

Visual Interfaces for Icon Programs

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VIB (Visual Interface Builder) is a program for building visual interfaces (GUIs) and custom dialogs for use in Icon programs. A visual interface consists of a canvas on which interface tools are placed. Interface tools are called *vidgets* (virtual input devices) and include buttons, menus, sliders, and so forth.

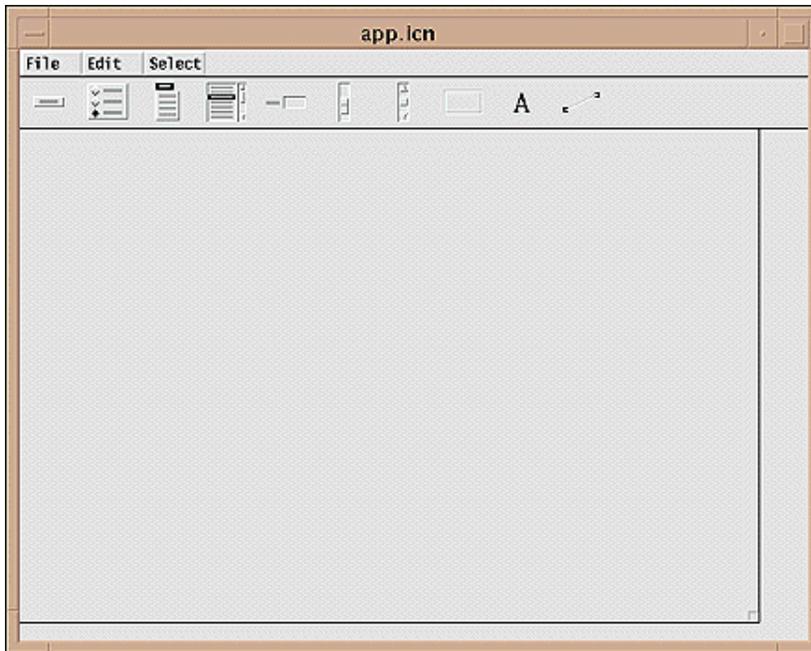
User actions on vidgets, such as clicking the mouse on a button or dragging on a slider, cause events. Such events produce *callbacks*, which are calls to procedures in the application that handle user events.

VIB produces code for the interface. A complete application consists of interface code, event handling procedures, and the functionality for the application itself.

VIB also can construct custom dialogs.

1. The VIB Window

The VIB window has a menu bar at the top. Below this there is a vidget bar with icons representing the various kinds of vidgets. The remaining portion of the VIB window contains the canvas for the interface or dialog, which is indicated by a rectangular area with a box on its lower-right corner.



2. VIB Menus

The `File` menu provides several services related to files and the overall application:



The `new` item creates a new file for an interface or dialog. The `open` item opens an existing interface file. The `save` and `save as` items write interface files. The `refresh` item redraws the canvas, which is needed occasionally if something does not appear correctly. The `prototype` item is used to run the interface or canvas as if were being used in an application. And, of course, the `quit` item terminates the VIB session.

A notation like `@S` indicates a keyboard shortcut for the item in question. The `@` indicates the meta key is to be depressed while typing the letter (`s` in this example), which can be upper- or lowercase.

The `Edit` menu provides services related to manipulating widgets:



The `copy` item copies a widget, while the `delete` item deletes one. The `undelete` item can be used to restore the last deleted widget. The final two items allow widgets to be visually aligned.

The `select` menu allows one of the widgets to be selected for manipulation:

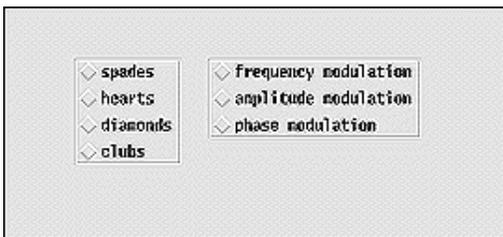


3. Widgets

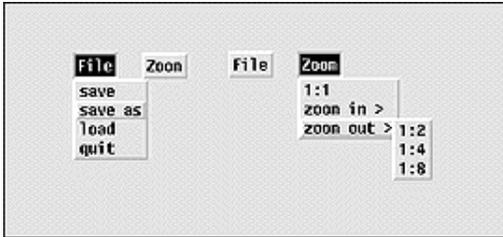
VIB provides several kinds of widgets. These are described below in the order they appear in the widget bar. Examples of the visual appearances of widgets accompany the descriptions.



There are two types of **buttons**: regular buttons that just produce a callback when pushed and toggle buttons that also maintain an on/off state. Different styles provide different visual appearances for buttons.



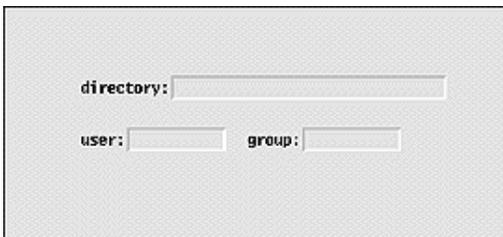
Radio buttons allow the user to select one of a number of choices.



