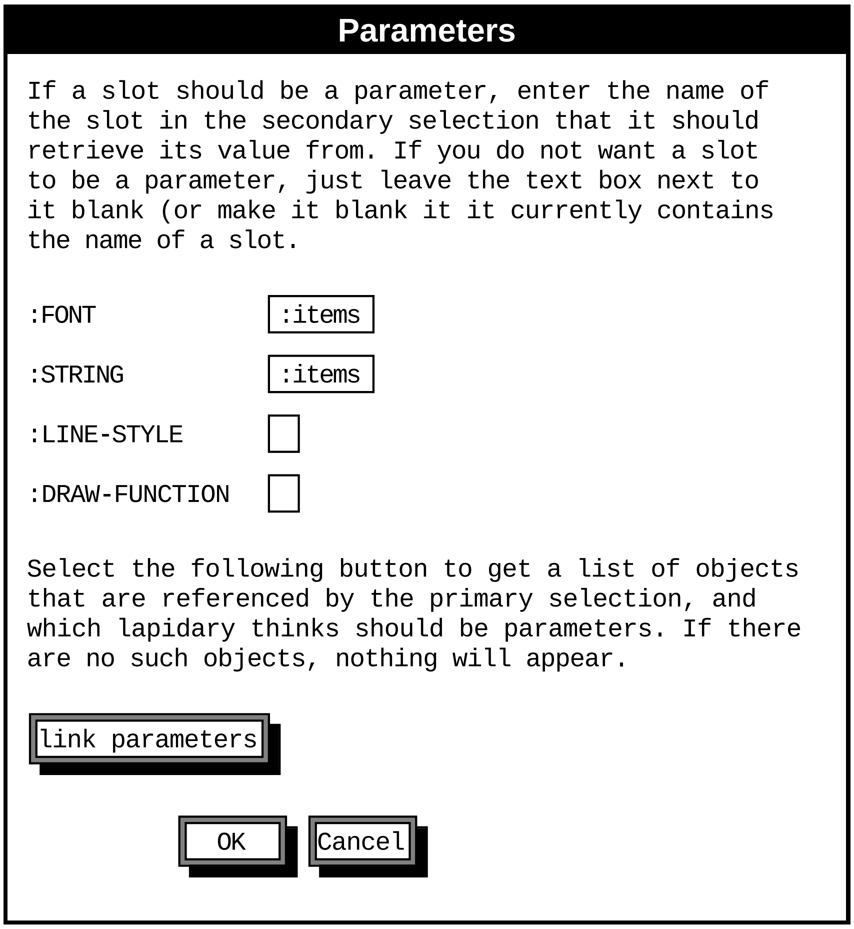


Figure 2-10: Parameters dialog box for an Aggrelist

2.4. Arrange

- `Bring to Front:` Brings the selected objects to the front of their aggregadget (i.e., they will cover all other objects in their aggregadget). If multiple objects are selected, it brings the objects to the front in their current order.

- `Send to Back:` Sends the selected objects to the back of their aggregadget (i.e., they will be covered by all other objects in their aggregadget). If multiple objects are selected, it sends the objects to the back in their current order.

- `Make Aggregadget:` Creates a new aggregadget and adds all selected objects (both primary and secondary selections) to it. The selected objects must initially belong to the same aggregadget or else Lapidary will print an error message and abort the operation. The `:left` and `:top` slots of the objects added to the aggregadget are constrained to the aggregadget unless they were already constrained (if the object is a line, the `:x1`, `:y1`, `:x2`, and `:y2` slots are constrained). The constraints tie the objects to the northwest corner of the aggregadget and use absolute offsets based on the current position of the objects. Thus if an object is 10 pixels from the left side of the aggregadget (the bounding box of the aggregadget is computed from the initial bounding boxes of the objects), the object's `:left` slot will be constrained to be 10 pixels from the left side of the aggregadget. If the object is a line, the object's endpoints will be tied to the aggregadget's northwest corner by absolute fixed offsets. These constraints cause the objects to move with the aggregadget when the aggregadgets moves. If the user wants different constraints to apply, the user can primary select an object, secondary select the aggregadget, and attach a different constraint. The aggregadget derives its width and height from its children, so the :width and :height slots of the children are not constrained to the aggregadget. Because the aggregadget computes its width and height from its children, it is not permitted to resize an aggregadget.

- `Ungroup:` Destroys selected aggregadgets and moves their components to the aggregadgets' parents.

2.5. Constraints

- `Line Constraints:` Brings up the line constraints dialog box (Figure 3-2).
- `Box Constraints:` Brings up the box constraints dialog box (Figure 3-1)
- `C32:` Brings up C32. Each primary and secondary selection is displayed in the spreadsheet, and additional Lapidary objects can be displayed using the `Point to Object` command. While Lapidary is running, only objects in Lapidary's drawing windows can be displayed in the spreadsheet. Nothing will happen if the user attempts to execute the `Point to Object` command on an object which is not in a Lapidary drawing window. The C32 chapter describes how to use C32 and Section 3.3 describes a number of modifications Lapidary makes to C32.

2.6. Other

- `Interactors:` Displays a menu of interactors that the user can choose to look at. Once the user selects an interactor, the information from that interactor will be displayed in the appropriate interactor dialog box (see Section 4) and the user is free to change it. In addition, menu items are provided for the five Garnet-defined interactor types: choice (encompassing both menu and button interactors), move/grow, two-point, text, and angle. If the user has selected a set of objects, then the interactors menu will contain all interactors associated with these objects. Lapidary will display all interactors whose `:start-where` slot references these objects, or whose `:feedback-obj` or `:final-feedback-obj` points at these objects. If no objects are selected, then the interactors menu will contain all interactors that have been created in Lapidary.
- `Clear Workspace:` Deletes all objects from Lapidary but does not destroy any of the drawing windows.

2.7. Test and Build Radio Buttons

- `Test:` Deactivates the Lapidary interactors that operate on the drawing windows and activates all user-defined interactors. This allows the user to experiment with the look-and-feel that the user has created.
- `Build:` Deactivates all user-defined interactors and reactivates the Lapidary interactors, allowing the user to modify the look-and-feel.

3. Creating Constraints

Lapidary provides two menus for creating constraints, one that deals with ‘‘box’’ constraints (constraints on non-line objects) and one that deals with line constraints. In addition, several of the property menus provide a custom constraint option that allows the user to input a constraint that determines the property. Each of the menus contains buttons labeled with tiny rectangular boxes that indicate how an object will be positioned if the constraint associated with that button is chosen. The rectangular boxes in the buttons are colored black to indicate that the primary object is the object that will be constrained, and the white rectangular boxes positioned at the four corners of the rectangle in the box constraint menu indicate that the secondary selection is the object that will be referenced in the constraint.

The Box and Line Constraint dialog boxes, can be used separately from Lapidary (see section 3.4).

The constraint menus can display the current position and size of a primary selection. By pressing the `Show Constraints` button in the constraint menus, the user can see what types of constraints are on the slots of an object. If two objects are selected, Lapidary will display the types of the constraints between the two objects.

