A Quick Introduction to the Panel Library

Tom Duff
td@plan9.att.com

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 *done* button and processes mouse events until the user hits it.

```
#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);
          pllabel(root,    0,  "Hello,   world!");
          plbutton(root,     0,  "done",   done);

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

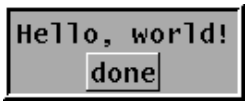
```
void ereshaped(Rectangle r){
        screen.r=r;
        plpack(root, r);
        bitblt(&screen, r.min, &screen, r, Zero);
        pldraw(root, &screen);
}
```

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 for 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 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:

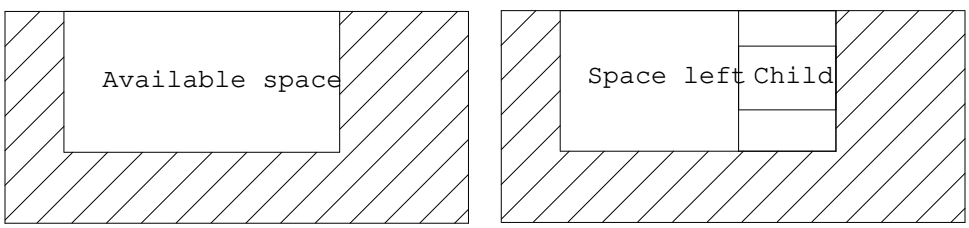
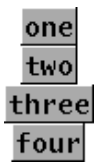


Figure (a) shows the available space in a frame before packing a child whose flag is PACKE . Figure (b) shows the child in place and indicates the space available for packing the next child.

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);
```

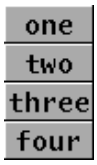
produce this:



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:

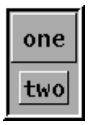
Of course, flagging the last button PLACES or PLACECEN produces the same result, since it has no surplus space in the north-south direction.

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 is 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);
```

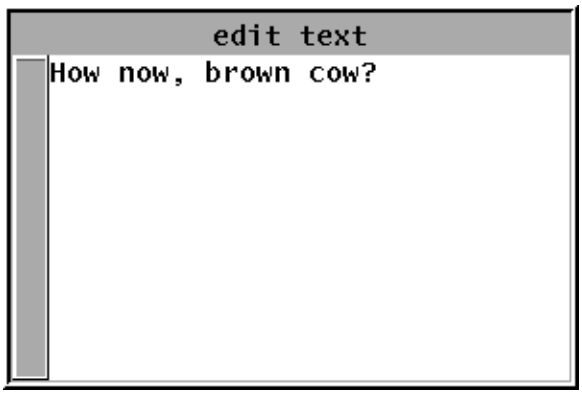
and its display:



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:

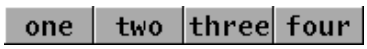


Note that the EXPAND flag must be supplied to both the root panel and the text window. The root expands to fill the space passed in as plpack s second argument. Without it, the text window would expand to fill the root, but the root would remain as small as possible.

Fourth, the MAXX and MAXY flags set the panels 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 panels coordinates Rectangle in r .

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

initially created and inereshaped . 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 (*layer*(2)), see

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 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 a 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 users code to create the applications 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. As a reminder: in the following descriptions, the first two arguments of every panel-creation function are a pointer to the new panels parent (0 if there is none) and the flags that guide plpack . The new panels 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  *plcheckbutton(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 BITMAP bit must be set in flags word.

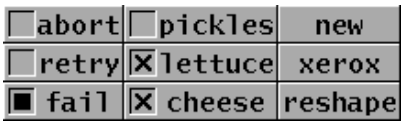
Plcheckbutton and plradiobutton create push-buttons that, when drawn, contain a check-box that may be marked or not. Pushing the button flips the check mark on or off. In addition, when a radio button turns on, it also turns off all its radio button siblings, so at most one radio button in a group can 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 button's. The third argument reflects the state of the check. When a radio button turns off one of its siblings, that 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 item flags 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 button's 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);
plcheckbutton(g,    PACKN|FILLX,    "pickles",    0);
p=plcheckbutton(g,     PACKN|FILLX,    "lettuce",    0);
plsetbutton(p,    1);
p=plcheckbutton(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:



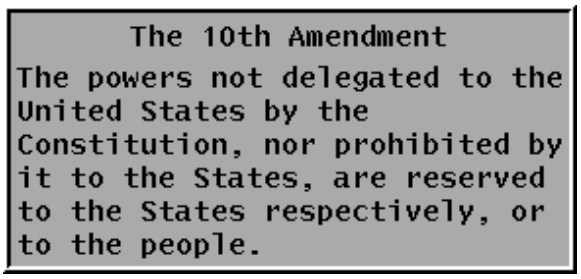
9. Labels and Message boxes

