

A Quick Introduction to the Panel Library

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1. Introduction

The panel library hides much of the dirty work involved in making simple user interfaces for interactive applications on Plan 9. The design is modeled strongly on Ousterhout's Tcl/Tk, except that the programming language is C and most of Tcl/Tk's automatic behind-the-scenes recalculation and redrawing is missing.

The library provides facilities to create user-interface panel elements such as push-buttons, text entry windows, sliders, etc., to re-initialize existing elements, to calculate layout automatically, to display panels in a bitmap, and to process mouse and keyboard events.

The library defines a `Panel` data type that describes the structural, geometric, and operational behavior of user-interface elements. When displayed in a bitmap, a panel corresponds to a rectangular area, usually with some identifying graphics like a frame or a label drawn on it. Panels are organized into trees, with each panel's children drawn on top of it and inside its rectangle. None of the children's rectangles overlap, so the whole structure is like a nest of boxes.

2. A Simple Example

Here is a simple example that displays a panel containing a label and a *done* button and processes mouse events until the user hits done.

```
#include <u.h>
#include <libc.h>
#include <libg.h>
#include <panel.h>
Panel *root;
void done(Panel *p, int buttons){
    USED(p, buttons);
    exits(0);
}

void main(void){
    binit(0, 0, 0);
    einit(Emouse);
    plinit(screen.ldepth);

    root=plframe(0, 0);
    pllabeled(root, 0, "Hello, world!");
    plbutton(root, 0, "done", done);

    ereshaped(screen.r);
    for(;;) plmouse(root, emouse());
}
```

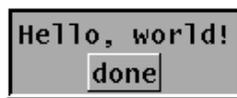
```
void ereshaped(Rectangle r){
    screen.r=r;
    plpack(root, r);
    bitblt(&screen, r.min, &screen, r, Zero);
    pldraw(root, &screen);
}
```

The `main` routine first calls initialization functions for the graphics library, the event library, and the panel library. The panel library needs to know the screen's `ldepth`, because it draws things differently on one-bit and multi-bit displays. (The examples here show the multi-bit version.)

The next three lines create a tree of panels. The root panel draws a frame around its children. Calling `plgroup` here instead of `plframe` would omit the frame. The children are a `Hello, world!` label and a button that calls the `done` routine when hit. The difference between `pllabel` and `plbutton` is that labels are not mouse-sensitive. The display reflects this by drawing the button in relief and changing its appearance when a mouse button is depressed over it.

Next, a call to `ereshaped` initializes the screen, and a simple loop sends mouse events to the root panel for processing.

The call to `plpack` in `ereshaped` calculates the geometry of the tree of panels, and `pldraw` displays the tree. Here's what the display looks like:



3. Display Layout

When `plpack` lays out a panel tree, it calculates a rectangle for each panel node, inside which the node's graphics and children are drawn. The layout of a node's children is controlled by flags given when the node is created. The first two arguments of every panel-creating function are a pointer to the parent panel and the flags used by `plpack`.

`Plpack` is declared thus:

```
int plpack(Panel *root, Rectangle space);
```

It packs `root` into `space`, and recursively packs each node's children into whatever space it has left over after drawing their parent's own graphics. `Plpack` stores each panel's placement in its field `r`, a `Rectangle`.

`Plpack` starts off with an empty rectangular frame, and fills it with children in eldest-to-youngest order. Placing each child uses up part of the frame and leaves a subrectangle of available space. For each child, it slices enough space to hold it from one of the four sides of the available space. Flag values `PACKN`, `PACKE`, `PACKS`, and `PACKW` determine which side the space is taken from. This figure illustrates the process:

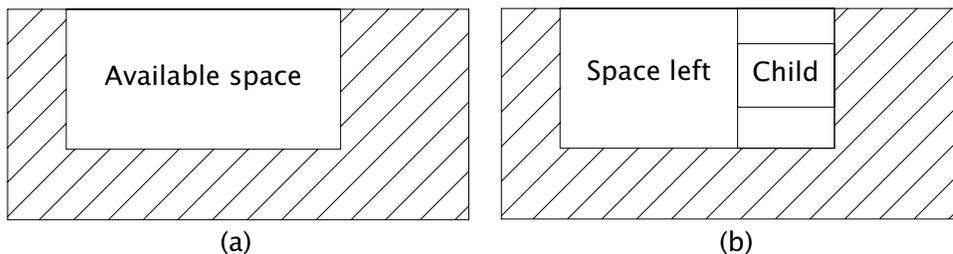
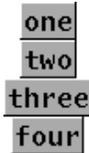


Figure (a) shows the available space in a frame before packing a child whose flag is `PACKE`. Figure (b) shows the child in place and indicates the space available for packing the next child.