3.1. Box Constraints

The box constraint menu allows constraints to be attached to the `:left`, `:top`, `:width`, and `:height` of an object (see Figure 3-1). The user attaches constraints by first selecting the object to be constrained (a primary selection) and the object to be referenced in the constraint (a secondary selection). The user then selects the appropriate buttons in the box constraint menu. The possible constraints for the `:left` slot are:

- left-outside: The right side of the primary selection is aligned with the left side of the secondary selection.
- left-inside: The left side of the primary selection is aligned with the left side of the secondary selection.
- center: The center of the primary selection is aligned with the center of the secondary selection.
- right-inside: The right side of the primary selection is aligned with the right side of the secondary selection.
- right-outside: The left side of the primary selection is aligned with the right side of the secondary selection.

The possible constraints for the `:top` slot are:

- top-outside: The bottom side of the primary selection is aligned with the top side of the secondary selection.
- top-inside: The top side of the primary selection is aligned with the top side of the secondary selection.
- center: The center of the primary selection is aligned with the center of the secondary selection.
- bottom-inside: The bottom side of the primary selection is aligned with the bottom side of the secondary selection.
- bottom-outside: The top side of the primary selection is aligned with the bottom side of the secondary selection.

The only option for the `:width` slot is to constrain the width of the primary selection to the width of the

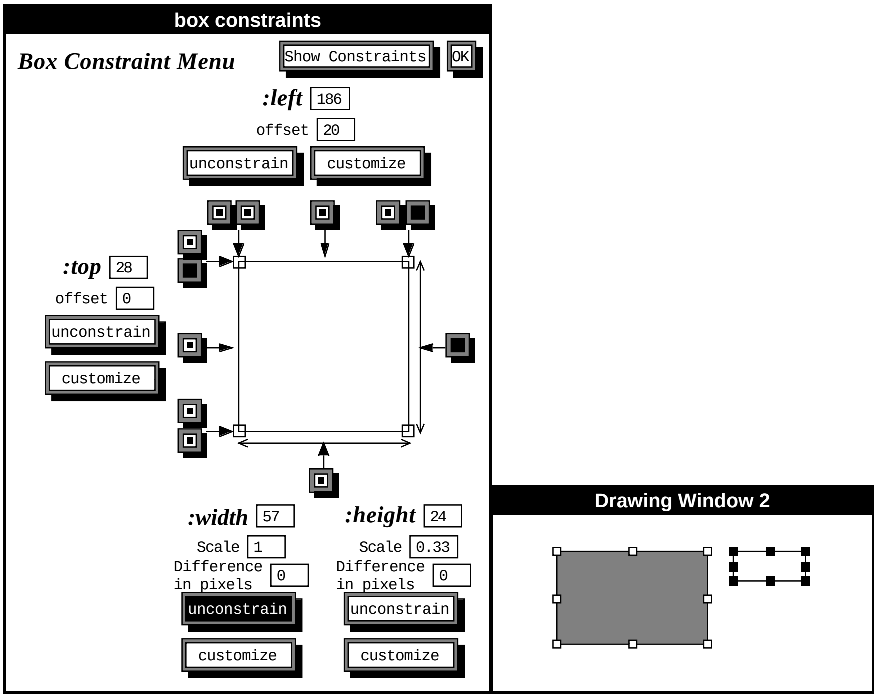


Figure 3-1: The constraint menu for box-like objects on the left, and a drawing window on the right. The white rectangle in the drawing window is the object to be constrained and the gray rectangle is the object to be referenced in the constraint. The white rectangle is constrained to be offset from the right of the gray rectangle by 20 pixels, and aligned at the top-inside of the gray rectangle. The white rectangle's width is not constrained and it is 33% as tall as the gray rectangle. If the gray rectangle changes, the white one will be adjusted automatically.

secondary selection and the only option for the `:height` slot is to constrain the height of the primary selection to the height of the secondary selection. In addition, each of the four slots may have a custom constraint attached to them (see Section 3.3). Each of the four slots also has an ‘‘Unconstrain’’ option that destroys the constraint attached to that slot.

The constraints in the box constraint menu can be fine-tuned by entering offsets for the constraints, and in the case of the size slots (width and height), scale factors as well. When an object is centered with respect to another object, the offset field changes to a percent field denoting an interval where 0% causes the center point of the constrained object to be attached to the left or top side of the object referenced in the constraint and 100% causes the center point of the constrained object to be attached to the right or bottom side of the object referenced in the constraint. By default this percentage is 50. The `Difference in pixels` and `Scale` factors cause the width and height constraints to be computed as *Scale * Dimension + Difference in pixels*.

Finally, each of the slots has a labeled box next to its name that allows the user to type in an integer that will be placed in that slot. If there is already a constraint in the slot, the constraint will not be destroyed so the value will only temporarily override the value computed by the constraint (the next time the constraint is recomputed, the value will be lost). This operation works only when there is one primary selection and no secondary selections.

3.2. Line Constraints

The line constraint menu allows the endpoints of a line to be attached to other objects or the `:left` and `:top` slots of a box object to be constrained to the endpoint of a line (Figure 3-2). The buttons on the box and line object in Figure 3-2 indicate the various locations where the endpoint of a line can be attached to a box or line object or where a point of a box can be attached to a line. Thus the two endpoints of a line can be attached to any of the corners, sides, or center of a box object and any of the corners, sides, or center of a box object can be attached to the endpoints or center of a line.

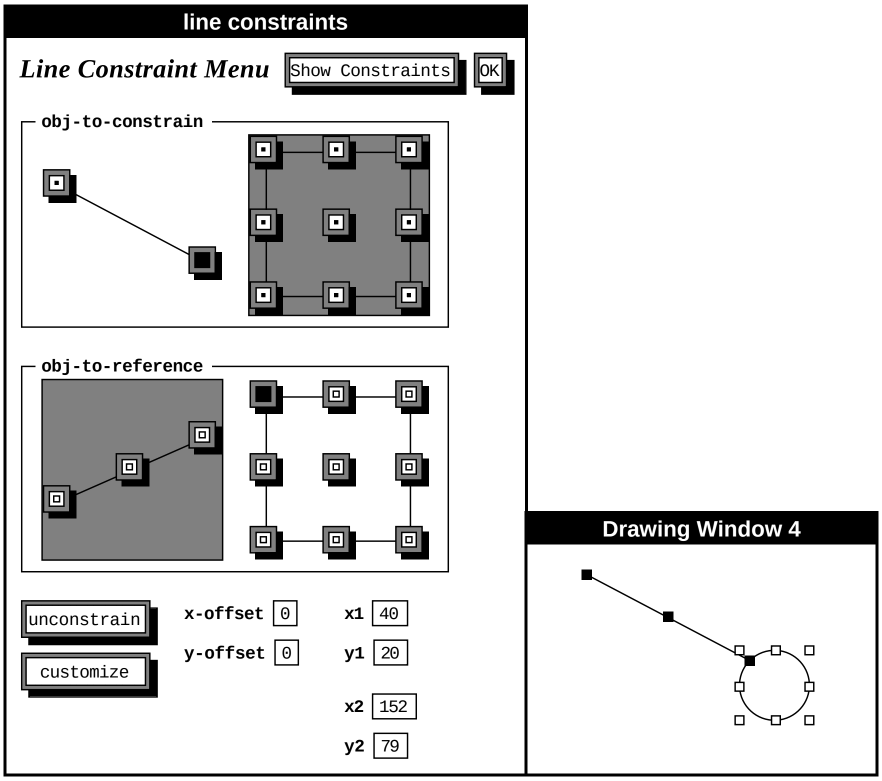


Figure 3-2: The constraint menu for line-like objects on the left, and a drawing window on the right. The arrow in the drawing window is the object to be constrained and the circle is the object to be referenced in the constraint. In the ‘‘obj-to-constrain’’ section of the constraint menu, the line feedback object has been rotated so that it has the same orientation as the selected arrow, and the box feedback object has been disabled (grayed-out). In the ‘‘obj-to-reference’’ section the line feedback object has been disabled since the object to be referenced in the constraint is a box-like object. The darkened buttons on the right endpoint of the line feedback object and the left corner of the box feedback object indicate that the right endpoint of the arrow is attached to the left corner of the circle.

