Prototypes

Product candidate chosen: Aerocase

High-risk elements identified:

1. Are all the bends in the flat pattern of bottom case achievable by using the finger brake?
2. Does the parallelogram mechanism works satisfactorily? Is the case rigid when its closed?
3. Does the lock work satisfactorily? Is it robust?

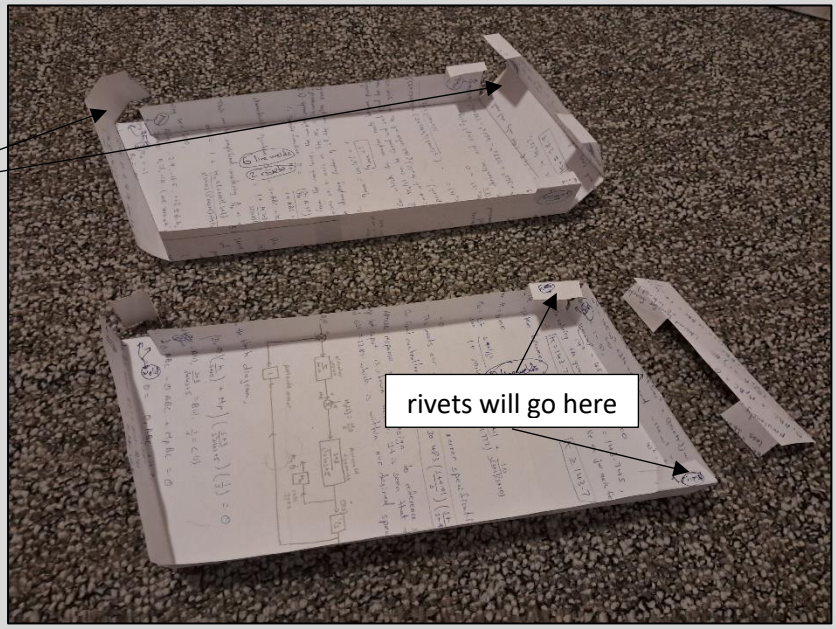
Other points to consider:

- Is it easy to put in all the instruments?

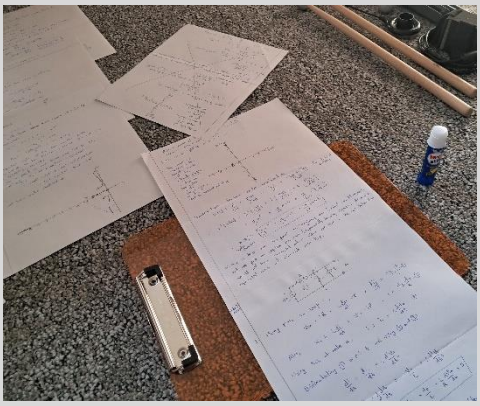
Prototyping to address the risk elements:

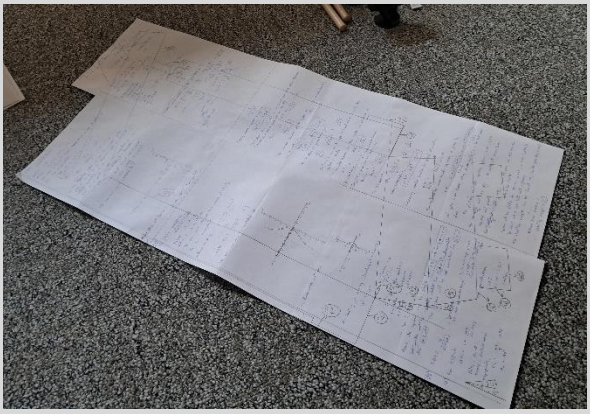
For making the prototype of aerocase, I had chosen to use paper and cardboard to make the process rapid, cheap, and easy to iterate. The bottom case will be made from sheet metal. To begin prototyping, first I had arranged all the instruments on the floor and measured approximate dimensions to get a sense of scale. For testing out different folding and joining methods, I had scaled down the dimensions by half and then using it, cut out two possible flat patterns out of paper and folded it to make the bottom case,