```
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:



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' 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 in par and is non-zero.

12. Sliders

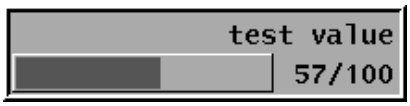
```
Panel  *plslider(Panel    *parent,   int  flags,  Point  size,
          void  (*hit)(Panel    *p,  int  but,  int  val,  int  len))
void  plsetslider(Panel    *p,  int  val,  int  range)
```

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 hit function to reflect the slider's

```
Panel  *sliderlabel;
char  sliderval[8]="    57/100";
void  hit(Panel   *p,  int  buttons,   int  val,  int  range){
          USED(p,   buttons);
          sprint(sliderval,     "%3d/100",    val*100/range);
          plinitlabel(sliderlabel,      PACKE,   sliderval);
          pldraw(sliderlabel,     &screen);
}
void  slider(void){
          Panel  *sl;
          root=plframe(0,     0);
          pllabel(root,    PACKN|PLACEE,    "test  value");
          sl=plslider(root,     PACKW|FILLY,    Pt(137,   0),  hit);
          plsetslider(sl,    57,  100);
          sliderlabel=pllabel(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);
pllabel(root,    PACKW,   "Type  here:  ");
plentry(root,    PACKW,   140,  "/dev/null",    0);
```

and here's the resulting display:

14. Pop-up panels

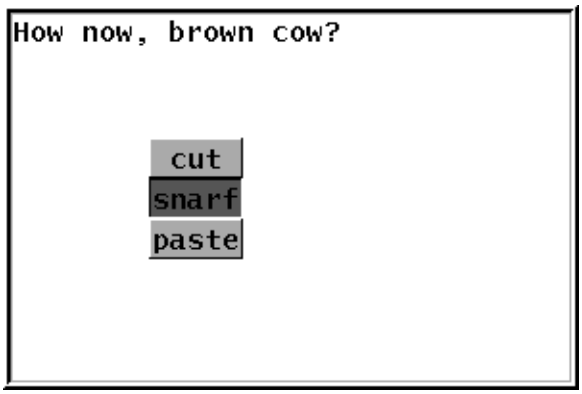
```
Panel  *plpopup(Panel    *parent,   int  flags,
          Panel  *but1,  Panel  *but2,  Panel  *but3);
```

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.

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, 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

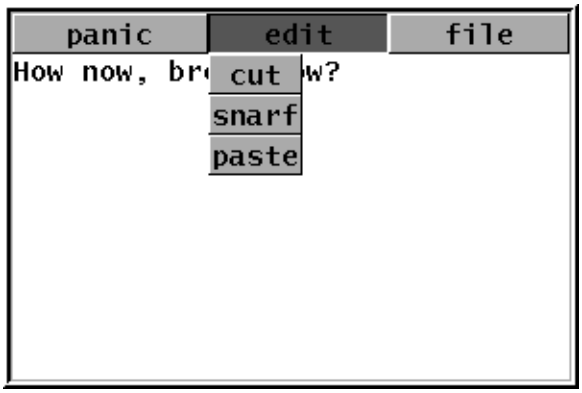
```
Panel  *plpulldown(Panel     *parent,   int  flags,
          Icon  *label,   Panel  *pull,   int  side);
Panel  *plmenubar(Panel     *parent,   int  flags,   int  itemflags,
          Icon  *label1,   Panel  *pull1,   Icon  *label2,   ...);
```