The line object in the constraint menu is oriented in the same direction as the selected line in the drawing window, so that the user knows which endpoint is being constrained. The buttons with the blackened rectangles indicate the points that can be constrained in the primary selection. Similarly, the buttons with the white rectangles indicate the points in the secondary selection that the primary selection can be attached to.

The `Unconstrain` button at the bottom of the menu allows the user to destroy the constraint on the selected point and the `Customize` button allows the user to input a custom constraint (described in

Section 3.3). Finally the `x-offset` and `y-offset` labeled boxes allow the user to enter offsets for the constraint. All offsets are added to the value computed by the constraint. For example, an x-offset of 10 causes an endpoint constrained to the northwest corner of a box object to appear 10 pixels to the right of that corner.

The end points of a line can be set directly by typing in values for x1, y1, x2 and y2. This function is only active if there is a single line as the primary selection and no secondary selections.

3.3. Custom Constraints

When the user selects the custom constraint option in any of the constraint or property menus, Lapidary brings up the C32 spreadsheet and a formula window for the desired slot. The user should enter a formula and press OK (or cancel to stop the operation). Both the OK and cancel buttons in the formula window will make C32 disappear.

Information on C32 can be found in the C32 chapter. However, Lapidary modifies C32 in a number of ways that are important for a user to know. First, it generates indirect references to objects rather than direct references. A direct reference explicitly lists an object in a constraint, whereas an indirect reference accesses the object indirectly through a link. For example, `(gv rect1 :left)` is a direct reference to `rect1`, whereas `(gvl :link0 :left)` is an indirect reference to `rect1` (this assumes that a pointer to `rect1` is stored in `:link0`). If the user always generates references using the C32 functions `Insert Ref from Mouse` and `Insert Ref from Spread`, then Lapidary will automatically generate indirect references and create appropriate link names. The user can edit these link names by bringing up the parameters menu and hitting the link parameters button (see Section 2.3). However, if the user inserts the references by typing them in, then the user should take care to use the `gvl` form and create the appropriate links. When the formula is completed, Lapidary checks whether there are any direct references in the formula and generates a warning if there are. At this point the user has the option of editing the formula or continuing with the formula as is. If the user chooses to leave direct references in the formula, Lapidary may not be able to generalize it, so the formula may behave strangely if it is inherited.

The second change Lapidary makes is in copying formulas. Lapidary copies all the links that the formula references to the object which is receiving the copied formula. If the links should point to new objects, the user must manually change them by selecting the `Show All Slots` option in C32 and editing the appropriate links (the names of the links that need to be modified can be found by looking at the formula).

3.4. The Constraint Gadget

The constraint menus have been bundled into a constraint gadget that can be used independently of Lapidary. The constraint gadget provides two menus: a box constraint menu for specifying box-type constraints (Figure 3-1) and a line constraint menu for specifying line-type constraints (Figure 3-2). These menus operate as described in Sections 3.1 and 3.2. The menus also provide access to C32 through `customize` buttons. The module can be loaded independently of Lapidary with `(garnet-load "lapidary:constraint-gadget-loader")` and is exported from the gadgets package (garnet-gadgets).

3.4.1. Programming Interface

The constraint gadget can be created (or made visible, if already created) by executing one of the `-do-go` or `show-` functions described in section 3.4.1.2. Certain slots of the gadget, described in section 3.4.1.1, are then set with the objects to be constrained. When the user operates the buttons in the dialog box, constraints will be set up among the indicated objects.

3.4.1.1. Slots of the Constraint Gadget

The constraint gadget exports one object called `gg::*constraint-gadget*`. This object contains four settable slots:

`:obj-to-constrain` - The object which should be constrained. This slot expects only one object — it will not take a list.

`:obj-to-reference` - The object which should be referenced in the constraint. This slot expects only one object — it will not take a list.

`:top-level-agg` - The top level aggregate containing constrainable objects. If the aggregate associated with a window is the top level aggregate, this slot may be left NIL (the default). However, if, for example, the window contains an editor aggregate and a feedback aggregate, then the `:top-level-agg` slot should be set to the editor aggregate.

`:custom-function` - A function that is executed whenever a constraint is attached to a slot. The function should take three parameters: an object, a slot, and a formula. The function is called after the formula has been installed on the slot, but before the formula has been evaluated. *This function is not called when the user calls the c32 function and provides a c32-custom-function as a parameter* (see Section 3.4.1.2 for details on the c32-custom-function and its parameters). The function is not called in this case since the constraint gadget does not install the formula if the c32-custom-function is provided.

It is also possible to prevent either the box-constraint or line-constraint menus from attaching a constraint to a slot by adding the slot's name to a list in the `:do-not-alter-slots` of an object. For example, to prevent a constraint from being attached to the `:width` or `:height` slots of a text object, the list `'(:width :height)` could be placed in the object's `:do-not-alter-slots` slot. If the user tries to attach a constraint to that slot, an error box will be popped up indicating that a constraint cannot be attached to that slot. C32 does not recognize the `:do-not-alter-slots`, and therefore the box-constraint and line-constraint menus cannot prevent the user from inserting a formula into a forbidden slot if a customize button is chosen.

3.4.1.2. Exported Functions

The following functions are exported from the constraint gadget module:

`gg:Box-Constraint-Do-Go` [*Function*]

`gg:Line-Constraint-Do-Go` [*Function*]

These functions create the Box and Line Constraint dialog boxes. They should not be executed multiple times, since there is only one `constraint-gadget` object. If the user clicks on an ''OK'' button and makes the dialog boxes invisible, then the following functions can be called to make them visible again:

`gg:Show-Box-Constraint-Menu` [*Function*]

`gg:Show-Line-Constraint-Menu` [*Function*]

These functions make the Box and Line Constraint dialog boxes visible. They can only be called after the `-do-go` functions above have been called to create the dialog boxes.

`gg:C32 &optional` *object slot* [*Function*]
`&key` *left top c32-custom-function prompt*

This function causes c32 to come up, with the *object* displayed in the first panel of the c32 window. The formula in *slot* will be displayed in c32's formula editing dialog box. The keyword parameters are as follows:

left, top - Controls placement of query box that users use to indicate that they are done with C32.

c32-custom-function - A function to be executed when the user hits the OK button in a formula window in C32. The function should take three parameters: an object, a slot, and a formula. If a custom function is provided, the formula will not be installed in the slot (thus the function in :custom-function will not be called—it must be called explicitly by the *c32-custom-function* if it should be executed). This gives the *c32-custom-function* an opportunity to defer the installation of the formula. For example, in Lapidary, the user can create formulas that define the values of various slots in an interactor, but until the user presses the ‘‘create-interactor’’ or ‘‘modify’’ buttons, the formulas should not be installed. Thus the Lapidary `c32-custom-function` places the formulas on a queue, but does not install them.