For example, 4 buttons packed below one another, like this,

```
root=plgroup(0, 0);
plbutton(root, PACKN, "one", 0);
plbutton(root, PACKN, "two", 0);
plbutton(root, PACKN, "three", 0);
plbutton(root, PACKN, "four", 0);
```

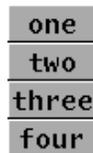
produce this:



Since the buttons are different sizes, the result looks ragged. The frame is wide enough to accommodate the widest button, and the parts sliced off for the four buttons are all the same size, but the buttons don't use all the space that `plpack` makes available to them. The `FILLX` flag expands a node in the `x` direction to fill any extra space sliced off for it. Here's the previous example, cleaned up:

```
root=plgroup(0, 0);
plbutton(root, PACKN|FILLX, "one", 0);
plbutton(root, PACKN|FILLX, "two", 0);
plbutton(root, PACKN|FILLX, "three", 0);
plbutton(root, PACKN|FILLX, "four", 0);
```

and here's the result:

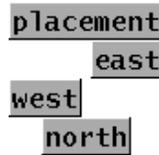


Similarly, `FILLY` expands in the `y` direction.

There may be some freedom in the placement of panels that do not use `FILLX` and `FILLY`. There are flags to place a panel at any of eight compass points of the space reserved for it, or at the center, called `PLACEN`, `PLACENE`, `PLACEE`, `PLACESE`, `PLACES`, `PLACESW`, `PLACEW`, `PLACENW`, and `PLACECEN`. Here's an example:

```
root=plgroup(0,0);
plbutton(root, PACKN, "placement", 0);
plbutton(root, PACKN|PLACEE, "east", 0);
plbutton(root, PACKN|PLACEW, "west", 0);
plbutton(root, PACKN|PLACEN, "north", 0);
```

and the resulting display:



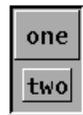
Of course, flagging the last button `PLACES` or `PLACECEN` produces the same result, since it has no surplus space in the north-south direction.

Normally, `plpack` fits everything into the smallest possible space. There are four ways to make things larger. First, the `FIXED` flag tells `plpack` that it should look in the panel's `fixedsize` field (a `Point`) to find the panel's dimensions. This is useful, for example, to make space for an image of known size. (`FIXED` is actually the OR of two flags, `FIXEDX` and `FIXEDY`, that individually fix the width and height of the panel.)

Second, a margin around a panel can be specified by setting its `pad` field (again, a `Point`) to a non-zero value. Similarly, a panel can be given extra space by setting its `ipad` field. The difference between the two is that `pad` asks for extra space outside the panel, where `ipad` asks for extra space inside. Both `pad` and `ipad` are added to the space requested for the `Panel` from its parent, but only `ipad` is added to the space actually given to the `Panel`—so they both represent increments on the total size of the requested rectangle, not margins around all four borders. Here's an example:

```
Panel *b;  
root=plframe(0,0);  
b=plbutton(root, PACKN, "one", 0);  
b->ipad=Pt(10,10);  
b=plbutton(root, PACKN, "two", 0);  
b->pad=Pt(10,10);
```

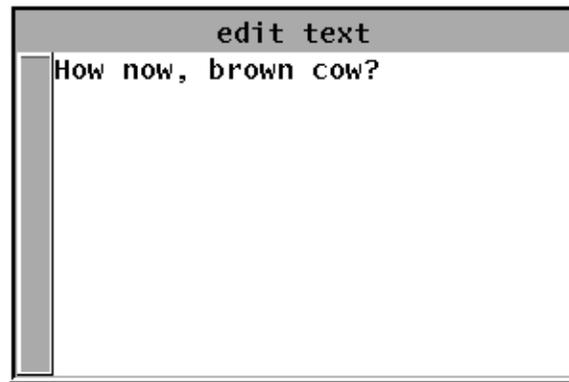
and its display:



Third, setting the `EXPAND` flag causes `plpack` to give the panel whatever unused space the parent may have. If multiple children of the same parent all set `EXPAND`, the unused space is distributed equitably among them. Here is a text editor panel, with a scroll bar to the left and a label on top. `Pledit`, described later, creates a window of editable text that uses up all the space left over after placing the label and scroll bar.

```
root=plframe(0, EXPAND);  
pllabel(root, PACKN|FILLX, "edit text");  
plscrollbar(root, PACKW|FILLY);  
pledit(root, PACKN|EXPAND, Pt(0,0),  
        L"How now, brown cow?", 19, 0);
```

Here's what it looks like:



Note that the EXPAND flag must be supplied to both the root panel and the text window. The root expands to fill the space passed in as `plpack`'s second argument. Without it, the text window would expand to fill the root, but the root would remain as small as possible.

Fourth, the MAXX and MAXY flags set the panel's width or height equal to the largest of its siblings. MAXX evens up the widths of a horizontal array of buttons, like this:

```
root=plgroup(0, 0);
plbutton(root, PACKW|MAXX, "one", 0);
plbutton(root, PACKW|MAXX, "two", 0);
plbutton(root, PACKW|MAXX, "three", 0);
plbutton(root, PACKW|MAXX, "four", 0);
```

This is the resulting display:



Specifying 0 for the flags is equivalent to using `PACKN|PLACECEN`, which seems like a reasonable default.

4. The Public Parts of a Panel

The `Panel` structure has a lot of fields that are just for the use of the library. Here are the fields that applications can use with impunity.

```
typedef struct Panel Panel;
struct Panel{
    Point ipad, pad; /* internal and external padding */
    Point fixedsize; /* size of FIXED panels */
    int user; /* available for application use */
    void *userp; /* available for application use */
    Rectangle r; /* filled in by pack */
    ... /* more private fields follow */
};
```

`Ipad`, `pad`, and `fixedsize` have already been discussed. The `user` and `userp` fields are not used by the library. Applications can use them for anything at all. It is often handy to have a common hit function for a group of panels and distinguish amongst them by an index number or private data stored in `user` or `userp`.

