Cockpit Building Series

Building Sub-Panels

BY KEN PECKHAM & FRANÇOIS DUMAS

Some time ago Ken Peckham and François Dumas started work on a book about cockpit building, after having met via the Internet on another topic. Ken has meanwhile built two complete cockpits; one for himself and one for a College in the US. Because they are both extremely busy people the writing of the book progresses only slowly. So when asked by Computer Pilot, they decided to agree to provide some of the information in a step-by-step series for your favorite magazine. The story will be mainly Ken telling how he built his cockpits, and showing it, and François adding general FS information in the mix. We hope you'll enjoy the series and if you start some building of your own, please tell us about it!

Now that we have some "real estate" in our cockpit and have gone over the setup and installation of the keyboard encoder, and how to make assignments in the flight simulator, it is time to populate our cockpit with controls and switches. There are many companies that will sell you ready-to-use switches and control modules for your flight simulator. Here are some examples of cockpit (parts) suppliers;

- GoFlight - **http://www.goflightinc.com**
- Flight Link - **http://www.flight-link.com**
- DakenSkys - **http://www.dakenskys.com**
- Flightsimulator.ch - **http://www.flightsimulator.ch/default.htm**
- CSI Cockpit Simulations - **http://em.ca/~cockpits/index.php3**
- CP Flight - **http://www.cpflight.com/index.htm**
- Precision Flight Controls – **http://www.flypfc.com**
- SimKits - **http://www.simkits.com/index.php**
- TRC - **http://www.therealcockpit.com**
- Engravity - **http://www.737cockpit.com**
- Flight Ilusion – **http://members.chello.nl/p.leerentveld**
- Sea Gull Simulations - **http://www.sgsim.com/**

Their products are top of the line, unfortunately in some cases, so are the prices for these items. This is not meant to persuade you not to buy these products! On the contrary, you should buy them, after all they are very good quality and most are very easy to install and use. The question you need to answer is; which items should you buy?

And which can you build for yourself at a drastic reduction in price? What do you want to leave to the professionals, and what do you want to tackle on your own? If money were not a factor, we would all flock to these suppliers and drop our credit card and buy everything. But once again we look back to our philosophy of building on a budget, and we make choices based on economic factors and decide to build a lot of these items ourselves. Fortunately, we can build a lot of things for our cockpit at less than one quarter of the cost of off-the-shelf items. And to make things even better, we can custom tailor them to meet our needs. With a little effort and knowledge (which I hope to provide to you here) the results can be quite dramatic, in the positive sense of the word.

Some items such as radios and autopilots with digital readouts are very hard to duplicate without spending a lot of money, and as such should be purchased from one of these suppliers. This is true if you want the added realism of having the led numerical displays with rotating knobs to control them. If you can use the onscreen display on the radio stack to read your radio frequencies (or other display items) and can settle for a *wafer switch* to scroll up and down through the frequencies, then you can simply make a controller with switches and buttons and then read the displays on the screen. This is exactly what I did when I designed and built this radar panel for controlling the Reality XP weather radar:

ACTIVATE RADAR RNG

As you can see in the picture, I press the buttons on my panel, and the radar display on the screen reacts. Instead of using rotating knobs which would require a rotary encoder to make them work, I installed spring loaded *wafer switches* for the Gain, Brightness, On/Off, and Tilt controls. These handy little switches are much cheaper than rotary encoders which require more expensive hardware, and a more complex interface with the computer than our keyboard encoder. They work by having two sets of contacts, one for up and one for down, and are spring loaded to return to center (off) when released. To use them in place of a rotary knob, you simply assign the up switch to increase the selection of the item you are controlling, and the down switch to decrease. Then you can add a repeat command in the keyboard encoder for the items you wish to continue increasing or decreasing (such as scrolling up or down through the frequency range) by holding the switch up or down.

