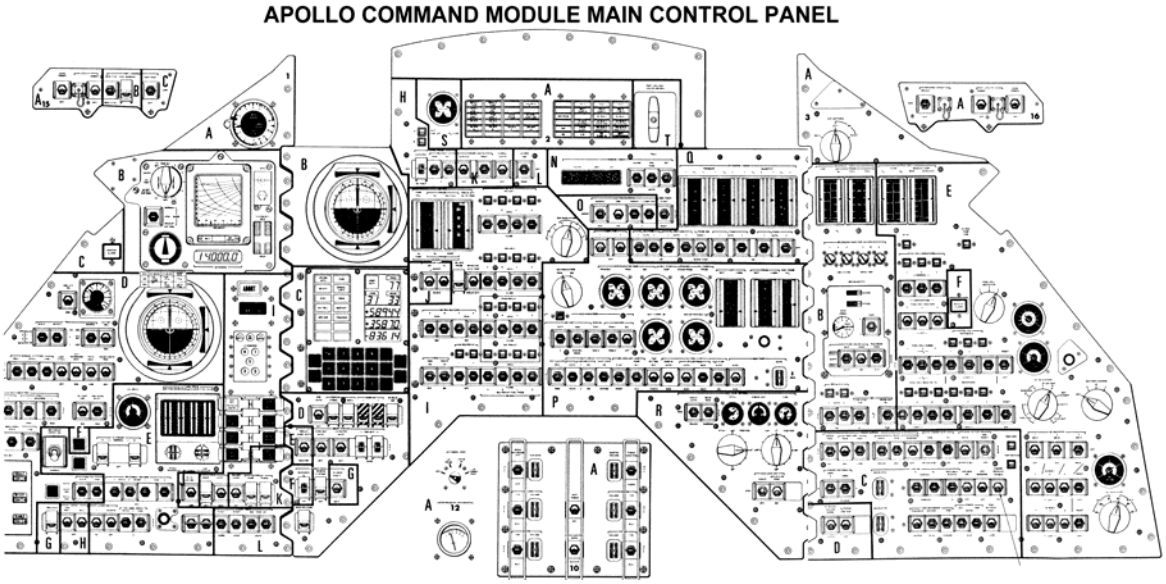
DRAFT:

So You Want to Build an Instrument Panel...?



When my sister visited me in Los Angeles I showed her around town and then took her on a little trans-oceanic flight to Catalina Island for a buffalo burger. One the homeward leg I noticed that she was paying increasing attention to the process of flying and began to wonder about all the instruments on the panel of our rented Cessna 172.

"What ARE all these instruments?" She pleaded.

Feigning puzzlement I pretended to examine them, then shrugged my shoulders and replied, "I dunno…maybe some kind of clocks I guess…."

And I laughed in empathy with her plight. She had a couple college degrees and was bright enough to comprehend almost anything, but this panel with its evenly spaced arrays of round dials and buttons and switches and circuit breakers seemed impossible to understand. It's not impossible of course, but it's far from the best that can be done.

Let's first examine the reasons bad panels happen to nice pilots:

1) Standardization can lead to bad practices being entrenched. Now, it is important to understand that standardization is both good and bad. When a knob is turned clockwise, this should increase something. When a switch is flipped upwards, something should get turned on. The pilot in command usually sits on the left so as to have the central console at his right hand. The "six-pack" of instruments became a standard after WWII.

The purpose of these "standards" is to make changing from one aircraft to another easier. Automakers have a similar problem. They cannot just arbitrarily decide where to put the brake pedal, or the headlight switch.

But it is important to know that these are simply design idioms, or customary ways of doing things. To stray too far from these patterns is to invite user complaints—and sometimes disaster.

2) Aesthetics, often bad aesthetics, is mistaken for human factors design. Is something a good design because it is pretty? Probably as far as human faces are concerned, but it is not true when function is concerned. Arranging controls and displays so that they are somehow artistically arranged missed the point of the whole exercise.