`Plpack` stores a panel's coordinates in `Rectangle r`.

`Plpack` should be called whenever changes occur that can be expected to affect the panel's layout. In particular, it should normally be called when a panel tree is

initially created and in `ereshaped`. Usually `plpack` should be called on the root of a panel tree. It is possible to call `plpack` on a subtree of a panel tree that has already been packed, for example when the subtree has been updated and the program wishes for those changes not to affect the rest of the display. In that case, `plpack`'s `Rectangle` argument should be the current size of the subtree to be repacked.

5. Panel-wrangling Functions

```
int plinit(int ldepth);
```

`Plinit` initializes the panel library's private data. It must be called before any other panel library routine, but after calling `binit` to initialize the graphics library. `Plinit`'s argument is normally `screen.ldepth`. The panel library draws its display in four shades of grey when they are available, but will use only black and white if told otherwise. `Plinit` returns 1 if it succeeds and 0 if it fails.

```
void pldraw(Panel *p, Bitmap *b);
```

`Pldraw` displays the panel tree pointed to by `p` on the bitmap `b`. The latter will usually be `&screen` but it could be something from the layer library (see *layer(2)*).

Because a panel's children are drawn nested inside it, programs can update parts of the display by calling `pldraw` on subtrees of a panel tree. For example, after calling `plinitlabel` (described below) to change the text of a label, it can be redisplayed by calling `pldraw` on the label, leaving the rest of the display alone.

```
void plmove(Panel *p, Point min);
```

`Plmove` relocates the panel tree pointed to by `p`, which must already have been processed by `plpack`, so that its upper left-hand corner is at `min`.

```
void plfree(Panel *p);
```

`Plfree` reclaims the storage used by the panel pointed to by `p`, and all its descendants.

6. Event Handling

```
void plmouse(Panel *recipient, Mouse m);  
void plgrabkb(Panel *p);  
void plkeyboard(Rune c);
```

The panel library handles mouse and keyboard input in a straightforward way. The application program acquires event information, usually by calling graphics library functions `emouse`, `ekbd`, or `event`, and passes it to the panel library's event-processing routines `plmouse` and `plkeyboard`. The arguments to `plmouse` are a pointer to a `Panel` tree to which the event will be sent and the data received from the mouse. `Plmouse` walks the panel tree looking for a mouse-sensitive panel whose rectangle contains the mouse event. Code specific to the panel type is called to process the event. For example, the `plbutton`-specific code highlights itself when a mouse button is pressed over it, calling the user-specified hit function if the mouse button is released before the mouse moves out of the button's rectangle.

Keyboard events are sent to a designated panel. The keyboard focus is changed by calling `plgrabkb`. Keyboard events are sent to the appropriate panel by calling `plkeyboard`, whose argument is the `Rune` received from the keyboard.

Here's a generic skeleton of a simple panel library application that uses both mouse and keyboard input:

```
#include <u.h>
#include <libc.h>
#include <libg.h>
#include <panel.h>
Panel *root;
Panel *mkpanels(void);
void eventloop(void);

void main(void){
    binit(0, 0, 0);
    einit(Emouse|Ekeyboard);
    plinit(screen.ldepth);

    root=mkpanels();

    ereshaped(screen.r);

    eventloop();
}

void eventloop(void){
    Event e;
    for(;;){
        switch(event(&e)){
            case Ekeyboard:
                plkeyboard(e.kbdc);
                break;
            case Emouse:
                plmouse(root, e.mouse);
                break;
        }
    }
}

void ereshaped(Rectangle r){
    screen.r=r;
    plpack(root, r);
    bitblt(&screen, r.min, &screen, r, Zero);
    pldraw(root, &screen);
}
```

The missing `mkpanels` function is the user's code to create the application's panel tree. The `main` function does all the necessary library initialization, calls `mkpanel` and `ereshaped` to create and display the panel tree, and calls `eventloop`, which gets keyboard and mouse events and passes them to `plkeyboard` and `plmouse`. Packing and displaying the panel tree is handled by `ereshaped`.

7. Panel Types

The examples so far have used a half-dozen panel types: `plframe`, `plgroup`, `plbutton`, `pllabel`, `plscrollbar`, and `pledit`, but those don't nearly exhaust the possibilities. A reminder: in the following descriptions, the first two arguments of every panel-creation function are a pointer to the new panel's parent (0 if there is none) and the flags that guide `plpack`. The new panel's parent must have been created by calling one of `plgroup`, `plframe`, or `plpopup`; otherwise the creation function will fail and return zero.

8. Buttons

```
Panel *plbutton(Panel *parent, int flags,  
               Icon *label, void (*hit)(Panel *, int));  
  
Panel *plcheckboxbutton(Panel *parent, int flags,  
                    Icon *label, void (*hit)(Panel *, int, int));  
  
Panel *plradiobutton(Panel *parent, int flags,  
                   Icon *label, void (*hit)(Panel *, int, int));  
  
void plsetbutton(Panel *panel, int value);  
  
Panel *plmenu(Panel *parent, int flags, Icon **items,  
             int itemflags, void (*hit)(int, int));
```

`Plbutton` creates a push-button that displays the given label when drawn. The function `hit` is called when the button is pressed (actually when it is released over it). Its arguments are a pointer to the panel and the mouse button(s) that caused the hit.