The constraint gadget stores the links that this formula uses in a meta-slot in the formula called `:links`. Like the formula, the links are not installed. That is, the link slots do not exist (unless another formula already uses them). Because the links have not been installed, the constraint gadget stores the links and the objects they point to in another meta-slot in the formula called `:links-and-objs`. The contents of this slot have the form (list (cons (link-name object))*). Links that already exist because another formula uses them will not be on this list.

The `c32-custom-function` or the application can install the links by calling the c32 function `install-links` which takes a formula and the object that the links should be installed in as arguments (the object that is passed to `c32-custom-function` is the object that should be passed to `install-links`). `install-links` will create the links, and if the link points to an object that is in the same aggregate as the object containing the link, `install-links` will create a path to the reference object and store it in the link slot. `install-links` destroys the `:links-and-objs` slot, so the `c32-custom-function` or application should take care to save the contents of this slot if they need to make further use of this information.

prompt - A text string that should be displayed in the query box that appears when C32 is invoked.

`gg:CG-Destroy-Constraint` *object slot* [*Function*]

This function destroys a constraint created by the constraint gadget. Required parameters are an object and a slot.

`gg:Valid-Integer-P` *gadget string* [*Function*]

`Valid-integer-p` determines if a string input by a Garnet gadget contains a valid integer. If it does not, the gadget’s original value is restored and an error message is printed.

`c32::Install-Links` *formula obj* [*Function*]

This function is provided by c32, though it is not exported. As mentioned above, it is useful for installing links when a custom function is provided in c32. The *formula* should have a `:links-and-objs` slot, whose value should be a list of the form ((*link-slot-name object*) (*link-slot-name object*) ...). The *obj* parameter names the object which the links should be installed in.

3.4.1.3. Programming with Links

Each constraint contains indirect references to objects rather than direct references. The set of link names it uses to make these indirect references is contained in the `:links` meta-slot of the formula and the name of the offset slot it uses is contained in the `:offset` meta-slot. If the formula involves the width or height slots, there is also a `:scale` meta-slot, containing the name of the scale slot that the formula uses. The constraint gadget generates link and offset names by appending the suffixes `-over` and `-offset` to the name of the slot that is being constrained. For example, if the left slot is being constrained, the link name will be `:left-over` and the offset name will be `:left-offset`. These slot names are stored in a formula’s `:links` and `:offset` meta-slots. For width and height slots, scale names are generated by appending the suffix `-scale` to the slot name. Thus the scale slot for a height constraint would be named `:height-scale`. When C32 generates link names, it generates them by appending a number to the prefix `link-`. Thus it generates links such as `:link-0` and `:link-1`.

3.4.2. Custom Constraints

When the user selects the custom constraint option in any of the constraint menus, the constraint gadget brings up the C32 spreadsheet and a formula window for the desired slot. The user should enter a formula and press OK (or cancel to stop the operation). Both the OK and cancel buttons in the formula window will make C32 disappear.

The constraint gadget modifies C32 in a number of ways that are important for a user to know. First, it generates indirect references to objects rather than direct references. A direct reference explicitly lists an object in a constraint, whereas an indirect reference accesses the object indirectly through a link. For example, `(gv RECT1 :left)` is a direct reference to `RECT1`, whereas `(gvl :link0 :left)` is an indirect reference to `RECT1` (this assumes that a pointer to `RECT1` is stored in `:link0`). If the user always generates references using the C32 functions `Insert Ref from Mouse` and `Insert Ref from Spread`, then the constraint gadget will automatically generate indirect references and create appropriate link names. The user can edit these link names by finding them in the spreadsheet and modifying them. However, if the user inserts the references by typing them in, then the user should take care to use the `gvl` form and create the appropriate links. When the formula is completed, the constraint gadget checks whether there are any direct references in the formula and generates a warning if there are. At this point the user has the option of editing the formula or continuing with the formula as is. If the user chooses to leave direct references in the formula, the constraint gadget may not be able to generalize it, so the formula may behave strangely if it is inherited.

The second change the constraint gadget makes is in copying formulas. The constraint gadget copies all the links that the formula references to the object which is receiving the copied formula. If the links should point to new objects, the user must manually change them by selecting the `Show All Slots` option in C32 and editing the appropriate links (the names of the links that need to be modified can be found by looking at the formula).

3.4.3. Feedback

The user can determine which constraints are attached to an object by selecting the object and an optional second object that the object may be constrained to, and then selecting the `Show Constraints` option. The appropriate constraint buttons will be highlighted and the offset fields set to the correct values. If only one object is selected, then all constraints that the constraint menu can represent will be shown. For example, the box constraint menu would display the constraints on the left, top, width, and height slots. If there are two selections, a constrained object and a reference object, then only the constraints in the constrained object that depend on the reference object are shown.

4. Interactors

Lapidary provides a set of dialog boxes that allow a user to define new interactors or modify existing ones. To create or modify an interactor, select the `Interactors` command from the Lapidary editor menu. Lapidary will display a menu listing Garnet-defined and user-defined interactors that may be viewed. Select the desired interactor and Lapidary will display the appropriate interactor dialog box.

All interactor dialog boxes have a number of standard items, including a set of action buttons, a name box, a `:start-where` field, and buttons for events. In addition, each dialog box allows the user to set the most commonly changed slots associated with that interactor. Other slots may be set using C32 (see section 3.3).

The name field allows the user to type in a name for the interactor. The name is not used to name the interactor, but instead is converted to a keyword and stored in the interactor's :known-as slot. If the interactor is saved, the user-provided name will be placed in the name parameter field for create-instance.

4.1. Action Buttons

The action buttons permit the following types of operations:

- Create Instance: This operation creates an instance of the displayed interactor and, if the user has modified any of the slot values, overrides the values inherited from this interactor with the modified values. In addition, Lapidary examines the `:start-where` field of the new interactor and if the start-where includes an aggregadget, adds the interactor to the aggregadget's behavior slot.
- Modify: This operation stores any changes that the user has made to the interactor's slots in the interactor.
- Destroy: This operation destroys the interactor.
- Save: This operation prompts the user for a file name and then writes out the interactor.
- C32: This operation brings up C32 and displays the interactor in the spreadsheet window. The user can then edit any slot in the interactor. Any changes the user makes will not be discarded by the `Cancel` button. It is generally advisable to bring up the C32 menu only *after* the interactor has been created. (the one exception to this rule is when C32 appears as the result of pressing a formula button. If the user enters a formula in the formula window, the formula will be installed in the instance). Otherwise the user will end up editing the prototype for the interactor to be created, instead of the interactor itself. The C32 chapter describes how to operate C32 and Section 3.3 describes the modifications Lapidary makes to C32.
- Cancel: This operation discards any changes the user has made to the dialog box since the last create-instance or modify command.

4.2. Events

Lapidary allows the user to define the start, stop, and abort events of an interactor using event cards. Each card defines one event and a list of events can be generated from a deck of cards. Each interactor dialog box contains buttons that pop up a window for each event that defines a start, stop or abort event. A sample event card is shown in Figure 4-1. Selecting `Delete this event` will cause this event to be deleted. However, Lapidary will not allow you to delete an event card if it is the only one that exists. `Add an event` causes a new event to be created. `OK` makes the window disappear and generates the event list for the desired event.