Building Control Panels

To build a control panel for your cockpit, you follow these basic steps:

1) Choose which system you want to build the control panel for.
2) Decide if you will make your own design layout or use the existing layout (using screenshots) of the panel already in the aircraft.
3) Develop the switch selection list needed to control the system you are building, such as toggle switches, pushbuttons, wafer switches, or rocker switches, and purchase the switches.
4) Design the "look" and layout of the panel and make a label for it using Microsoft "Paint" or other suitable graphics programs.
5) Print out the label (draft print) on paper and test fit your switches to check for spacing and clearance issues and adjust the layout as needed.
6) Determine and purchase the material you will use to make the panel.
7) Cut the panel to the proper size then print a temporary label (draft quality copy) on sticker paper and adhere it to your panel.
8) Carefully drill, and/or cut out holes needed to mount your switches and temporarily mount the switches into the panel.
9) Test all switch actions to determine they will work satisfactorily without interference with each other.
10) Remove switches from the panel.
11) Print (best quality) label on sticker paper, then laminate it with clear laminate for protection and install the permanent label on your panel.
12) Cut the holes out of the label and permanently install the switches.
13) Choose a "home" in your cockpit for the panel to "live".
14) Measure the length of the wires to reach from its "home" to the keyboard encoder.
15) Cut and install a wiring harness to the switches in your panel.
16) Install the panel in its new "home".
17) Connect all the wires to the keyboard encoder.
18) Program the encoder and the simulator with the switch assignments.
19) Fly!

It sounds like a lot of work, but it is really simple when you break it down into each of three *phases*. Steps 1-6 are all in the ***design phase***, and steps 7-12 are in the ***build phase***, leaving steps 13-18 for the ***installation phase***, and the last step is the best of all… the magic of flying with your new panel!

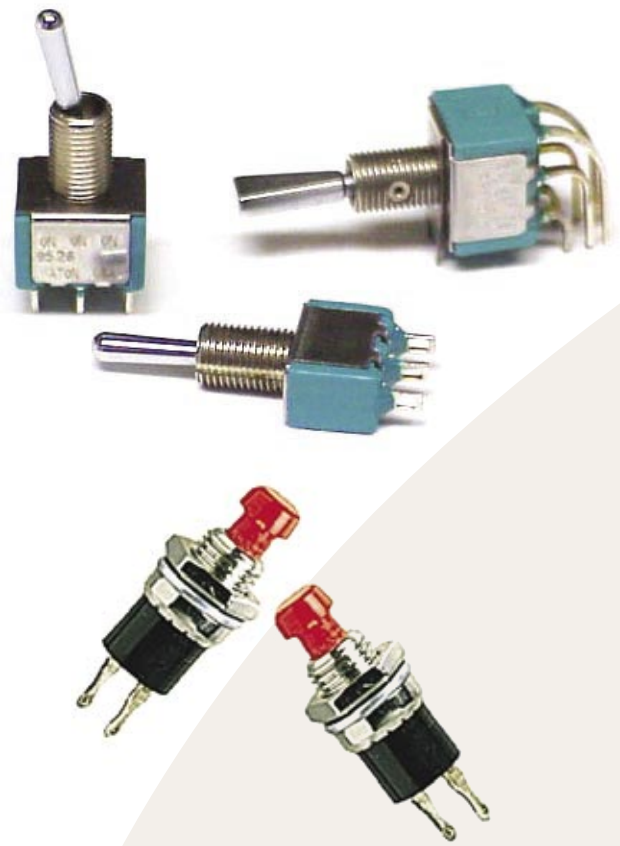
I will take you through the construction of one of my switch control panels following the outlined steps above. These steps and stages can be used and altered as needed to produce many different types of controls for your cockpit from simple light switch controls, to full blown GPS control panels.