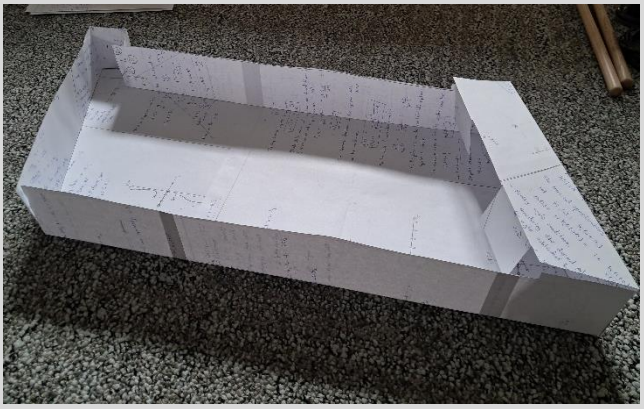
Here, I observed that the top pattern (in the image) was more difficult to bend than the bottom one. The rightmost and top left portion, where there are 3 right angle bends, is hard to achieve using finger brake. So, to simplify and resolve it, I made those parts separate. One downside of this design is that there will be more welding, and thus more difficult to properly align the faces. There will be 8 line welds and 2 rivet joints in the second design, as compared to 6 line welds and 2 rivet joints in the first one.



Next, to test out the parallelogram opening/closing mechanism, I proceeded to make an actual scale working prototype. This will also allow me to check the ease of placing/removing the instruments and give a sense dimensions while using the case in real life,

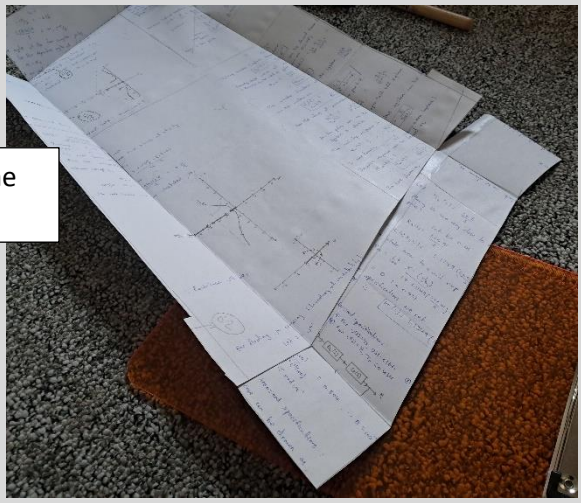






After trying to place all the instruments, I realized that the total case length is a bit short and the gap for allowing the camera to put inside is slightly small. Thereafter, I increased the length by 8 cm and the camera gap by 1 cm to make it easy to put in the instruments,