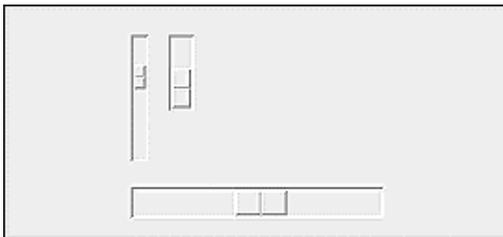
Menus are buttons concealing lists of items. The items are exposed when the menu's button is pushed. The user then can drag to a desired item to select it. Menus can have submenus.



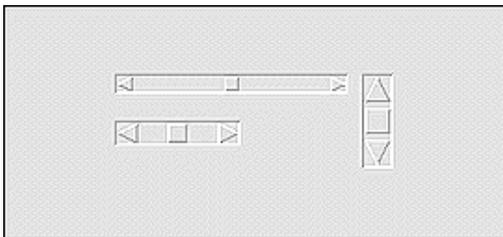
Text lists allow the user to scroll through lines of text and select one or more of them.



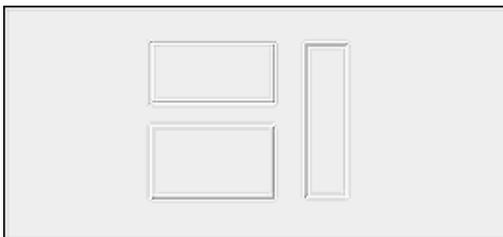
Text-entry fields provide the user with an area to enter and edit text.



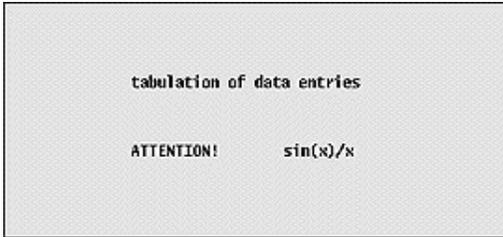
Sliders have a thumb that can be moved to select a numerical value within a specified range. Sliders can be oriented vertically or horizontally.



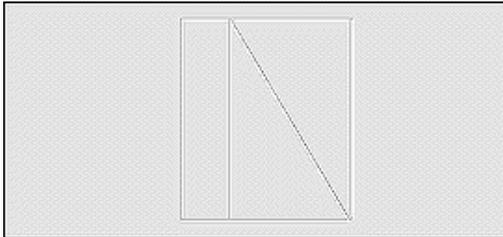
Scrollbars perform the same function as sliders, but they have buttons on the ends as well as a thumb for adjusting the position.



Regions delimit rectangular areas and can accept user events within those areas. Regions are available in several styles to provide different visual appearances.

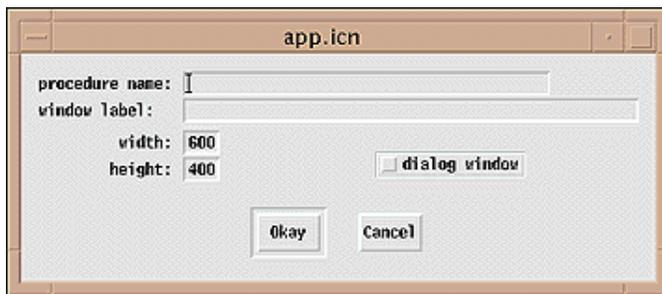


Labels provide text but do not accept events.



Lines can be used to decorate the interface. Lines do not accept events.

The application canvas is configured by using the box on its lower-right corner. Dragging this box resizes the application canvas. Clicking the right mouse button on this box brings up a dialog:



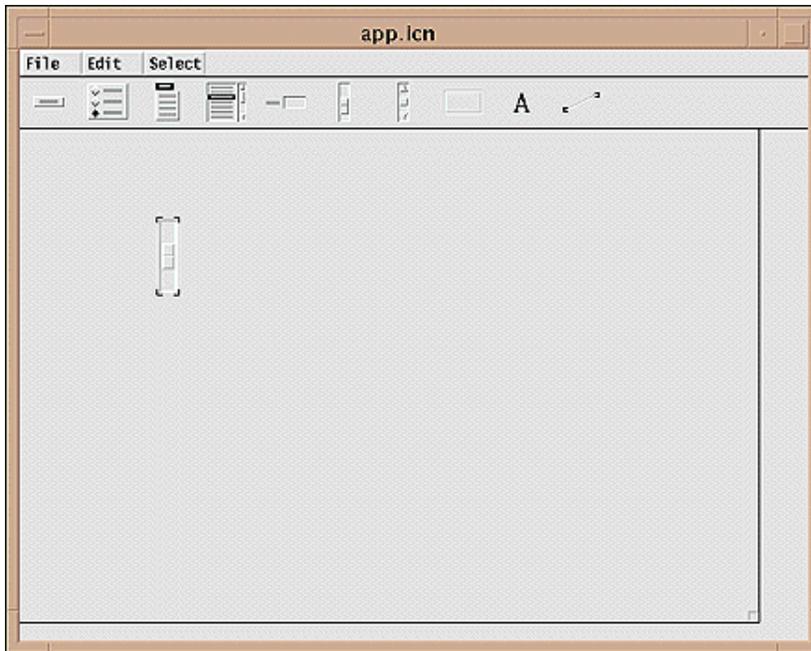
The dialog window button is checked when a custom dialog instead of an application interface is being constructed. In this case, the name of a procedure for invoking the dialog can be specified. Neither of these are relevant for building an application interface.

Note: The VIB window can be resized using the window manager if it is not large enough to accommodate the application canvas.