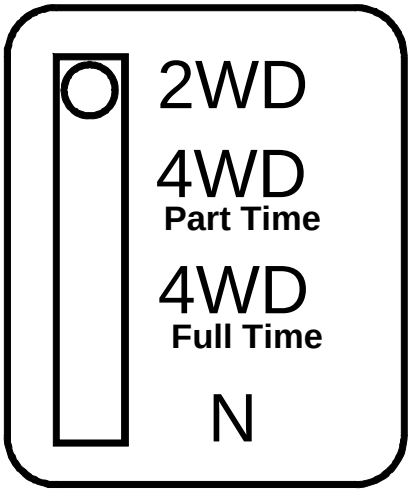
3) Fancy "Arrangement". When faced with an assortment of random objects, the designer will often arrange them in patterns. This seems to resolve some conflict in the designer's soul but actually does nothing to make the complexity easier to understand. Is putting identical switches in long rows good design? How about fuses and circuit breakers in grid patterns? Well, it might help to notice if one switch has been thrown, but it usually just adds to the difficulty of locating a particular switch. Furthermore it is a threadbare notion of design. It takes no skill or thought and makes a panel harder to use.

It turns out that human beings have a hard time dealing with symmetry. "Turn left…No I mean the *other* left!" Oddly this has been recognized for only about 35 years. Lab subjects, when shown two sets of images, fail to recognize when they have been shown mirror images of the first set. If you secretly think your brain is defective when you can't remember which gauge is which, or what side the fuel filler door is on or even if the red traffic signal is on the top or bottom, …welcome to the human brain.

An expensive and shameful example of poor design—Silly Symmetry. This Jaguar instrument panel violates every known design criteria for control panels—and at a price you can't afford.

Sensible Design: This is a panel from the 2005 Honda Accord. Notice that it is still quite conventional, but far easier to read and understand at a glance. The numbers are BIG. The tachometer and speedometer can't be confused. These designers were never seduced by the symmetry syrens.

But a cautionary word about cars—When you look at the design of a car interior, always note that many British and Japanese cars especially, are compromised by the need to design both left- and right-hand drive models.



I can't resist throwing this in. My 2004 Jeep Grand Cherokee transfer case shifter: The top The 2WD is for two wheel drive—fixed two-wheel rear drive.
That's fine. The "4WD Part Time" is actually 4WD FULL TIME and must not be used on pavement full time (because the tires wear out). The "4WD Full Time" is actually 4WD PART TIME, and the shift lever can be left there full time.

Proof that there are screw-ups everywhere.

Since people are bilaterally symmetrical, and often two people ride in the front seats, having symmetry ---ornamentation……

Mind Expanders in panel design---

1) Don't think of the instruments and controls in X-Y space only. How can Z-space be used?

2) What will an airplane control panel look like in ten years, a hundred, a thousand?

3) Examine instrument panels from new automobiles and show cars. Some are far better than others.

Checklist for panel design—

- The panel background should not add to the visual confusion. Stick with solid dull low-gloss colors. Avoid wood grains and milled finishes. If the panel is to be used at night, this is especially important.
- Labels should be as visible as is reasonably possible. Designers who put beige labels on putty-colored surfaces should be exiled to the inner circles of hell. Allow for color-deficient pilots like me.
- Remember that some day you will have to manipulate a control in turbulent weather. During the first seconds of the space shuttle launch the copilot turns or pushes a control on the panel in front of her. This takes one hand and still another hand to help out. Bad design is everywhere and we are sending it into the cosmos too. A knob provides stabilization for the hand that turns it. A button or a slide does not, and an additional means to stabilize the finger must be provided.

Here is an instrument panel built by Momo for a Ferrari grand prix racecar. Note that all the controls can be operated without letting go of the steering wheel. Note the digital display. Only Italians seem capable of designing with such flare! But Momo later toned this down considerably for the commercial market.

I know of no more succinct article on panel design than the three-part series by Ricardo A. Price, in Kitplanes Dec95 and Jan96 and Feb96. I pore over this stuff. I even have "Confusion in the Cockpit" from 1948 on the subject. But every time I want to make any comment on the subject I review Price's articles and am re-impressed. I highly recommend getting the back issues from Kitplanes (on line) if you have an interest in the subject. It's a real keeper.

http://www.kitplanes.com/magazine/avionics_electronics/7273-1.phtml
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Okay, so armed with Ricardo's articles and a head full of wild ideas and some caveats—let's look at designing a panel from scratch: Let's restrict our project to side-by-side, 2-place, left hand pilot-in-command, front engine, upright seating--basically a Cessna 172. Furthermore we consider the "right-seat person" to have only part-time piloting duties, or none at all.