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);
}
```

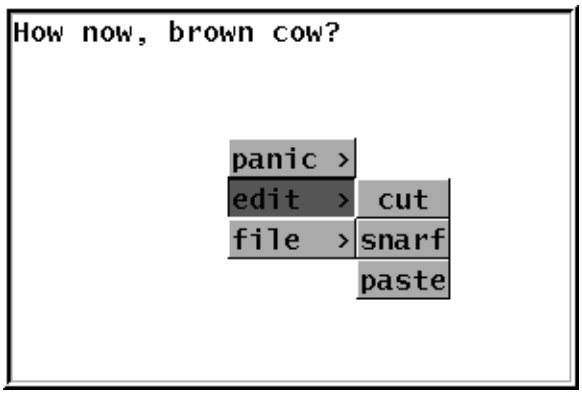
Here's the display, with one of the menus pulled down:



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

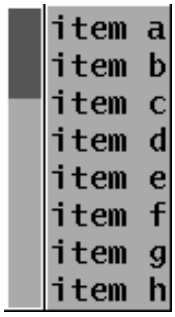
```
Panel  *pllist(Panel    *parent,   int  flags,
          char  *(*generate)(int    index),   int  nlist,
          void(*hit)(Panel    *p,  int  buttons,   int  index));

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;
        sprint(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 the 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 plescroll(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 plesel(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 in 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  *scrl,  *pop,  *menu,  *root;
          root=plgroup(0,    EXPAND);
          scrl=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,  scrl);
          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 scrollable edit 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 a 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 are drawn on the same line.

indent how many pixels to indent this Rtext by, if it is 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 Rtext the fields may point to.

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

Linebreakscan occurbetween Rtext nodes. Ifan Rtext node isdrawn atthebeginning of a line, its indent field tellshow far to indentitfrom the left margin. When an Rtext is drawn on the same lineas its predecessor, its space field indicateshow many pixelsof space to leavebetween the two. Ifspace iszero, therewillneverbe a linebreak between the node and its predecessor, to allowforwords withinternalfont changes.

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

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

Callingplsetpostextview scrollsa pltextview panelso thatthegiven Rtext appearsthe upper left-handcorner. Plgetpostextview returnsa pointerto the Rtext that the given panel currently displays in its upper left-hand corner.

19. Panel Reinitialization

For each panel-creationfunction, thereis a corresponding reinitializationfunction whose name isjustthecreationfunctionwiththeinitialletterspl changed toplinit . Its arguments are the same as the creationfunctions, except thatthe initialPanel pointerindicatesthepaneltobe re-initialized, notits parent. For example, thereisan plinitmessage corresponding toplmessage , thatcan be used to change thetext displayed in a message panel.

The implementation has two shortcomings. First, for no good reason, plinitmenubar ismissing. Second, you cant change the kind of a panel by calling a differentplinit function on it.

20. Nothing is Automatic

When you use thepanellibrary, nothinghappens automatically. There are no daemons watchingforchanges inthestateofpanelsto recompute their geometry or redisplaythem. Ifyou callplinitmessage to post a message to an errorwindow, you must callpldraw tosee thedisplay. Ifyou add a new paneltoa tree, you must repack itand redisplayityourself. Ifyou callplmove you shouldalsocallpldraw tosee the result.

21. Caveat Emptor

The Panellibraryisnew softwarecreatedto buildthe World-Wide Web browser *mothra* (1). Itistoo young to have been triedin many otherprograms, so itshould probably be regarded as experimental.