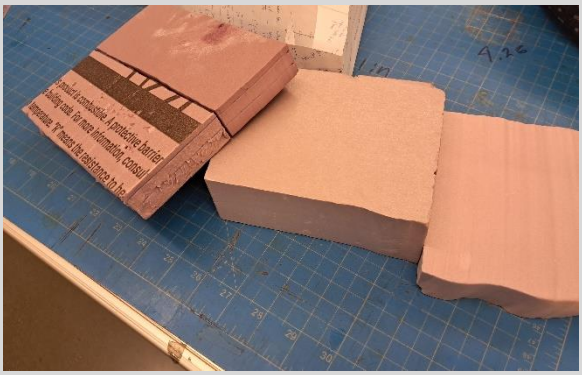
Increasing the length

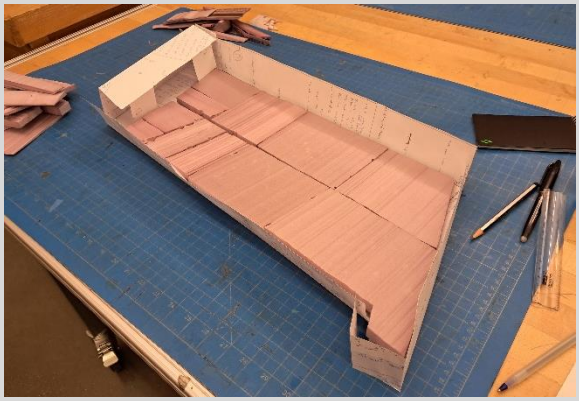


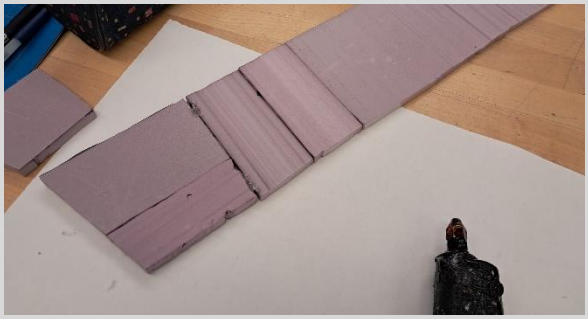
Increasing the camera gap

Final design with updated dimensions

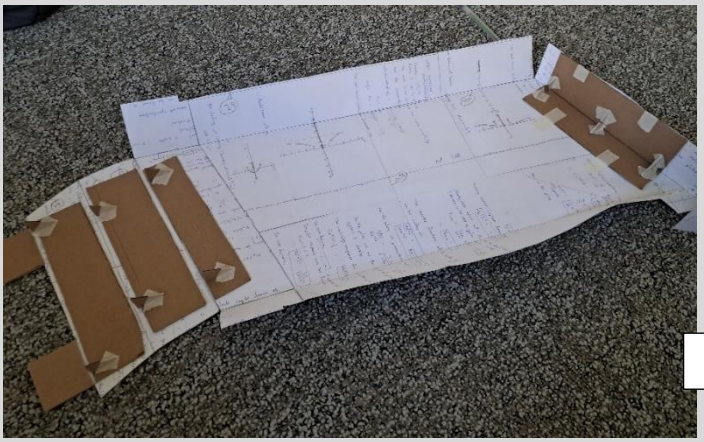
I had used pink foam to make the top two cover lids,

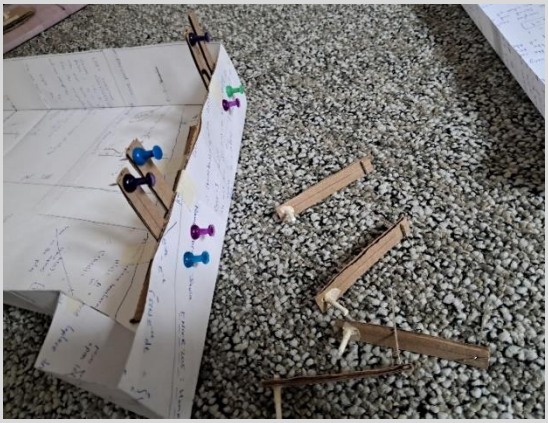


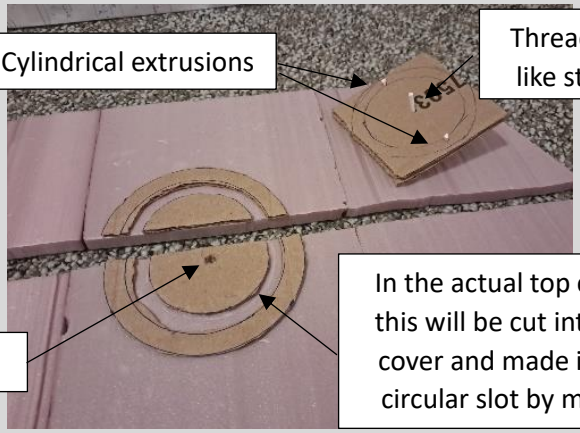




Cardboard and pushpins were used to complete building the mechanism as well as the lock,







The parallelogram mechanism and the lock worked as they were intended. The lock secured the top covers rigidly in place. The opening/closing mechanism was observed to be bit loose; the top covers swayed and rotated a bit when moving them in and out. This might be because of the close placement of the links, increasing the distance between them can make the motion more rigid. Also, some interference between the links and bottom case was seen when the case is fully opened. A rectangular edge cut in the bottom case can solve this issue.

Lessons learnt from the prototypes:

- It is hard to make the bottom case by bending only a single flat pattern. Three or more sheet metal parts will be required to be bent and welded/rivetted together to get the bottom case.
- The parallelogram mechanism works satisfactorily but feels a bit shaky when moving the top covers. Increasing the spacing between the links can make the mechanism more rigid. Also, to eliminate any interference between the links and the bottom case, gaps can be provided in the bottom case at suitable locations to allow free link movement. A combination of through holes and slots can also be used at top side linkage connections, to ensure a more robust and flexible part mating.
- The lock works robustly and holds the two top covers together rigidly. The no. of cylindrical extrusions on the periphery can be increased from 2 to 3 to ensure locking at any lock orientation. The lock will have an embossed design of drums and will be cast from metal. To have the lock of minimum possible thickness, casting limitations pertaining to minimum wall thickness will have to be considered.