4. Creating Vidgets

A vidget is created by clicking on its icon in the vidget bar and dragging it into position on the application canvas. It can be repositioned later.

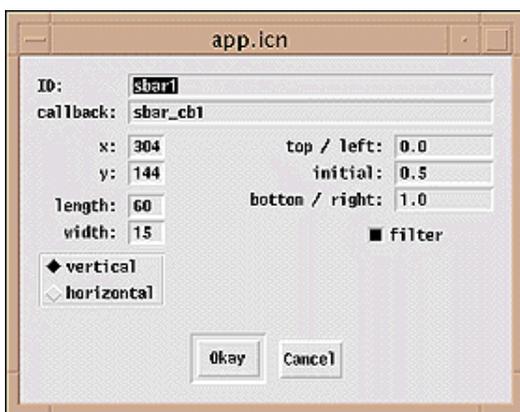
The result of creating and placing a slider vidget is shown below:



5. Vidget Attributes

Vidgets have a variety of attributes, some of which are common to all vidgets and some that are specific to the type of the vidget. When a vidget is created, it has default attributes. These attributes can be changed later.

Clicking with the right mouse button on a vidget brings up a dialog showing the vidget's attributes. The default attributes for a slider vidget are shown below:



Every vidget has an ID attribute. Vidgets are identified by their IDs, both in VIB and in the application that uses the interface. All vidgets also have a position, given as the x-y coordinates of its upper-left corner. Most kinds of vidgets have size attributes as well. All vidgets except for labels and lines have a callback attribute that names the application procedure that is called when the user manipulates the vidget. In the case of a slider vidget, there also is an attribute for orienting it vertically or horizontally. Finally, numerical values can be set for the endpoints of the slider, and the filter option controls the circumstances under which the callback procedure is invoked.

The initial default values for widget attributes usually should be changed. For example, it usually is advisable to choose IDs and callback names that have mnemonic meanings for the widget in question.

Configuration dialogs for the various kinds of widgets are given in Appendix A. The attributes of widgets are described in more detail in Appendix B.

6. Manipulating Widgets

Selecting and Deselecting Widgets

A widget can be moved or modified only when it is *selected*. Only one widget can be selected at a time. A widget can be selected by clicking on it, which highlights its corners to indicate it is selected. When a widget is selected, any previously selected widget is deselected. Clicking on the canvas at any place other than on a widget deselects the currently selected widget, leaving no widget selected.

A widget also can be selected by using the `select` menu, which displays the IDs of all widgets as shown earlier. This method of selection is useful if a widget is "lost" because it is behind another widget or because it is too small to be selected by clicking on it.

Resizing Widgets

A widget can be resized by selecting it, pressing the mouse on one of its four corners, and dragging that corner to a new location. The diagonally opposite corner remains anchored, and the size changes. Some widgets enforce constraints on resizing. For example, a button cannot be made smaller than its label. Other widget types, such as menus, cannot be resized at all.

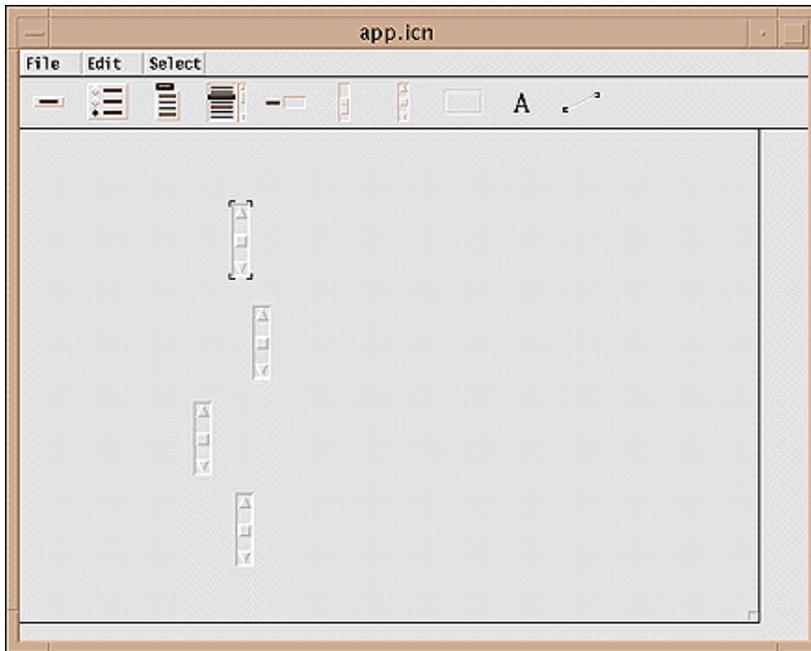
Positioning Widgets

A widget can be repositioned by selecting it and dragging with the left mouse button depressed. A selected widget can be moved one pixel at a time by using the arrow keys on the keyboard. This is useful for small movements and precise positioning. A widget also can be repositioned by using its dialog and changing the x-y coordinates of its upper-left corner.