Any combination of `shift`, `control`, and `meta` can be selected, but if the `any modifier` button is

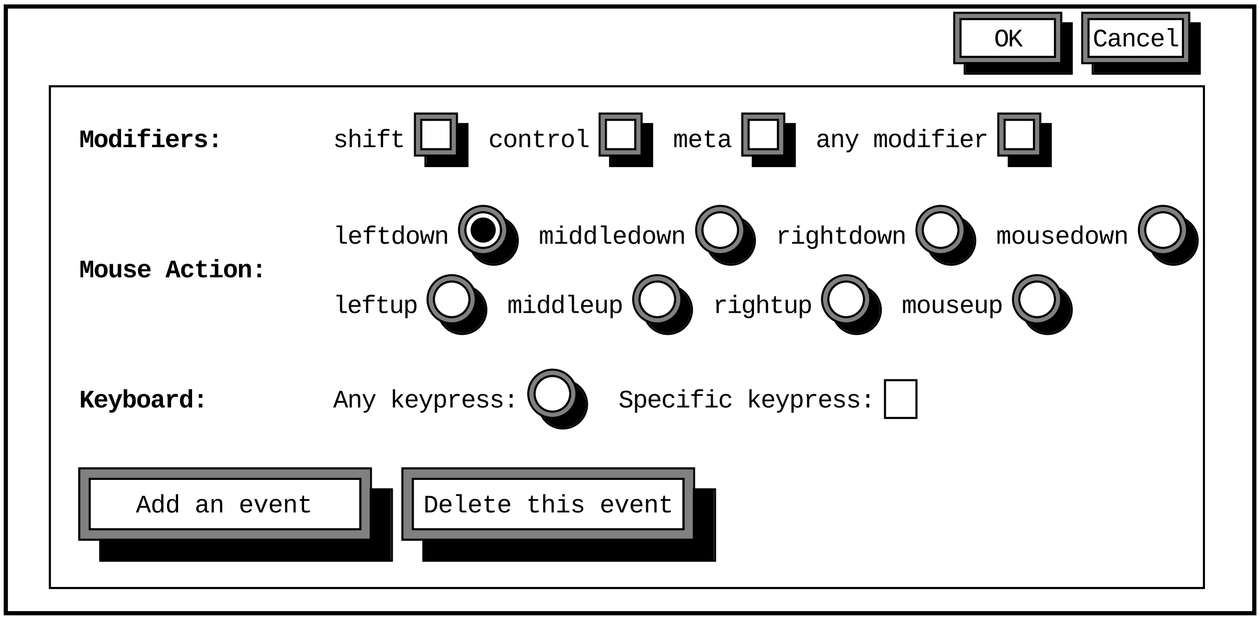


Figure 4-1: A sample event card deck

selected then the other modifier buttons will become unselected. The mouse actions and keyboard items are all mutually exclusive, so selecting one will cause the previously selected item to be deselected. Events like #\Return can be generated by simply typing ‘‘Return’’ in the `Specific keypress` box (quotes are not needed).

4.3. :Start Where

Every interactor dialog box displays two commonly used start-wheres for an interactor and allows the user to select an alternative one using the `other` button (Figure 4-2). If `other` is selected, a dialog box will appear which lists all possible :start-where’s. Once the desired start-where is selected, Lapidary will incorporate the selected object in the drawing window into the start-where if it is appropriate (which it is in all cases but `t` and `nil`). If the start-where requires a slot (which the `list` start-where’s do), Lapidary will request the name of a slot.

If the user wants a type restriction, then pressing the `type restriction` button will cause Lapidary to request a type restriction. A type restriction can be either an atom (e.g., opal:text) or a list of items (e.g., (list opal:text opal:rectangle)). The type restriction button is a toggle button so if it is already selected, selecting it again will cause the type restriction to be removed. Also, selecting a new start-where will cause the type restriction to be removed.

4.4. Formulas

Selecting a formula button in any of the interactor dialog boxes causes the interactor to be displayed in the C32 spreadsheet window and the current value of the slot associated with the formula button to be displayed in a C32 formula window. This value can then be edited into a formula. When the `OK` button is pressed in the formula window, C32 disappears and the formula is batched with the other changes that have been made to the interactor since the last `Create Instance` or `Modify` command. The formula is not actually installed until the `Create Instance` or `Modify` buttons are selected. If the user selects `Cancel` in the interactor dialog box, the formula will be discarded. The formula will also be discarded if the user selects `Cancel` in the C32 formula window.

4.5. Specific Interactors

4.5.1. Choice Interactor

The choice interactor dialog box allows the user to create either a button interactor or menu interactor, depending on whether the `menu` or `button` radio button is selected (Figure 4-2). The other slots that can be set using this dialog box are:

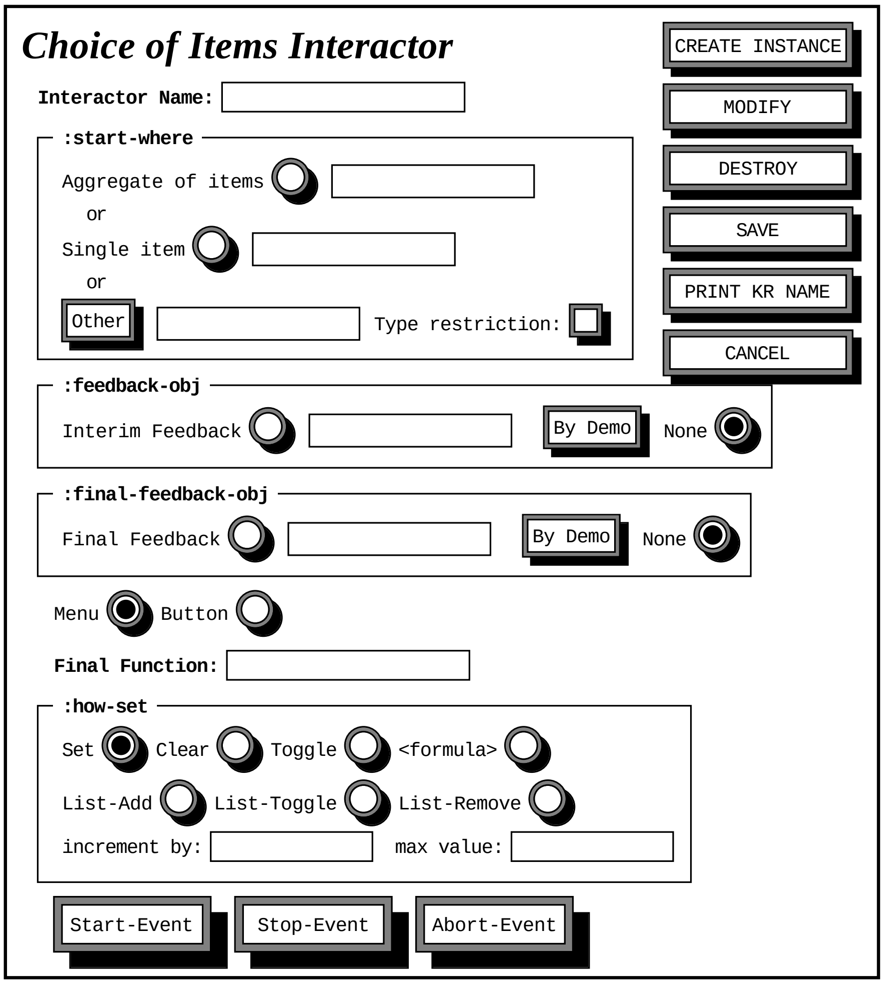


Figure 4-2: Choice interactor dialog box

- :start-where. If the user selects either `aggregadget of items` or `single item` and there is a least one selection in a drawing window (it may be either a primary or secondary selection), then start-where's with `:element-of` and `:in-box` are generated with the selected object.