Here, `Icon*` is a synonym for `void*`. The actual argument may be a `char*` or a `Bitmap*`, in which case the `BITMAP` bit must be set in the `flags` word.

`Plcheckboxbutton` and `plradiobutton` create push-buttons that, when drawn, contain a check-box that may be marked or not. Pushing the button flips the check mark on or off. In addition, when a radio button turns on, it turns off all its radio button siblings, so at most one radio button in a group can be on at any instant. (They're called radio buttons because they imitate the buttons on a car radio.) The function `plsetbutton` allows the state of the check-box to be initialized. By default it is 0 (off).

The state of the check mark is available to the hit routine in the `check` field of the button. The hit function's first argument points to the button. The second argument is the mouse buttons. The third argument reflects the state of the check. When a radio button turns off one of its siblings, the sibling's hit function is not called.

The `plmenu` function creates a group (see below) containing an array of buttons. The `items` argument is an array of `Icon` pointers, ending with a zero pointer, that gives the label of each button. The `itemflags` button indicates the flags to be used when creating each button. Whenever a menu button is hit, the `hit` function is called with the mouse buttons as first argument and the panel's index in the `items` array as second argument. Here's code that makes a radio button list, a check list, and a menu:

```
Panel *g, *p;
char *buttons[4];
root=plgroup(0,0);
g=plgroup(root, PACKW);
plradiobutton(g, PACKN|FILLX, "abort", 0);
plradiobutton(g, PACKN|FILLX, "retry", 0);
p=plradiobutton(g, PACKN|FILLX, "fail", 0);
plsetbutton(p, 1);
g=plgroup(root, PACKW);
plcheckboxbutton(g, PACKN|FILLX, "pickles", 0);
p=plcheckboxbutton(g, PACKN|FILLX, "lettuce", 0);
plsetbutton(p, 1);
p=plcheckboxbutton(g, PACKN|FILLX, "cheese", 0);
plsetbutton(p, 1);
buttons[0]="new";
buttons[1]="xerox";
buttons[2]="reshape";
buttons[3]=0;
plmenu(root, PACKW, buttons, PACKN|FILLX, 0);
```

and here's the result:

<input type="checkbox"/> abort	<input type="checkbox"/> pickles	new
<input type="checkbox"/> retry	<input checked="" type="checkbox"/> lettuce	xerox
<input checked="" type="checkbox"/> fail	<input checked="" type="checkbox"/> cheese	reshape

9. Labels and Message boxes

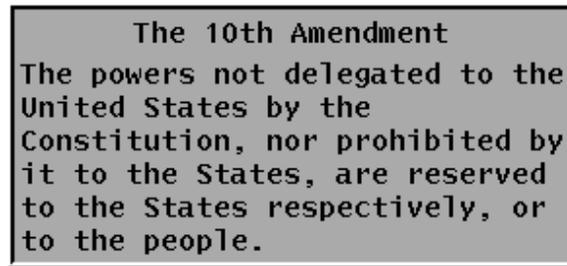
```
Panel *pllabel(Panel *parent, int flags, Icon *label);
```

```
Panel *plmessage(Panel *parent, int flags, int width,
char *text);
```

A label, when drawn, displays its text at the appropriate place on the screen. Labels are intended for short pieces of text such as titles. Message panels display longer pieces of text, such as error messages or dialog box verbiage, on multiple lines with wrapping at word boundaries. The width argument gives the desired width of the Panel, in pixels. (It may come out larger if the text contains words longer than the nominal width—message panels don't hyphenate.) Neither responds to mouse activity. Here's an example:

```
root=plframe(0, 0);
pllabel(root, PACKN|FILLX, "The 10th Amendment");
plmessage(root, PACKN, 280,
"The powers not delegated to the "
"United States by the Constitution, "
"nor prohibited by it to the States, "
"are reserved to the States respectively, "
"or to the people.");
```

and the result:



The 10th Amendment
The powers not delegated to the
United States by the
Constitution, nor prohibited by
it to the States, are reserved
to the States respectively, or
to the people.

10. Grouping

```
Panel *plgroup(Panel *parent, int flags)
```

```
Panel *plframe(Panel *parent, int flags)
```

Groups are useful to help arrange Panels, both logically and on the screen. For example, a Panel with two independent sets of radio buttons needs to place them in groups so that each won't reset the other. A frame behaves just like a group, except that it also draws a rectangular frame around its children. Neither responds to mouse activity, although their children may.

Most of the examples above use `plgroup` or `plframe`, so we won't include another here.

11. Canvas

```
Panel *plcanvas(Panel *parent, int flags,  
               void (*draw)(Panel *), void (*hit)(Panel *, Mouse *));
```

A canvas is just an empty piece of screen that passes mouse events through to a user-supplied `hit` function. The argument `draw`, if non-null, points to a function that is called back by `pldraw` to draw the canvas's display. The `hit` function, if non-zero, passes mouse events back to be handled by user code. Mouse coordinates are guaranteed to be inside the canvas's rectangle, except that whenever the mouse leaves the rectangle a single event is passed back that has the `OUT` bit set in its `buttons` field. Note that the canvas will be created with zero size, unless the `EXPAND` or `FIXED` flag is specified or `ipad` is non-zero.