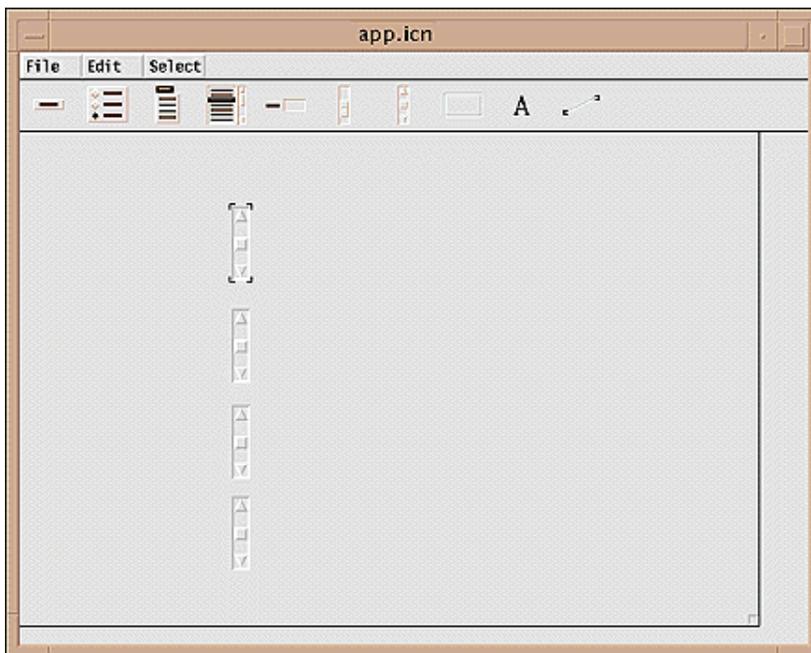
Widgets can be aligned by selecting an "anchor" widget and then choosing `align horiz` or `align vert` from the `edit` menu. Horizontal alignment aligns the left edges of widgets with the left edge of the anchor widget, while vertical alignment aligns the tops.

When an alignment is chosen from the `edit` menu, the mouse pointer changes to a shape that indicates horizontal or vertical movement, corresponding to the type of alignment chosen. Subsequently, clicking on a widget aligns it with the anchor widget. Several widgets can be aligned in this manner. Clicking on the canvas off any widget restores the cursor to an arrow and its normal functionality.

The following image shows four scrollbars that need to be aligned horizontally with the topmost one selected as the anchor:



After selecting `align horiz` and clicking on each of the three scrollbars below the anchor, the result is



Note that the anchor widget still is selected.

Deleting Widgets

The selected widget can be deleted by choosing `delete (@X)` from the `Edit` menu or by pressing the `delete` key. This operation can be undone by choosing `undelete (@U)` from the `Edit` menu, provided no other action has been performed since the widget was deleted.

Copying Widgets

The selected widget can be copied by choosing copy (@C) from the `edit` menu.

The copied widget is selected when it is created. It is offset vertically and horizontally from the widget from which it was copied. Attributes other than the ID, callback, and position are inherited from the widget from which it was created.

7. Custom Dialogs

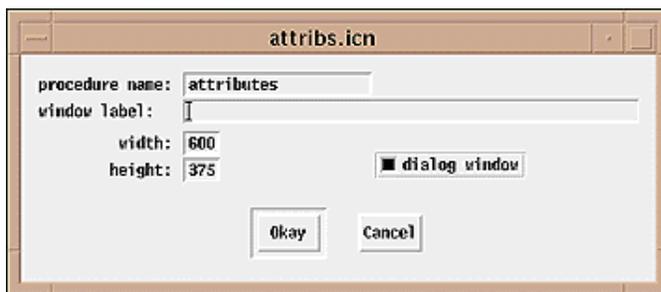
A custom dialog is very similar to a visual interface for an application: Widgets with various functionalities can be positioned as desired.

There are two noticeable differences between custom dialogs and visual interfaces:

- Menus, regions, and text lists cannot be used in custom dialogs. They may be created and placed, but they are ignored when the dialog is saved.
- A custom dialog must have at least one regular button, so that it can be dismissed. VIB refuses to save a custom dialog without a regular button.

VIB must be told that it is creating a custom dialog rather than a visual interface, which is the default. This is done in the canvas dialog that comes up as a result of clicking with the right mouse button on the lower-right corner of the application canvas.

Two things are needed to create a custom dialog: providing a procedure name by which the dialog will be called and setting the dialog window toggle, as shown in this example:



One button can be designated as the default button for dismissing a custom dialog. This is done by setting the dialog default toggle in the attribute dialog for the button:



8. Prototyping

The application canvas as shown by VIB is very similar to the way it appears in an application. The dashed lines that show the boundary of a region with an invisible border do not, of course, show when the visual interface is used in an application.

The exact appearance of the interface can be obtained by selecting `prototype (@P)` from the `File` menu. This constructs and launches an application with the current interface and a dummy program for handling events.

Manipulating vidgets on the prototype produces information about callbacks, IDs, and vidget values.

A prototype for a visual interface can be terminated by typing `q` with the cursor not on a vidget. The prototype for a custom dialog can be dismissed by clicking on one of its regular buttons. A dialog is presented to confirm that you wish to terminate the prototype instead of continuing to test it.

9. Callbacks

When the user presses a button, selects an item from a menu, or activates some other interface tool, a procedure associated with the vidget is called. Such procedures are called callbacks because user actions on the interface result in calls back to procedures in the application.

Callback procedures have the following form:

```
procedure cb(vidget, value)
```

The first argument identifies the vidget that produced the callback, and the second argument gives a value. The vidget argument is not always needed, but it can be used to distinguish among different vidgets that share the same callback procedure. The value often is important, since in many cases it indicates the nature of the user action.