- :feedback-obj. Selecting the radio button associated with `interim feedback` will cause the selected object in the Lapidary drawing windows to become the interim feedback for this interactor. If this object is constrained to one of the objects that satisfies the start-where or to a component of one of these objects, Lapidary will automatically generalize the constraints so that the object can appear with any of the objects in the start-where.

  The user can also use the `by-demo` option to demonstrate interim feedback. Lapidary will pop up an OK/Cancel box when an object that satisfies the start-where is selected. The user can then use the various Lapidary menus to modify this object so that it looks as it should when the object's `:interim-selected` slot is set. Once the desired look is achieved, the user selects OK and the changes will be installed so that the object looks like its original self when it is not interim selected, and will look like the by-demo copy when it is interim selected.

Lapidary implements the by-demo operation by comparing the values of the following slots in the original object and the copied object: `:left, :top, :width, :height, :visible, :draw-function, :font, :string, :line-style, :filling-style, :x1, :x2, :y1, :y2`.

The last option the user can choose is `none` in which case nil will be stored in the `:feedback-obj` slot. This will not undo the effects of a by-demo operation since by-demo also places nil in the `:feedback-obj` slot.

- :final-feedback. The options for final feedback are identical to those for `:feedback-obj`. The by-demo changes will appear when the object's `:selected` slot is set to `t`. Multiple final feedback objects can be created by selecting several objects and pressing the final feedback button. Lapidary will then bring up C32 and prompt the designer for a constraint that determines when to use each kind of feedback object at run-time.
- :final-function. The user can type in the name of a function that should be called when the interactor completes.
- :how-set. The user can set the `:how-set` slot by selecting a radio button or entering numbers in the `increment-by` and (optionally) `max value` fields.

4.5.2. Move/Grow Interactor

The move/grow interactor dialog box (Figure 4-3) allows the user to specify a move/grow interactor. The slots that can be set using this dialog box are:

- :start-where. If the user selects either `Object to Press Over` or `One of This Aggregate` and there is at least one selection in a drawing window (it may be either a primary or secondary selection), then start-where's with :in-box and :element-of are generated with the selected object.
- :line-p. This slot is set by the `Line` and `Box` buttons. If a formula is selected, the formula should return `t` if the interactor is moving/growing a line, and `nil` if it is moving/growing a box object.
- :grow-p. This slot is set by the `Grow` and `Move` buttons. If a formula is selected, the formula should return `t` if the interactor is growing an object, and `nil` if it is moving an object.
- :min-length. Specifies a minimum length for lines.
- :min-width. Specifies a minimum width for box objects.
- :min-height. Specifies a minimum height for box objects.
- :obj-to-change. The user can let the move/grow interactor modify the object that satisfies the start-where, present an example object to change to Lapidary or use a formula to compute the object to change. This slot would be set if the interaction should start over a feedback object such as selection handles, but should actually move the object under the feedback object.

  If the user presents an example object to change to Lapidary by selecting an object and pressing the `Change this object` button, Lapidary will automatically construct a formula so that the interactor changes the correct object at run-time. For example, in Figure 4-3, the user wants the move interactor to start over one of the selection handles, but wants the object highlighted by the selection handles moved. The user can specify that the interactor should start over the selection handles by selecting the aggregate containing the selection handles and pressing the `One of This Aggregate` radio button in the move/grow dialog box. The user can specify that the object highlighted by the selection handles at run-time should be the object changed by selecting the example object that the selection handles currently highlight and pressing the `Change this object` button in the move/grow dialog box. Occasionally Lapidary may not be able to determine from the start-where objects which object should be changed at run-time. In this case Lapidary will give the user the choice of entering a formula or of having the example object selected as the obj-to-change be the actual object changed at run-time.

- :final-function. The user can type in the name of a function that should be called when the interactor completes.
- :feedback-obj. An interim feedback object can be created by creating the desired object and pressing the interim-feedback button. Constraints will be automatically attached to the feedback object that cause it to move or grow appropriately, and that make it visible/invisible at the appropriate times. If multiple objects are selected, Lapidary will bring up C32 and prompt the designer for a constraint that determines when to use each kind of feedback object at run-time.
- :attach-point. Controls where the mouse will attach to the object.

The grow and move parameters allow the user to control which slots in the object that is being grown or moved will actually be set. If a formula is entered, it must return a value that can be used by the slot :slots-to-set (see the Interactors chapter for more details on this slot).

Example: To create an interactor that moves a box,

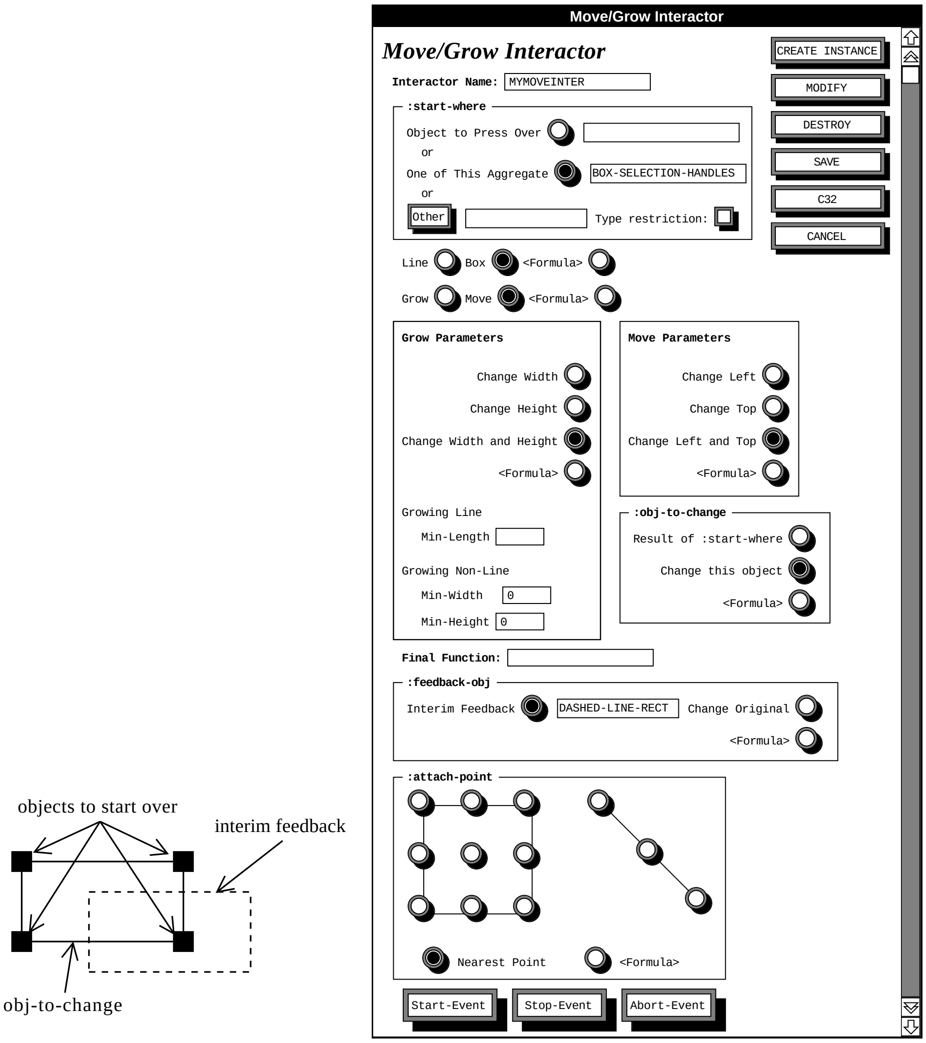
1. Create the box and leave it selected
2. Select interactors from the editor menu and then select move/grow
3. In :start-where click on ‘‘Object to Press Over’’. This will cause the selected rectangle’s KR name to be displayed.
4. Press the CREATE INSTANCE action button

To test the interactor press test button in the editor menu and drag it around.