Design Phase (1-6)

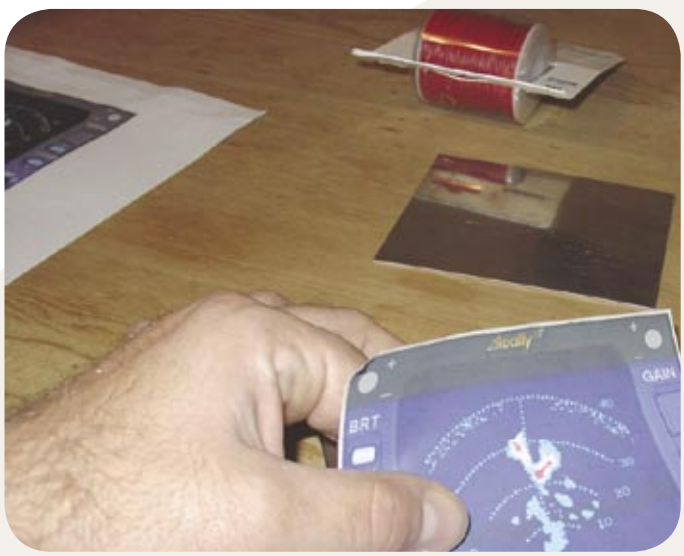
1. **Choose what to build:** For this article I will illustrate the building of a control panel for the Reality XP Weather Radar system (RXP WX500).

2. **Design layout:** Rather than designing and building my own switch layout, I decided to use a screenshot of the RXP WX500. The panel used for this system is almost an exact duplicate for a real world Bendix color radar system. You can also use a photo of a real world item just as easily by scanning it in for printing of a switch panel label.

3. **Switch selection:** For the RXP WX500 I will use 8 small momentary pushbutton switches (I purchased mine from Radio Shack, catalog P/N 275-1547 that came as a bag of 4 for US$3.29). I will use 4 *wafer switches* in place of the rotating knobs in each corner of the RXP WX500. These are called "Mini, DPDT on-off-on toggle switches" (I found mine at Jameco.com for under US$1.50 each). Make sure you get the spring loaded to center "Off" switches.



4. **Make Label:** In this case it was a simple matter of displaying the radar on my monitor and re-sizing it to the approximate actual size I wanted for my control panel. Then by pressing the "Print Screen" button the image is copied to the clipboard in Windows Then you can go to: **Start/All_Programs/Accessories/Paint**. This will open up the built-in graphics editing program in Windows called "Paint". Then along the top of the screen, select "Edit" and "Paste". This will paste a picture of what you had on your screen onto the paint "canvas" that can be manipulated, and cropped and resized by using the standard Windows icon-based tool palette on the left side of the screen, and/or the drop down menu-based tools. There is a lot of help within the program to assist you in learning how to use it so I will not go too deep into a lesson on "Paint", but I will point out a few menu items that will come in handy. In the "Image" drop down menu, under "Attributes" you can obtain the size of your page (canvas) in inches or centimeters. This is useful to give you a reference as to exactly how big your label needs to be while building it in paint. By opening paint twice and setting the attributes to the size of your intended panel in one window, you can cut, shrink or stretch part of the image from the other paint window into the preset sized "canvas" and make your label into the correct size you need. It takes a little practice to use these features, but once you figure them out it is amazing how nice your panel faces can turn out. Any picture in electronic format, such as .jpg, bmp, tiff, or gif, can be "massaged", cut, pasted or manipulated into a custom label for your switch panel. Of course, if you have other graphics software it can be used to make the labels also. The best part of learning to use "Paint" is, if you have windows on your computer, Paint is already there, so in keeping with our "Budget building" theme, you will not have to purchase new software programs to make your labels.



5. **Test fitting of switches:** By printing the label on a sheet of paper and test fitting the switches you will alleviate clearance issues that can arise. The body of some switches can be much bigger than the actual part that protrudes through the panel, and if you skip this step you may find that the switches need to be spaced further apart for clearance. It is best to find this out now *before* you drill all the holes and try to install the switches (I know, I did this once and it can really add a lot of time, expense, and aggravation to have to start all over).

Looking at the picture you can see that, in this case, it was a simple matter of printing the label on paper (draft copy) and laying the switches in place to see if any of them would interfere with the others. In some cases you may have to actually cut holes in the paper where the switches will go and temporarily "mount" the switches through the paper as you would into the finished panel in order to check for proper clearance. If you have interference issues you may have to increase the size of the panel, or simply shift some of the switch locations by cutting and moving parts of the label around until you have enough clearance for the "offending" switch.