For a toggle button, the value is null when the toggle is turned off and 1 (nonnull) when it is turned on. This makes testing of the state of a toggle easy, as in

```
procedure pause_cb(vidget, value)
```

```

    if \value then      # stop display
    else                # continue display

    return

end

```

The callback value for a radio button is the (string) label of the selected button, as in

```

procedure shape_cb(vidget, value)

    case value of {
        "discs":      # set shape to filled circle
        "rings":      # set shape to output circle
    }

    return

end

```

Since menus can have submenus, their callback values are lists whose first elements are the text for the item selected from the main menu, whose second elements are the text for the item selected from the first submenu, and so on. If there are no submenus, the callback value for a menu is a one-element list, as illustrated by

```

procedure file_cb(vidget, value)

    case value[1] of {
        "snapshot @S": # take snapshot
        "quit @Q":     # shut down the application
    }

    return

end

```

Notice that the list element is the complete text for the item selected.

The callback value for a text-entry field is the text in the field at the time the user presses return with the I-beam cursor in the field. There is no callback until the user presses return.

The callback value for a slider or scrollbar is the numerical value in the given range, as determined by the position of the thumb. A slider or scrollbar can be configured in two ways: to provide callbacks as the user moves the thumb, or "filtered" to provide a callback only when the user releases the thumb. Filtering is appropriate when only the final value is important, as in

```

procedure density_cb(vidget, value)

    density := value      # set global variable

    return

end

```

Unfiltered callbacks may be needed when the application needs to respond while the user moves the thumb, as in scrolling an image.

The callback value for a text-list widget depends on the kind of the text list. If the widget allows selection of only a single item, the value is the selected line. If the widget allows multiple selections, the value is a list of the selected lines. There is no callback for a text list that does not allow selection.

The form of callback procedures for regions is somewhat different from the callback procedures for other widgets. The second argument is the event produced by the user, and there are two additional arguments that indicate where on the application canvas (not the region) the event occurred:

```
procedure cb(widget, e, x, y)
```

Note in particular that *e* is not a value associated with the region widget, as it is for other kinds of widgets; it is the actual event, such as a mouse press or a character from the keyboard.

Labels and lines do not produce callbacks; they provide decoration only.

10. The Structure of a VIB Application

An application with a VIB interface usually has several relatively distinct components:

header
main procedure
initialization
application functionality
callbacks
VIB interface

The sections above the thick line are written by the programmer of the application. VIB produces the section of code below the thick line. It is used to create the interface. Here is a typical example.

```

====<<vib:begin>>====      modify using vib; do not remove this marker line
procedure ui_atts()
    return ["size=600,455", "bg=pale gray"]
end

procedure ui(win, cbk)
return vsetup(win, cbk,
    [":Sizer::0,0,600,455:kaleido", ],
    ["file:Menu:pull::12,3,36,21:File", file_cb,
     ["snapshot @S", "quit @Q"]],
    ["label01:Label::13,180,21,13:min", ],
    ["label02:Label::152,180,21,13:max", ],
    ["label03:Label::13,240,21,13:min", ],
    ["label04:Label::152,240,21,13:max", ],
    ["label05:Label::13,300,21,13:min", ],
    ["label06:Label::152,300,21,13:max", ],
    ["label07:Label::7,120,28,13:slow", ],
    ["label08:Label::151,120,28,13:fast", ],
    ["lbl_density:Label::67,160,49,13:density", ],
    ["lbl_max_radius:Label::43,280,98,13:maximum radius", ],

```

```

["lbl_min_radius:Label:::44,220,98,13:minimum radius",],
["lbl_speed:Label:::74,100,35,13:speed",],
["line:Line:::0,30,600,30:",],
["pause:Button:regular:1:33,55,45,20:pause",pause_cb],
["reset:Button:regular:111,55,45,20:reset",reset_cb],
["sld_density:Slider:h:1:42,180,100,15:1,100,50",density_cb],
["sld_max_radius:Slider:h:1:42,300,100,15:1,230,115",max_radius_cb],
["sld_min_radius:Slider:h:1:42,240,100,15:1,230,115",min_radius_cb],
["sld_speed:Slider:h:1:42,120,100,15:500,0,250",speed_cb],
["region:Rect:raised:::188,42,400,400:",],
)
end
#===<<vib:end>>===      end of section maintained by vib

```

The procedure `ui()` in the VIB section opens the application, draws and initializes the vidgets, and returns a table that contains the vidget records.

A program with a VIB interface typically begins with

```
vidgets := ui()
```

The keys in the table returned by `ui()` are the vidget IDs. Their corresponding values are the vidget records. One vidget in the table returned by `ui()` is particularly important: a "root" vidget that encloses all other vidgets and processes events that occur on them. The root vidget has the ID `root`.

In an application with a VIB interface, events are not handled by `Event()` but by higher-level procedures that understand vidgets and the meaning of events that occur on them. There are two procedures that handle vidget events, `ProcessEvent()` and `GetEvents()`.

`ProcessEvent(root, missed, all, resize)` processes a single event. If the event takes place on a vidget and is appropriate for the vidget (such as a mouse press within the area of a button), a callback for that vidget occurs. The arguments `missed`, `all`, and `resize` are optional procedures that are called for events that occur when the mouse pointer is not on a vidget or are not appropriate for that vidget (such as a keyboard event with the mouse cursor on a button), for all events, and for resize events, respectively. For example,

```
ProcessEvent(root, , shortcuts)
```

might be used to call `shortcuts()` for all events in order to handle keyboard shortcuts that are entered whether the mouse pointer is on a vidget or not.