4.5.3. Two Point Interactor

The two point interactor dialog box (Figure 4-4) allows a user to create a two point interactor. The slots that can be set using this dialog box are:

- :start-where. If the user selects `Start Anywhere in Window` then a start-where with `t` is generated. if the user selects `Start in Box` and there is at least one selection in a drawing window (it may be either a primary or secondary selection), then a start-where with :in-box is generated with the selected object.
- :line-p. This slot is set by the buttons `Create Line` and `Create Non-Line`. If a formula is selected, the formula should return `t` if the interactor is creating a line, and `nil` if it is creating a box object.
- :min-length. Specifies a minimum length for lines.
- :min-width. Specifies a minimum width for box objects.
- :min-height. Specifies a minimum height for box objects.
- :flip-if-change-side. Indicates whether a box may flip over when it is being created.
- :abort-if-too-small. Indicates whether the operation should be aborted if the object is too



(a) (b)

Figure 4-3: (a) The various parts for a move behavior; and (b) the dialog box for specifying the move/grow interactor. The user can now directly select the obj-to-change and Lapidary will create a formula that automatically selects the correct object to change at run-time.

small or whether an object of the minimum size should be created.

- :feedback-obj. An interim feedback object can be created by creating the desired object and pressing the interim-feedback button. Constraints will be automatically attached to the feedback object that cause it to sweep out as the mouse cursor is moved, and that make it visible/invisible at the appropriate times. If multiple objects are selected, then Lapidary will bring up C32 and prompt the designer for a constraint that determines when to use each kind of feedback object at run-time. If the standard feedback option is selected, a box or line feedback object is automatically created according to whether a line or box is being created.

- :final-function. The user can type in the name of a function that should be called when the interactor completes.

Example: To create a two-point interactor with line feedback

1) select the interactors option from `other` in the editor menu and then select two point interactor in the menu that pops up

2) click on Start Anywhere in Window

3) click on Create Line

4) click on Standard Feedback

5) click on CREATE INSTANCE

To test this interactor, enter test mode, press down on the left mouse button, and sweep out a line. No line will be created because a final function was not provided.

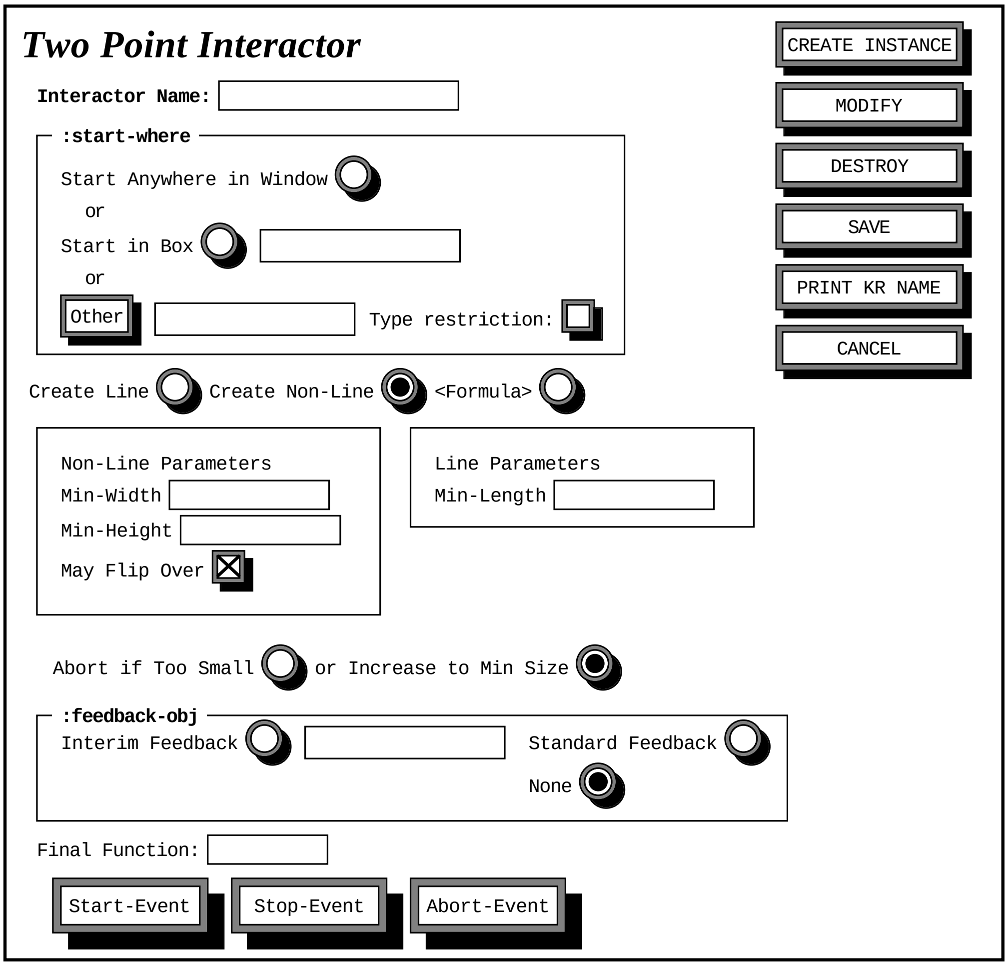


Figure 4-4: Two point interactor dialog box

4.5.4. Text Interactor

The text interactor dialog box (Figure 4-5) allows the user to create or modify a text interactor and to edit the following slots:

- :start-where. If the user selects either `object to press over` or `one of this aggregadget` and there is at least one selection in a drawing window (it may be either a