6. **Material Selection:** There are several materials that are suitable to use for making your switch panel. Sheet metal or thin plywood are the two best choices, although plexiglass masonite or other suitable sheet materials such as hard plastics can also be used. The things to think about when choosing a material are; finding a source to purchase the item, ease of cutting and shaping, do you need special tools to work with the material, the thickness of the material, and will your switches mount through it easily, and of course the cost. The best material I have found is sheet metal made of aluminum. It is lightweight and can be cut easily with standard home power tools like a jigsaw, or even a table saw with a carbide blade. It can also be easily shaped with power sanders or Dremel rotary tools to very precise shapes. It is easy to drill and shape and smooth out the edges with a hand file, and it is strong enough not to flex when operating switches mounted through it. Where do you find sheet aluminum you may ask? You can usually find this material at home supply stores, hardware stores, or local sheet metal fabricators – they often have offcut bins where you can pick up small pieces at good prices. It is sold as kick plates for the bottom of doors and comes in a variety of sizes, and materials. You can get it in stainless steel, brass, and aluminum. I prefer aluminum for the ease of cutting, drilling and shaping/smoothing.

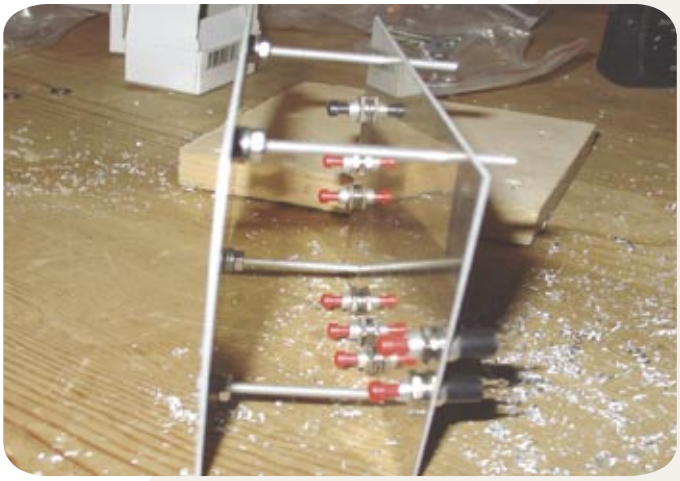
Build Phase (7-9) (first half)

7. **Cut Panel to Size and Affix Draft label:** By using a jig saw with a metal cutting blade, I cut a piece of sheet aluminum to the proper size. Then using a hand file and/or a belt sander, work the edges to a smooth finish. Once the panel is cut, it is time to add a draft label to help with positioning the holes for the switches. By printing the label I created on sticker paper using the "draft" setting in my print setup, I make a suitable working label without wasting precious color ink. I then take the draft label and carefully apply it to the smoothest side of the sub panel.

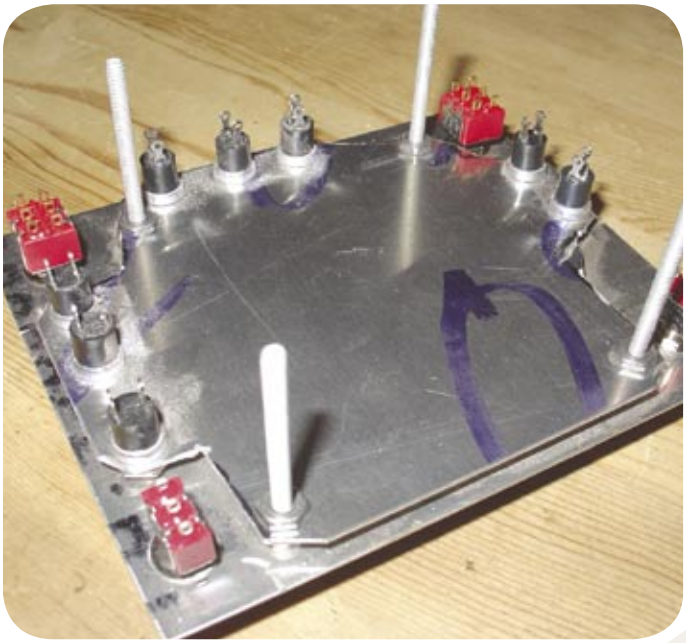
8. **Drill and Mount Switches :** With the label in place it is quite easy to see where all the switches will go. Using a center punch and a hammer, lightly tap a point where each switch hole is to be drilled. This prevents the drill bit from walking and also prevents the hole spacing from changing. If the drill were allowed to walk, even a small amount before it took a bite and went through the panel, it can noticeably change the switch spacing, and in some cases could cause clearance issues with the switch body behind the panel. For this reason it is best to use a punch, and a sharp drill bit. You might also like to look out for special "panel" drill bits for sheet metal as these will provide a faster drilling action.