The procedure `ProcessEvent()` is used when an application wants to handle events one by one. Such programs typically have an event loop of the form

```

repeat {
  while *Pending() > 0 do
    ProcessEvent(vidgets["root"])
    # work performed between processing events
  }
}

```

In the repeat loop, if there are any pending events, they are processed before going on. This assures prompt response to the user. If no events are pending, other work is done. The amount of computation done before checking again for user events should be small, so as to assure a responsive interface.

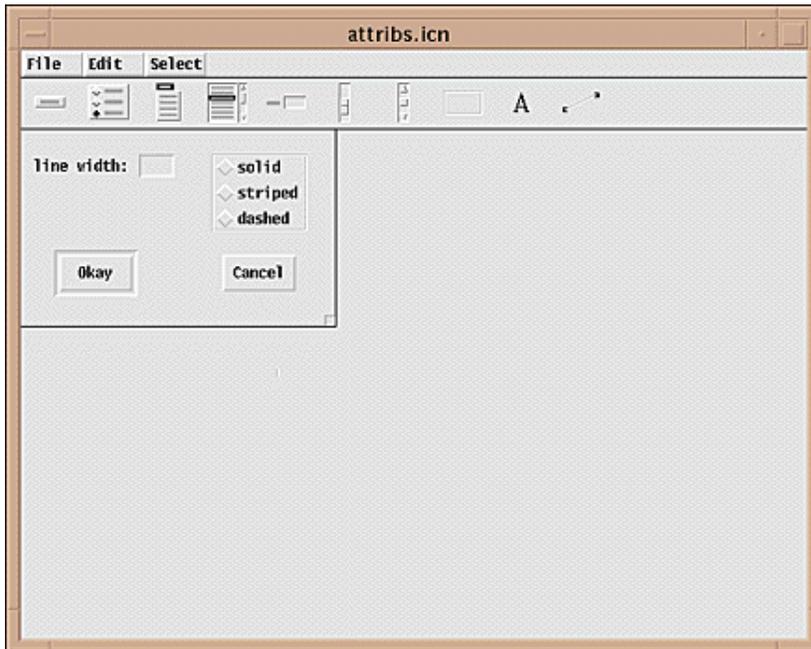
The procedure `GetEvents(root, missed, all, resize)`, whose arguments have the same meaning as those for `ProcessEvent()`, handles all events and does not return control to the program. `GetEvents()` is appropriate for applications that are entirely "event-driven" and perform processing only in response to user events and the resulting callbacks.

11. Using Custom Dialogs

A custom dialog is invoked by calling the procedure named in VIB's canvas dialog. The argument of the procedure is a table whose keys are the IDs of the vidgets in the dialog and whose corresponding values are the states of these vidgets.

When a dialog is dismissed, it returns the text of the button used to dismiss it (as for standard dialogs). Before returning, it also changes the values in the table to correspond to the states of the vidgets when the dialog was dismissed.

Here's a custom dialog as shown in VIB:



Here's the code for a procedure to use this custom dialog:

```
link dsetup                                # dialog setup

procedure attribs(win)
  static atts

  initial atts := table()                 # table of vidget IDs
  /win := &window

  # Assign values from current attributes.
  atts["linewidth"] := WAttrib(win, "linewidth")
```

```

atts["linestyle"] := WAttrib(win, "linestyle")

# Call up the dialog.

repeat {
  attributes(win, atts) == "Okay" | fail
  # Set attributes from table.
  WAttrib(win, "linewidth=" || atts["linewidth"]) | {
    Notice("Invalid linewidth.")
    next
  }
  WAttrib(win, "linestyle=" || atts["linestyle"])
  return
}

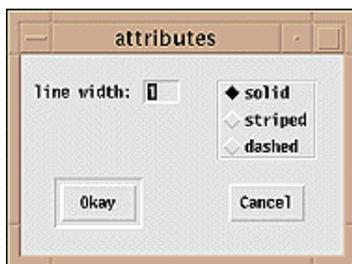
end

####<<vib:begin>>==== modify using vib; do not remove this marker line
procedure attributes(win, deftbl)
static dstate
initial dstate := dsetup(win,
  ["attributes:Sizer::1:0,0,256,160:",],
  ["cancel:Button:regular::164,102,60,30:Cancel",],
  ["linestyle:Choice::3:155,20,78,63:",,
    ["solid", "striped", "dashed"]],
  ["linewidth:Text::3:10,20,115,19:line width: \\=",],
  ["okay:Button:regular:-1:31,102,60,30:Okay",],
)
return dpopup(win, deftbl, dstate)
end
####<<vib:end>>==== end of section maintained by vib

```

If the value for the line width is invalid, an attempt to set it fails. If this happens, the user is notified and the dialog is presented again. The radio button choices, on the other hand, are guaranteed to be legal by virtue of the button names used.

An example of the use of an attribute dialog is



12. Limitations

VIB has several limitations that should be considered before designing an interface:

- VIB can handle only one interface section in a file.
- The location and attributes of widgets cannot be changed when an application is running.
- There is no provision for adding new kinds of widgets.
- There is no provision for decorating widgets with images.