12. Sliders

```
Panel *plslider(Panel *parent, int flags, Point size,  
               void (*hit)(Panel *p, int but, int val, int len))  
void plsetslider(Panel *p, int val, int range)
```

A slider displays a thermometer-like indicator that can be adjusted with the mouse. The argument `size` is its nominal size. (It may be given a different size by `plpack` due to flag settings.) The `hit` routine is called whenever the slider's value changes. Its arguments are a pointer to the slider, the mouse buttons, the value the slider now indicates, and the slider's length, both measured in pixels. Sliders slide horizontally or vertically depending on whether the `x` component of `size` is larger than the `y` component.

A slider's position can be set by calling `plsetslider`, whose arguments are a pointer to the slider, what to set its position to, and the maximum value that the `val` argument is assumed to take. The value will be rescaled to the slider's actual size.

Here's an example that makes a compound panel containing a slider and a couple of labels, one of which is updated by the slider's hit function to reflect the slider's value:

```
Panel *sliderlabel;
char sliderval[8]=" 57/100";
void hit(Panel *p, int buttons, int val, int range){
    USED(p, buttons);
    sprintf(sliderval, "%3d/100", val*100/range);
    plinitlabel(sliderlabel, PACKE, sliderval);
    pldraw(sliderlabel, &screen);
}
void slider(void){
    Panel *sl;
    root=plframe(0, 0);
    pllabeled(root, PACKN|PLACEE, "test value");
    sl=plslider(root, PACKW|FILLY, Pt(137, 0), hit);
    plsetslider(sl, 57, 100);
    sliderlabel=pllabeled(root, PACKE, sliderval);
}
```



The `hit` function calls `plinitlabel` and `pldraw` to reinitialize and redisplay `sliderlabel`, making the label track the slider's value. Panel reinitialization functions such as `plinitlabel` are discussed in more detail below.

Note also that the slider's size is given as `Pt(0,137)`; the `FILLY` flag makes it come out the same height as the label next to it.

13. Text entry

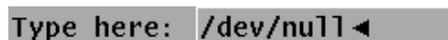
```
Panel *plentry(Panel *parent, int flags, int width,
               char *init, void (*hit)(Panel *p, char *text))
char *plentryval(Panel *);
```

Entry panels display a line of text that can be edited by typing. The `width` and `init` arguments specify the entry's width in pixels and the initial contents of its string. Clicking an entry with the mouse makes it the keyboard focus. Characters typed in the entry are added to end of the displayed string. Backspace deletes the last character. `Ctrl-U` deletes the whole string. `Ctrl-W` deletes a trailing word (sequence of letters and digits) and any following punctuation. Typing the newline character causes the `hit` routine to be called with pointers to the entry and the current text (without a newline) as arguments. The current text can be retrieved at any time by calling `plentryval`.

Here's code for an example:

```
root=plgroup(0,0);
pllabeled(root, PACKW, "Type here: ");
plentry(root, PACKW, 140, "/dev/null", 0);
```

and here's the resulting display:



14. Pop-up panels

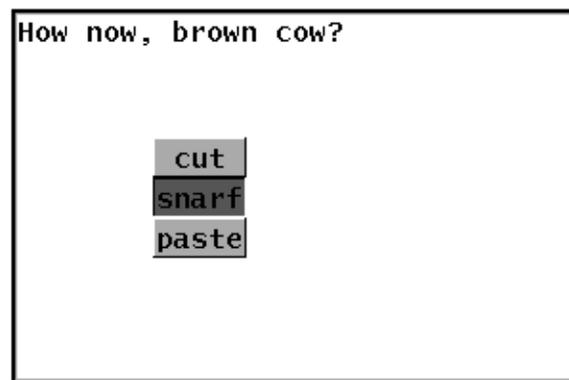
```
Panel *plpopup(Panel *parent, int flags,  
              Panel *but1, Panel *but2, Panel *but3);
```

Just like a group, a pop-up panel has children that it displays and that can be sensitive to mouse events. The difference is that when it receives a mouse event with a specified button pressed, it may temporarily display a new panel and send events on to it. The `but1`, `but2`, and `but3` arguments point at the roots of panel trees to be popped up when the appropriate mouse button is pressed. A zero pointer indicates that mouse events with that button depressed are passed on to the pop-up panel's children.