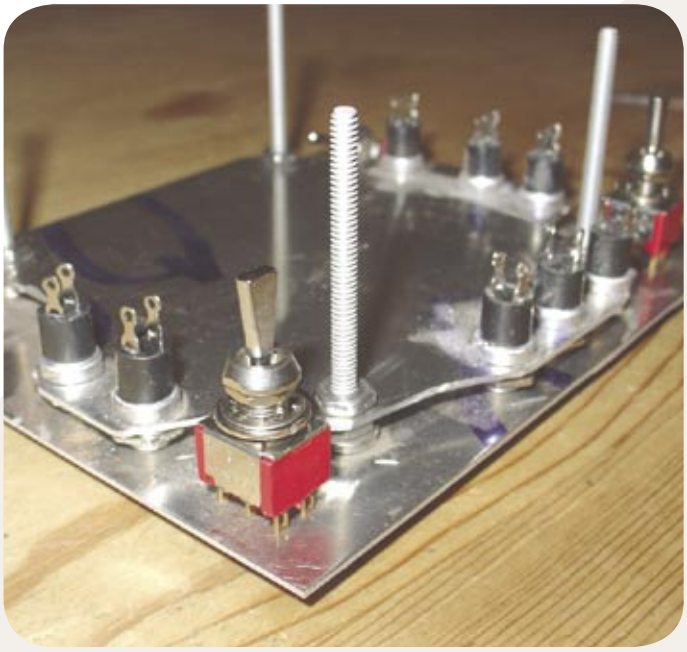
On this particular panel I used a “Double” or “False face” design. What this does is to mount the switches on one sheet of aluminum and then have another sheet in the front that only allows the button faces to protrude through. This makes for a cleaner looking panel, without all the nuts and washers for the buttons showing. It does, however, take a little more time and care to get all the holes to line up correctly on the two panels. The way I accomplished this was to clamp the two sheets together and drill four holes through both of them in the corners of the radar screen. These holes will ultimately accept countersunk screws and the two sheets will be spaced apart with small flat washers. But for the build up, I first installed the screws through these four holes and bolted the two plates together with no space between them. This then allowed me to drill all the switch mount holes through both plates at the same time so they line up perfectly. I first drilled the holes to the correct diameter for the pushbuttons to protrude through with enough room for them to operate without binding. Then I separated the two plates and drilled the holes in the back plate (the one that the pushbuttons will actually mount through) larger, by going up a little at a time with successive drill bits until I reached the proper size for the screw body to fit through. By working the holes in this manner, there is less chance of a hole “migrating” as can happen with a drill that is too large if it is not perfectly centered.

Once all the holes are drilled it is time to temporarily mount all the switches through the panel. On this particular project, because of the “Double” or “False face” design, I first installed the pushbuttons through the back plate. Then I assembled the two plates with washers between the plates stacked onto the four countersunk spacer screws.



Once this is done, I then trim off as much of the back plate as I can to make it easier to mount into the cockpit, as well as to allow me to mount the remaining wafer switches into the corners of the front panel.





Then the four wafer switches get installed through the front panel and we are ready to test the operations of all the switches in the sub-panel.

This concludes the first half of the sub-panel build article. Next month we will continue by finishing the second half of the “Build” phase (steps 9-12) of our project, where we will show you how to install the final finished panel label and final switch installations. Then we will install the wiring and proceed to the “installation” phase where we will put this panel into the cockpit and illustrate how the new panel will ultimately control the radar system in the cockpit.