Design -Part 3

So, this time we will focus on Design considerations. Again, this is not the only way to do it but certainly some things to noodle on.

Materials selection will be next week so let's save those discussions for now.

First let's talk about missions. You really want to try to figure out what you are going to do with the balloon and set some hard limitations. Try to understand before you start designing and building what are the "must haves" and where can you sacrifice.

For example, if one of your requirements is to take advantage of FAR Part 103 ultralight operations, overall weight is going to be a hard limitation for you.

Another example, actually came up for Andy and I. That is design life. How long do you want the aircraft to last? If you build a balloon with 0.3oz fabric will it fly probably, and will you get more than 20 hours out of it? Not unless you are spending big money on the exotic and advanced materials.

Design intent sounds pretty easy, but actually writing down what you are trying to accomplish and what limitations are obstacles, can save you money and time when hard decisions come up. It's kind of like setting personal limits as a pilot. I know that in general for me, I feel comfortable flying right over densely populated areas, as long as the step change in wind speeds are at certain altitude above the ground. If they are too low, we either choose another flight area with more open spaces to land or we don't fly. That's a personal limitation for me. Same concept with designs.

I am willing to accept a higher cost but I am not willing to risk single point failures. Thus, I try to think of redundancies and what could fail in flight and what can be done in the design to mitigate it. An example of this is the load plate. As you know most load rings are just that, a big ring. But what happens if that ring breaks or accidentally is compromised by a lightning strike or powerline encounter, the result would most likely be catastrophic. If you look at the plans, our load plates have 8 holes for 16 load tapes, if any portion of the load plate breaks it is not catastrophic failure because there are 7 other load carrying sections. I am setting up bulk ordering to get the cost per plate under $100. So, think that through, in terms of risk why do you have so many cables? In case one breaks of course. I have seen many ingenious and value engineered options from welded SS rings to aluminum climbing rings. All inexpensive, lightweight and effective. But 1 failure is catastrophic loss, isn't $100 worth the extra cost.

Those are the types of tradeoffs that you have to consider when designing.
Design intent
Personal Limitations
Risk Mitigations/Redundancy

Then we can get into aesthetics,
Let's talk basic shape, some people like round, some like flat, some like bulbous, some like asymmetrical, the shape of the balloon is as personal as the colors and patterns.

The plans I shared are for a mostly flat spherical balloon, with 16 gores and horizontal cut fabric. Here are some generalizations you can keep in your pocket.
More gores = more load distribution
More load distribution allows lighter weight materials
Sacrifice is generally, more gores means more sewing or labor expense in manufacturing.

If you tried to sew completely rectangular panels you would end up with a rectangular tower with no top. Thus, as most of you have seen most horizontal cut panels are slightly trapezoidal and have slight tapers on the top and bottom edges at both corners. The steeper the taper the more bulbous.

Some other things to consider are mouth geometry and deflation/maneuvering vent control and activation. If you look at the plans, this balloon has 16 centering lines which keep the parachute vent in place and those lines attach to the same loops as the pull-down lines or the lines that open the vent. Having personally owned and spent many hours piloting the certified Adams A-B and A55S which are big brothers to this design. It is a simple and effective design that works great when its rigged properly. But if it's not rigged properly, the result is leaky or off centered, resulting in higher fuel burn and potentially over temps from rapid temp recoveries.

Some pros to this design are that we have already figured out a way to increase or decrease the size slightly without significantly affecting design geometry.
For example, if you chose to oversize this balloon by 10% by cutting the panels slightly larger, the best way to do it is to add a few inches of material at the vertical centerline of each panel.

Here is an example, the current diameter at the equator is 42'6". If you were to add 6 inches to the upper and lower measurements of all panels, the diameter, mouth, and crown diameters would increase slightly. Primarily the Diameter at the equator would be calculated like this using basic math.
42.5' x 3.14 = 133.45 circumference add 8ft (4 in x 16 gores) to 141.45 ft circumference and divide by 3.14 for a new diameter of 45ft. Now since the height has not really changed you can use a basic proportion formula to figure out an roughly estimated difference in volume.
For example:

Est volume = [45(new diameter) x 38,200(current volume)] / 42.4 (current diameter)

The new volume would be in the neighborhood of 40-41k cuft.

Mathematically you can do the reverse and accomplish approximately a 35k cuft balloon by removing 6in.

It is rudimentary but unless you are willing to go to engineering school or pay for extremely expensive CAD software you get the idea of approximating the changes.

Of course, the new diameters will require a myriad of adjustments from parachute sizes to cable lengths so as I said in the beginning it's always best practice to have a mentor or unbiased 3rd party double check your thought process before you start modifying designs but if your set on doing it yourself, manage your risk accordingly.

This balloon could absolutely be built using vertically cut panels, you would need to cut each panel in half and tape them together top to bottom.

Hope this helps. I love the discussions. Please don't hesitate to reach out if you would like help or have further questions.

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