Here's an example, a text editor window with a couple of pop-up menus. Pressing button 2 will pop up the cut/snarf/paste menu. Pressing button 3 will pop up the read/write/exit menu. Pressing button 1 doesn't pop up a menu — the mouse events pass through the `plpopup` to its child, the `pledit` panel.

```
char *menu2[]={  
    "cut",  
    "snarf",  
    "paste",  
    0  
};  
char *menu3[]={  
    "read",  
    "write",  
    "exit",  
    0  
};  
void popup(void){  
    Panel *m2, *m3, *pop;  
    m2=plmenu(0, 0, menu2, PACKN|FILLX, 0);  
    m3=plmenu(0, 0, menu3, PACKN|FILLX, 0);  
    root=plframe(0, EXPAND);  
    pop=plpopup(root, EXPAND, 0, m2, m3);  
    pledit(pop, EXPAND, Pt(0,0),  
          L"How now, brown cow?", 19, 0);  
}
```

Here's what the screen looks like with the middle button depressed:



15. Pull-down panels and menu bars

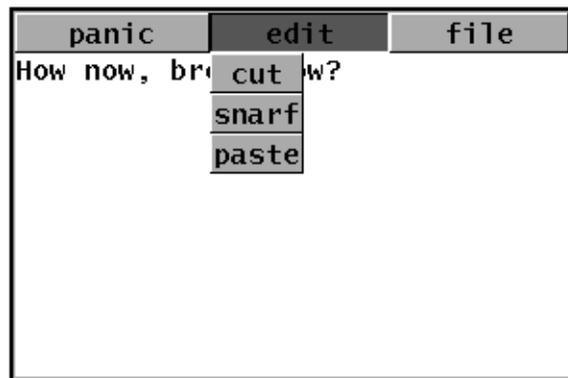
```
Panel *plpulldown(Panel *parent, int flags,  
                 Icon *label, Panel *pull, int side);  
Panel *plmenubar(Panel *parent, int flags, int itemflags,  
                Icon *label1, Panel *pull1, Icon *label2, ...);
```

A pull-down panel looks like an ordinary button when displayed. When hit, it displays the panel pointed to by `pull`, and passes further mouse events off to it. The `side` argument must be one of `PACKN`, `PACKE`, `PACKS` or `PACKW`. It indicates on which side of the pull-down button the `pull` panel should be displayed. Pull-down panels can be used in menus to provide cascading submenus. An array of pull-down panels arranged across the top of the screen behaves as a menu bar. The `plmenubar` routine creates a group containing just such an array. Its arguments (after the obligatory `parent` and `flags`) are the flags to be used for each menu bar item, followed by the `label` and `pull` arguments of the items. The list is terminated by a zero `label` pointer.

Here's an edit window with a menu bar at the top:

```
char *menu1[]={  
    "abort",  
    "retry",  
    "fail",  
    0  
};  
void mbar(void){  
    Panel *m1, *m2, *m3;  
    m1=plmenu(0, 0, menu1, PACKN|FILLX, 0);  
    m2=plmenu(0, 0, menu2, PACKN|FILLX, 0);  
    m3=plmenu(0, 0, menu3, PACKN|FILLX, 0);  
    root=plframe(0, EXPAND);  
    plmenubar(root, PACKN|FILLX, PACKW|EXPAND,  
              "panic", m1, "edit", m2, "file", m3, 0);  
    pledit(root, EXPAND, Pt(0,0),  
           L"How now, brown cow?", 19, 0);  
}
```

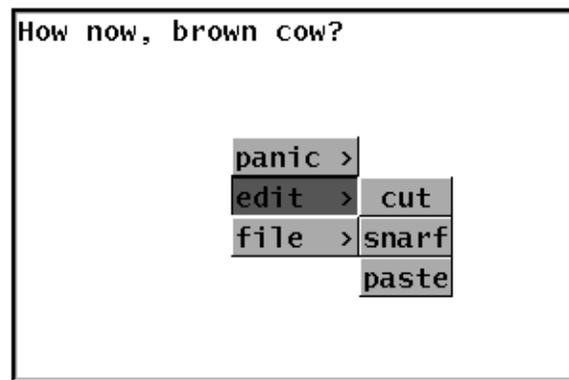
Here's the display, with one of the menus pulled down:



Here's code for a similar arrangement, but with the menu bar converted to a pop-up menu with the sub-menus cascaded to the right:

```
Panel *m1, *m2, *m3, *menu, *pop;
m1=plmenu(0, 0, menu1, PACKN|FILLX, 0);
m2=plmenu(0, 0, menu2, PACKN|FILLX, 0);
m3=plmenu(0, 0, menu3, PACKN|FILLX, 0);
menu=plgroup(0,0);
plpulldown(menu, PACKN|FILLX, "panic >", m1, PACKE);
plpulldown(menu, PACKN|FILLX, "edit >", m2, PACKE);
plpulldown(menu, PACKN|FILLX, "file >", m2, PACKE);
root=plframe(0, EXPAND);
pop=plpopup(root, EXPAND, 0, menu, 0);
pledit(pop, EXPAND, Pt(0,0),
      L"How now, brown cow?", 19, 0);
```

Here's the display, with the main menu popped up and showing a sub-menu:



16. Scrollable lists and scroll bars

```
Panel *pllist(Panel *parent, int flags,
             char *(*generate)(int index), int nlist,
             void(*hit)(Panel *p, int buttons, int index));

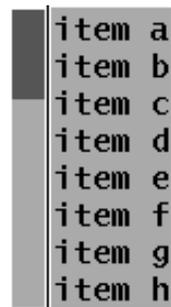
Panel *plscrollbar(Panel *parent, int flags);
void plscroll(Panel *scrollee,
             Panel *xscroller, Panel *yscroller);
```