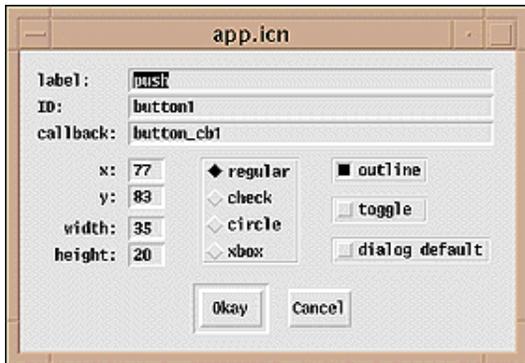
Acknowledgments

Jon Lipp created the widgets under Clint Jeffery's direction. Mary Cameron produced the first version of the interface builder as a class project.

Appendix A -- Widget Configuration Dialogs

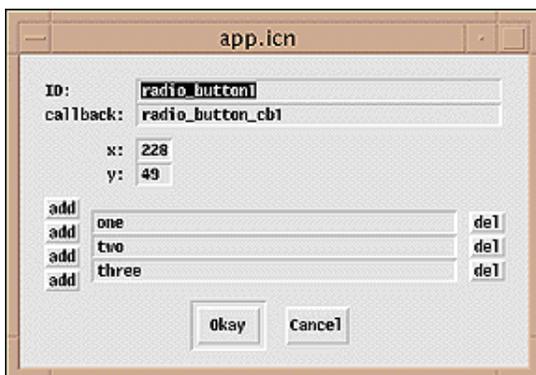
Button Configuration Dialog

The dialog for configuring a button is shown below with initial defaults. The label attribute is what appears on the button. The radio buttons in the center and the outline button at the right provide choices for the visual appearance of the button. The toggle button allows a choice of a regular button or one that maintains an on/off state. The dialog default button is used to designate a default button used to dismiss a custom dialog when the user enters return.



Radio Button Configuration Dialog

The configuration dialog for a set of radio buttons is shown below with its default values. Three buttons are provided initially with default names. These names can be changed by editing the text-entry fields. Additional buttons can be added by clicking on one of the add buttons that appear at the left; the top and bottom add buttons insert a field above and below the first and last fields, respectively. The other add buttons insert fields between existing ones, as indicated by their positions. The del buttons at the right delete the fields to their immediate left.



Menu Configuration Dialog

The configuration dialog for a menu is shown below with its default values. Three items are provided initially with default names. The items can be edited and items can be added and deleted in the manner used for radio buttons.



Clicking on create submenu brings up a dialog for a submenu as shown below.



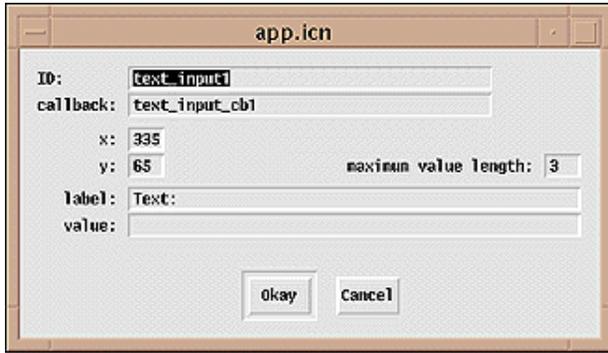
Text-List Configuration Dialog

In the dialog for configuring a text-list widget, there are three choices for user selection: read only, which allows the user to scroll through the lines but not select any; select one, which allows the user to select a single line; and select many, which allows selection of any or all lines.



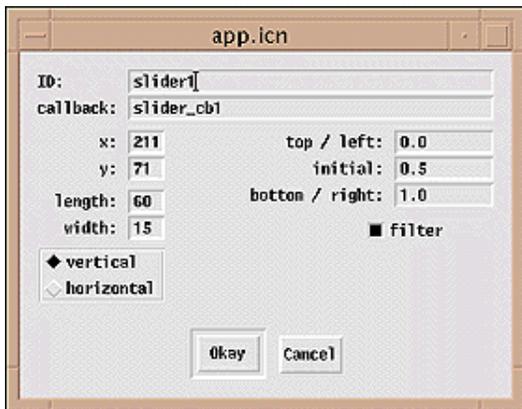
Text-Entry Configuration Dialog

In the dialog for configuring a text-entry widget, the label field provides for text that appears at the left of the field. An initial value for the text can be entered and the number of characters allowed in the field can be specified.



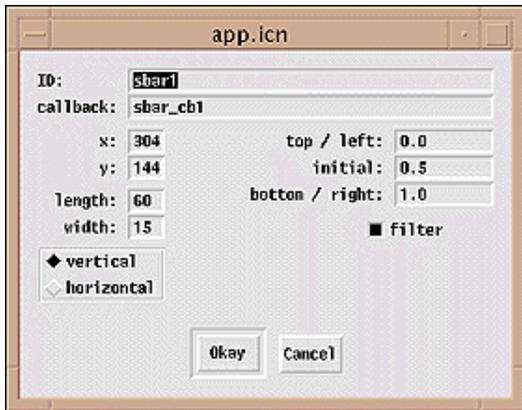
Slider Configuration Dialog

The configuration dialog for a slider widget allows its dimensions and orientation to be changed as indicated. The default values of the extreme positions of the thumb default to 0.0 and 1.0, allowing scaling in the application. If the filter toggle is on, a callback only occurs when the user releases the thumb. Otherwise, a callback occurs whenever the user moves the thumb.