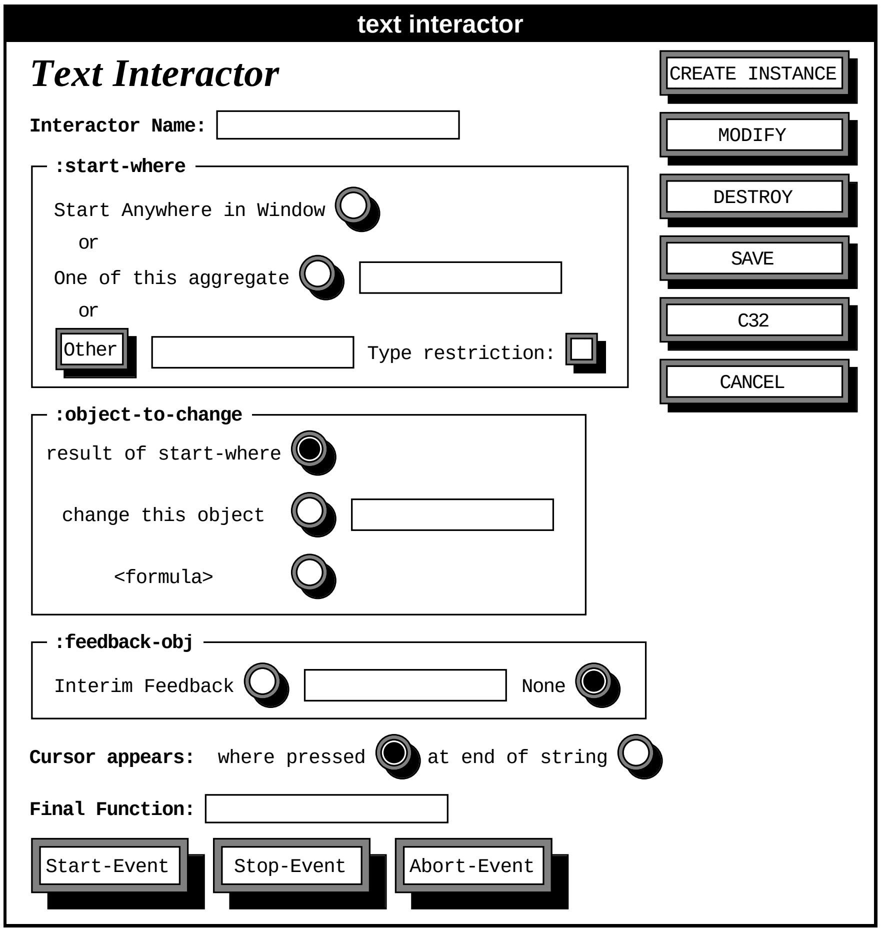


Figure 4-5: Text interactor dialog box

primary or secondary selection), then start-wheres with `:in-box` and `:element-of` are generated with the selected object.

- :obj-to-change. The user can either let the text interactor modify the object that satisfies the start-where or use a formula to compute the object to change. Lapidary can construct a formula for this slot if necessary (see section 4.5.2).

- :feedback-obj. An interim feedback object can be created by creating a text object and pressing the interim-feedback button. Constraints will be automatically attached to the feedback object that cause it to appear at the selected text object and that make it visible/invisible at the appropriate times. If multiple objects are selected, then Lapidary will bring up C32 and prompt the designer for a constraint that determines when to use each kind of feedback object at run-time.

- :cursor-where-press. This slot is set by the buttons `where pressed` and `at end of string`. If `where pressed` is selected, the text editing cursor will appear under the mouse cursor. If `at end of string` is selected, the text editing cursor will always appear at the end of the string when editing starts.

- :final-function. The user can type in the name of a function that should be called when the interactor completes.

4.5.5. Angle Interactor

The angle interactor dialog box (Figure 4-6) allows the user to create and modify an angle interactor. The slots that can be set by this dialog box are:

- :start-where. If the user selects `object to press over` and there is a least one selection in a drawing window (it may be either a primary or secondary selection), then a start-where with `:in-box` is generated. If the user selects `start anywhere in window`, then a start-where of `t` is generated.
- :obj-to-change. The user can either let the angle interactor modify the object that satisfies the start-where or use a formula to compute the object to change.
- :feedback-obj. An interim feedback object can be created by creating an object, selecting it, and pushing the interim feedback button. The :angle slot of the object will be set as the interactor is operated and the object will be made visible/invisible as appropriate. To make the feedback object or the object that gets the final angle change in response to changes in the :angle slot, custom constraints must be created for the position and size slots. See the angle interactor section in the Interactors chapter for sample constraints. If multiple objects are selected, then Lapidary will bring up C32 and prompt the designer for a constraint that determines when to use each kind of feedback object at run-time.
- :final-function. The user can type in the name of a function that should be called when the interactor completes.
- :center-of-rotation. This is the center of rotation for the interaction. The user can either enter a list of `(x,y)`, enter a formula that returns a list of `(x,y)` or select one of the standard locations for the center of rotation by selecting the appropriate button.

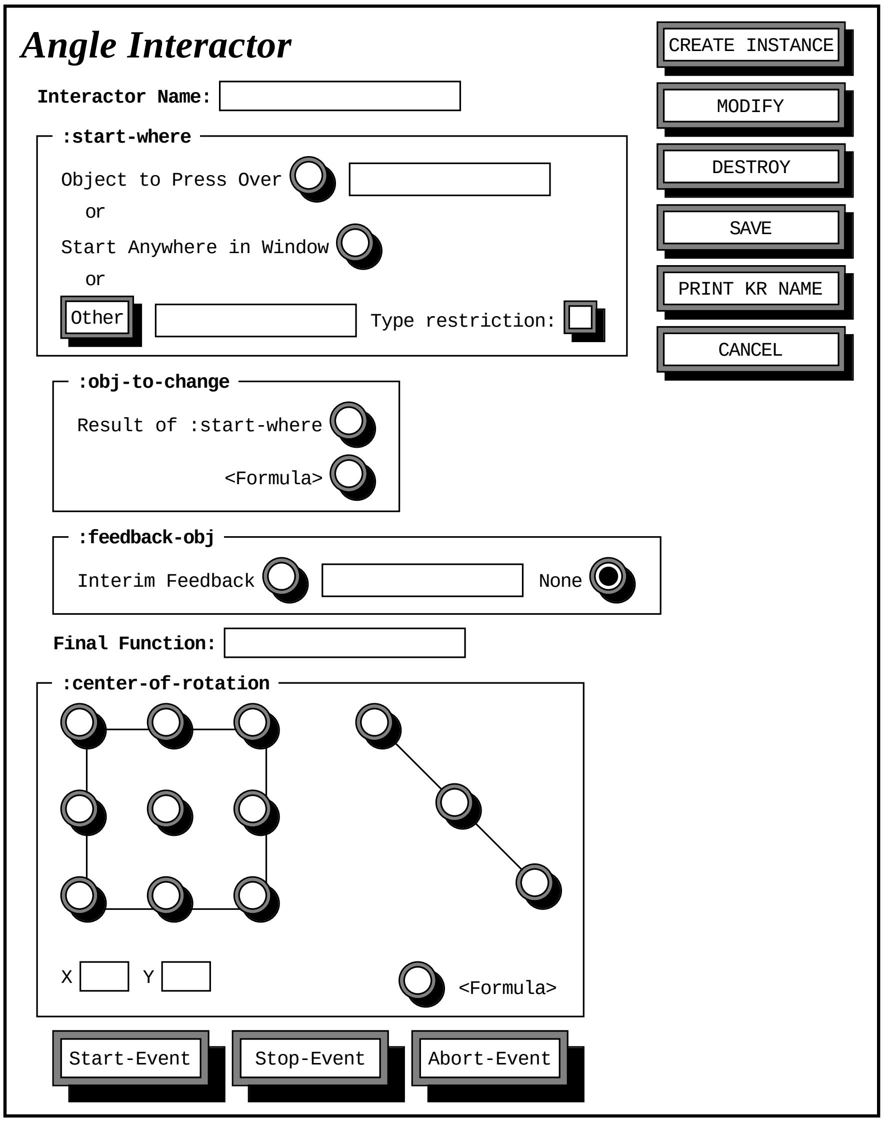


Figure 4-6: Angle interactor dialog box

5. Getting Applications to Run

Lapidary-generated files consist of a set of create-instance calls. The objects created are stored in a list and assigned to the variable *Garnet-Objects-Just-Created*. The top of a Lapidary-generated file contains code to load the lapidary-functions.lisp file, which provides functionality to support the created objects.

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