A list panel displays a list of character strings. The `generate` function must return a pointer to the n th string (using zero-origin indexing) when passed n as an argument. If n is out of range, it must return a zero pointer. When one of the displayed strings is selected with the mouse, the `hit` function is called with a pointer to the panel, the mouse buttons, and the string's index as arguments. The minimum number of entries displayed is controlled by the `nlist` parameter. If `flags` has `FILLY` set, the list may be longer. The list may be scrolled by creating a scroll bar panel and calling `plscroll` to associate the scroll bar with the list. `Plscroll`'s arguments are the panel to be scrolled, a scroll bar that will scroll it in the x direction, and a scroll bar for the y direction. Either of these last two may be empty if the scrollee cannot be scrolled in the corresponding direction. (In fact, no currently-defined panel scrolls in the x direction, so the `xscroller` argument is purely for future expansion.)

Here's code to create a list box with a scroll bar:

```
char *genlist(int which){
    static char buf[7];
    if(which<0 || 26<=which) return 0;
    sprintf(buf, "item %c", which+'a');
    return buf;
}
void scroll(void){
    Panel *l, *s;
    root=plgroup(0, 0);
    l=pllist(root, PACKE, genlist, 8, 0);
    s=plscrollbar(root, PACKW|FILLY);
    plscroll(l, 0, s);
}
```

and here's what the display looks like:



17. Editable text

```
Panel *pledit(Panel *parent, int flags, Point minsize,
              Rune *text, int ntext, void (*hit)(Panel *));
```

The `pledit` function creates a scrollable window of single-font text. Its arguments are:

`minsize`

the minimum acceptable size (in pixels) of the window.

`text`

an array of Runes (not chars) containing the window's initial contents.

`ntext`

the number of runes in `text`.

`hit`

Text in an edit window can be selected by sweeping with the mouse. After each selection, `hit` is called with a pointer to the panel as argument.

When a `pledit` window is the keyboard focus, typed-in characters mostly replace the current selection. The exceptions are backspace, which deletes the selection and the character before it (if any), `ctrl-U`, which deletes back to the beginning of the line on which the selection starts, and `ctrl-W`, which deletes back to the beginning of the word at which the selection starts.

There are a half-dozen functions that manipulate the text in a `pledit` window and its display.

```
Rune *pleget(Panel *p);
```

returns a pointer to the window's text. Note: this is not the same as the `text` pointer passed to `pledit`, which is only used to initialize an internal text buffer. The pointer returned by `pleget` is only good as long as the text remains

unchanged. (That is, until the next character is typed, or `plpaste` is called.)

```
int plelen(Panel *p);
    returns the length of the window's text.

void plscroll(Panel *p, int top);
    The top argument is an index into the window's text. The window is scrolled so
    that the line containing the indexed Rune is at the top of the window.

void plegetsel(Panel *p, int *sel0, int *sel1);
    stores the index of the first character of the selection in sel0 and the first beyond
    in sel1.

void pleasel(Panel *p, int sel0, int sel1);
    picks a new selection, updating the display correspondingly

void plepaste(Panel *p, Rune *text, int ntext);
    removes the runes currently selected from the buffer, replacing them with the text
    pointed to by text, whose length is ntext.
```

The following example uses the panel library and the generic application skeleton given above to implement most of a simple cut-and-paste text editor. It lacks only facilities to read and write files.

```
Rune text[];
char *buttons[]={
    "cut",
    "paste",
    "snarf",
    "exit",
    0
};
Rune *snarfbuf=0;
int nsnarfbuf=0;
Panel *edit;
void hitmenu(int, int);
void snarf(void);

Panel *mkpanels(void){
    Panel *sctl, *pop, *menu, *root;
    root=plgroup(0, EXPAND);
    sctl=plscrollbar(root, PACKW);
    menu=plmenu(0, 0, buttons, FILLX, hitmenu);
    pop=plpopup(root, EXPAND, 0, menu, menu);
    edit=pledit(pop, EXPAND, Pt(0,0),
        text, sizeof(text)/sizeof(Rune)-1, 0);
    plscroll(edit, 0, sctl);
    plgrabkb(edit);
    return root;
}
```

```
void hitmenu(int button, int index){
    USED(button);
    switch(index){
    case 0: /* cut */
        snarf();
        plepaste(edit, 0, 0);
        break;
    case 1: /* paste */
        plepaste(edit, snarfbuf, nsnarfbuf);
        break;
    case 2: /* snarf */
        snarf();
        break;
    case 3: /* exit */
        exits(0);
    }
}

void snarf(void){
    int s0, s1;
    Rune *text;
    plegetsel(edit, &s0, &s1);
    if(s0==s1) return;
    text=pleget(edit);
    if(snarfbuf) free(snarfbuf);
    nsnarfbuf=s1-s0;
    snarfbuf=malloc(nsnarfbuf*sizeof(Rune));
    memmove(snarfbuf, text+s0, nsnarfbuf*sizeof(Rune));
}
```

The `mkpanels` function creates a display with a scroll bar and a `pledit` window, over which button 2 or button 3 pops up a four-entry menu. The `hitmenu` function processes menu commands. `Snarf` copies the current selection into `snarfbuf`, unless the selection is empty.