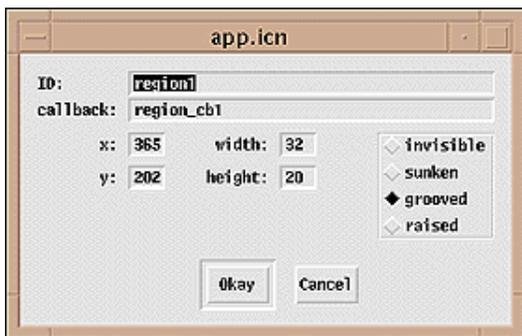
Scrollbar Configuration Dialog

The configuration dialog for a scrollbar is the same as the dialog for a slider, since the only differences between the two types of widgets are their visual appearance and the functionality by which the user can change the position of the thumb.



Region Configuration Dialog

The configuration dialog of a region provides four choices for the appearance of the border.



Label Configuration Dialog

Label widgets are the simplest of all widgets.



Line Dialog

A line widget differs from other widgets in having x,y coordinates for its end points.



Appendix B -- Vidget Information

Vidgets are implemented by Icon records, with a different record type for each kind of vidget. The set of vidgets is fixed and there are no provisions for adding new kinds of vidgets.

Vidget Fields

Vidgets have fields that contain their attributes. Some fields are common to all kinds of vidgets, while some are peculiar to a particular kind of vidget. The attributes of a vidget can be accessed through these fields.

Every vidget has an `id` field, which is the identifying name given to the vidget in VIB.

The most commonly used fields are the ones that give the locations and sizes of vidgets:

```
ax    x coordinate of the upper-left corner of the vidget
ay    y coordinate of the upper-left corner of the vidget
aw    width of the vidget
ah    height of the vidget
```

The `a` stands for "absolute". All vidgets except for lines have these attributes. Lines are specified by their end points:

```
x1    x coordinate of the beginning of the line
y1    y coordinate of the beginning of the line
x2    x coordinate of the end of the line
y2    y coordinate of the end of the line
```

Regions also have attributes that give their usable dimensions inside the decorating border they may have:

```
ux    x coordinate of the upper-left corner of the usable area
uy    y coordinate of the upper-left corner of the usable area
uw    width of the usable area
uh    height of the usable area
```

Vidget States and Callbacks

The following vidgets can have callbacks. Some maintain states; for these, the values passed generally are the same as their states at the time the callback occurs.

For text lists, the state always is a list of integers; this differs from the callback value. The first integer

indexes the top line currently displayed; this reflects the position of the scrollbar thumb. Additional integers, if any, index the currently selected items.

widget	state	callback value
regular button		1
toggle button	x	1 if on, null if off
radio buttons	x	text of selected button
menu		list of selected items
single-selection text list	x	selected item, or null if nothing is selected
multiple-selection text list	x	list of selected items
text-entry	x	text entered
slider	x	numerical value for position
scrollbar	x	numerical value for position
region		event and the x,y coordinates where it occurs

The state of some widgets when they are not activated is indicated visually:

widget	visual indication
toggle button	highlighted if on (foreground and background reversed), not highlighted if off
radio buttons	selected button highlighted
text list	selected lines highlighted
text-entry	current text displayed
slider	slider thumb position
scrollbar	slider thumb position

Widget Activation

A widget is activated by pressing a mouse button while the mouse pointer is positioned within the area of the widget. (Note that the entire area occupied by a widget may not be visually evident.) For a widget that has a callback procedure, the callback occurs in the following situations following the activation of the widget:

widget	callback time
button	when the mouse button is released
radio buttons	when the mouse button is released
menu	when the mouse button is released with the mouse cursor on a selected item
text list	when the mouse button is released
text-entry	when return is entered with the mouse pointer within the field
slider	if unfiltered, when the mouse is dragged on the slider; otherwise when the mouse button is released
scrollbar	if unfiltered, when the mouse is dragged on the slider or released on an end button; otherwise when the mouse button is released
region	when any keyboard or mouse event occurs within the region

The state of some widgets is indicated visually while they are activated:

widget	visual indication
button	highlighted (foreground and background reversed)
menu	items pulled down, with the potentially selected one highlighted
radio buttons	selected button highlighted

text list	selected lines highlighted
text-entry	text highlighted
slider	thumb position
scrollbar	thumb position

There is no visual indication when the callback occurs for a slider or scrollbar widget. The user cannot tell if the widget is filtered or if a callback only occurs when the mouse button is released. There is no visual indication when a callback occurs when the user finishes with a text-entry widget. To produce a callback for a text-entry widget, the user must type return while the I-beam cursor is in the text-entry field. If the user forgets this, no callback occurs. Since this is easy to forget, the user may think there has been a callback to accept the contents of the text-entry field when there has not been one. For this reason, text-entry widgets are best used in dialogs and not directly on an interface.

Setting and Getting Widget States

For widgets that have states, `VSetState(widget, state)` sets the state of `widget`. It does this by producing a callback to the widget as if the user had done it. Similarly, `VGetState(widget)` returns the state of `widget`.

For a text-list or menu widget, `VSetItems(widget, lst)` sets the list of items for `widget` to `lst`. Similarly, `VGetItems(widget)` returns the current list of items.