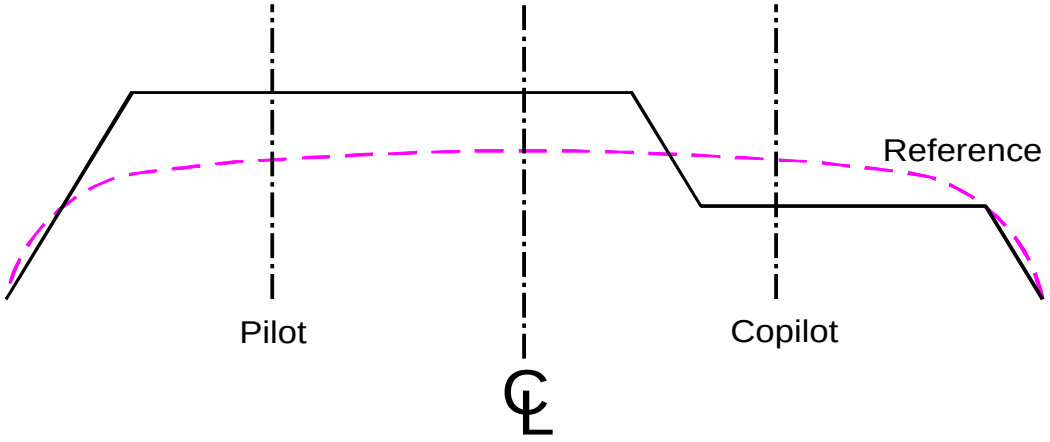
So where do we start? We could start with a conventional panel and move some stuff around, but let's start instead with the fundamentals:

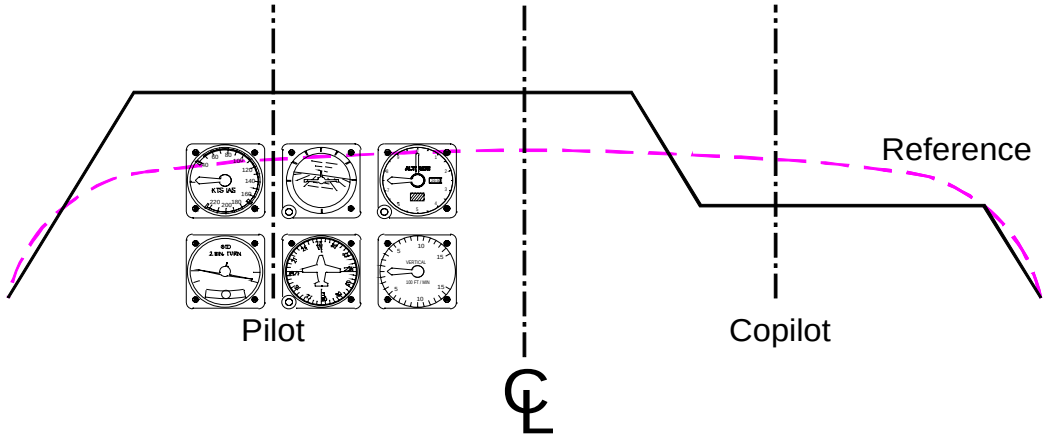
Where are the pilot's eyes and what do they need to see?

The top lip of the instrument panel needs to obscure the top of the engine cowling. All the pilot should be able to see is in front of-- and to the quarters of the aircraft. This is because the top of the engine cowling gives no information. Nothing happens to the top of the cowling that we need to see or know anything about. Even those expensive Lycoming engine parts are going to explode out of the sides, not the top—so ignore it!

Usually, the pilot needs to see traffic off the lower front quarters; so dipping the panel on the right side is a good idea. This will not reduce what the right-seat person sees, although she will wind up with a little less panel space.

We now have this:





Additional Design Tips:
Although labels are fine or even necessary, a design rule to remember is “An added sign shouts *bad design*”.
Consider Hand Stabilizers. Many switch guards are stabilizers. Knobs are usually their own stabilizers. Commercial panels often have bumps and edges and handles added so the pilots can operate controls in turbulence.
Don’t allow an oversight, such as leaving a switch in the wrong position, to cause a problem.
Controls that need to be distinguished from each other should differ by more than just a single feature. For example, controls could have different shapes and sizes to make them more distinguishable. Likewise, the shape of a control should reveal how it is to be operated