18. Formatted text

```
Panel *pltextview(Panel *parent, int flags, Point minsize,
                 Rtext *text, void (*hit)(Panel *p, int buttons, Rtext *t));
```

A `pltextview` panel displays scrollable multi-font formatted text interspersed with illustrations and sub-panels. Any word of text or bitmap illustration can be marked sensitive to mouse events — in-line panels always are. `Pltextview`'s arguments are

`minsize`

the minimum acceptable size for the window. `text` points to a linked list of `rtext` structures (described below) describing text and illustrations, their spacing and layout, and indicating which segments are mouse-sensitive.

`hit`

the function called to register a mouse hit. Its arguments are the panel in which the hit occurred, which mouse buttons were pressed, and a pointer to the piece of text that was hit.

Each member of a list of `Rtext` structures describes either a `Font` and a string that will be displayed in a single call to `string`, or a `Bitmap` to be displayed by calling `bitblt` (see `bitblt(2)`). Here is (part of) the definition of `Rtext`:

```
typedef struct Rtext Rtext;
struct Rtext{
    int hot;        /* responds to hits? */
    void *user;    /* user data */
    int space;     /* how much space if no break */
    int indent;    /* how much space after a line break */
    Bitmap *b;     /* what to display, if b!=0 */
    Panel *p;      /* what do display, if p!=0 and b==0 */
    Font *font;    /* font in which to draw text */
    char *text;    /* what to display, if b==0 and p==0 */
    Rtext *next;
    ...           /* more private fields follow */
};
```

Its fields are:

hot non-zero if this Rtext is mouse-sensitive.

user a pointer not used by the panel library. It can be used in a hit function to interpret the mouse action.

space how many pixels of space to leave between this Rtext and the previous one, if they're drawn on the same line.

indent how many pixels to indent this Rtext by, if it's the first one on a line.

b If b!=0 this Rtext is an illustration and b points to a bitmap containing it.

p If b==0 and p!=0 this Rtext is an inline panel.

text If b==0 and p==0 this Rtext must point a string displayable by a single call to string.

font the font in which text should be displayed.

next a pointer to the next Rtext in the list.

The following three functions create new Rtexts, returning pointers to the newly allocated storage:

```
Rtext *plrtstr(Rtext **head, int space, int indent,
              Font *f, char *s, int hot, void *user);

Rtext *plrtbitmap(Rtext **head, int space, int indent,
                 Bitmap *b, int hot, void *user);

Rtext *plrtpanel(Rtext **head, int space, int indent,
                 Panel *p, void *user);
```

These functions create new Rtext nodes of the three kinds. Plrtstr creates a string node with font f and text s, plrtbitmap creates a bitblt node with bitmap b, and plrtpanel creates a subpanel node with Panel p. Since plrtstr doesn't make a copy of the string s, be careful that its storage is not accidentally overwritten. The space, indent, hot, and user arguments are used to initialize the corresponding fields of the new Rtext. Since subpanel nodes are always mouse-sensitive, plrtpanel does not take a hot argument. Head is a pointer to a pointer to the first node of an Rtext list. Initialize *head=0 before making a new list. Plrtstr, plrtbitmap, and plrtpanel will update it appropriately.

The function

```
void plrtfree(Rtext *t);
```

discards the list pointed to by t. The caller is responsible for disposing of any fonts, strings, bitmaps, and user data that the Rtext's fields may point to.

Each Rtext node can be drawn in a single call to string, bitblt, or pldraw.

Line breaks can occur between `Rtext` nodes. If an `Rtext` node is drawn at the beginning of a line, its `indent` field tells how far to indent it from the left margin. When an `Rtext` is drawn on the same line as its predecessor, its `space` field indicates how many pixels of space to leave between the two. If `space` is zero, there will never be a line break between the node and its predecessor, to allow for words with internal font changes.

```
Rtext *plgetpostextview(Panel *p);
```

```
void plsetpostextview(Panel *p, Rtext *top);
```

Calling `plsetpostextview` scrolls a `pltextview` panel so that the given `Rtext` appears the upper left-hand corner. `Plgetpostextview` returns a pointer to the `Rtext` that the given panel currently displays in its upper left-hand corner.

19. Panel Reinitialization

For each panel-creation function, there is a corresponding reinitialization function whose name is just the creation function with the initial letters `pl` changed to `plinit`. Its arguments are the same as the creation function's, except that the initial `Panel` pointer indicates the panel to be re-initialized, not its parent. For example, there is an `plinitmessage` corresponding to `plmessage`, that can be used to change the text displayed in a message panel.

The implementation has two shortcomings. First, for no good reason, `plinitmenubar` is missing. Second, you can't change the kind of a panel by calling a different `plinit` function on it.

20. Nothing is Automatic

When you use the panel library, nothing happens automatically. There are no daemons watching for changes in the state of panels to recompute their geometry or redisplay them. If you call `plinitmessage` to post a message to an error window, you must call `pldraw` to see the display. If you add a new panel to a tree, you must repack it and redisplay it yourself. If you call `plmove` you should also call `pldraw` to see the result.

21. Caveat Emptor

The Panel library is new software created to build the World-Wide Web browser *mothra*(1). It is too young to have been tried in many other programs, so it should probably be regarded as experimental.