Sustainable Chair Technical Report

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***Abstract*—This report details the design process used to construct a lightweight foam-core board chair. The chair had to hold and fit an 80kg man, not use fasteners or glue, and have a mass of less than 500g. Sketches were drawn of possible chair designs that met the functional requirements, and those sketches were analyzed for stress concentrations. The designs were compared using a Pugh chart, and the design with the most points in the Pugh chart was created in Autodesk Inventor. The parts were fabricated and assembled, and the chair was tested and it successfully held an 80kg man.**

I. Introduction

Light weighting techniques are an integral part in the design process of many objects. They effectively decrease weight while preserving the objects strength. This paper describes the design, fabrication, and experimental testing of one such object, a chair solely comprised of foam core board.

The chair met the following functional requirements: hold a 80kg man, seat height between 480mm and 530mm, seat depth between 380mm and 420mm, seat width between 380mm and 420mm, back height between 250mm and 450mm, made entirely of 18" x 24" x 3/16" foam core board, no fasteners, glue, tape, and a mass of less than 500g. The construction of this chair better acquainted me with the design and light weighting process. The projected view of the final chair is shown in Figure 1. This paper will explain each step taken in the design process of the sustainable chair, from sketching to experimental testing.

II. Concept Generation and Evaluation

A. Sketching and Comparing Three Designs

Three chair designs were sketched on isometric grid paper, shown respectively in Figures 2–4. A Pugh chart containing all three designs, shown in Table I, compares them to one another based on strength, mass, and ease of design. Since the third design had the most points on the Pugh chart, I modelled it in Autodesk Inventor.

III. Analysis

A. Drawing Lines of Force and Running a Stress Analysis

Lines of force were drawn on the sketches to identify potential stress concentrations (see Fig. 2–4. The high stress concentrations were removed by adding fillets to the legs. Once the parts of the chair were created, they were assembled, and a stress analysis test identified areas of high stress (see Fig. 5). The stresses on the chair were all relatively the same which meant that the load would be evenly distributed across the entire structure.

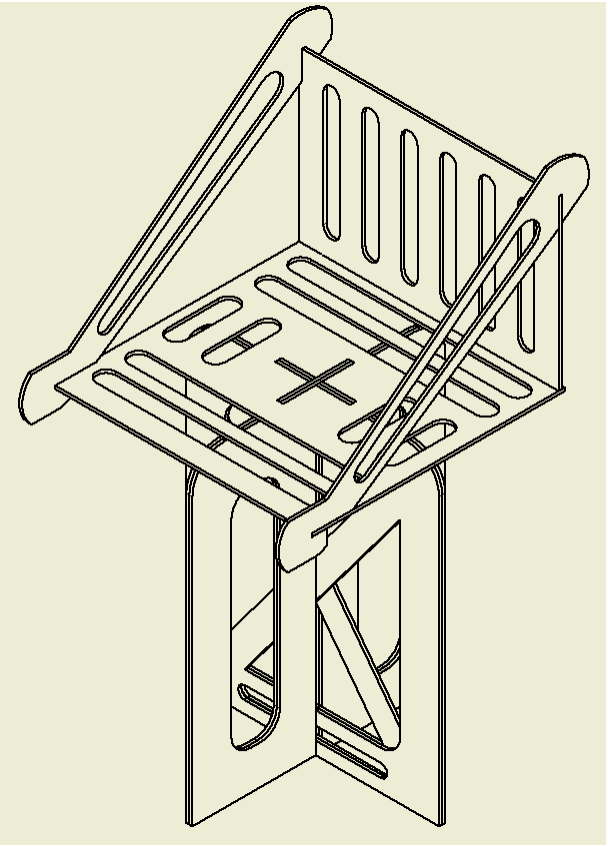


Fig. 1. Projected View of Final Chair.

	Weight	Design 1	Design 2	Design 3
Strength	3	2	2	4
Mass	2	3	2	3
Ease of Design	1	2	3	1
Total		14	13	19

TABLE I
A Pugh Chart Comparing Designs 1-3.

IV. Experimental Results

A. Testing and Remodeling Chair

The chair needed more strength in its legs to prevent them from buckling. Since more weight would be added to the chair if the legs were strengthened, material from the back support, seat, and back pieces had to be removed. Again, the final chair can be seen in Figure 1. The stress analysis for this design is shown in Figure 6. The design of each part of the chair was

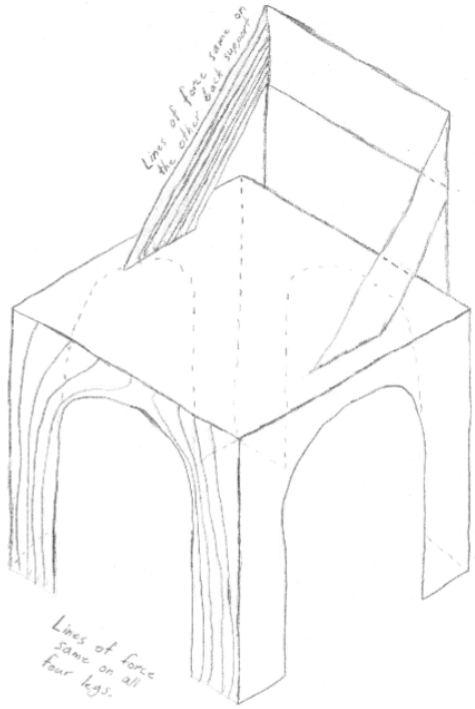


Fig. 2. Sketch of Chair Design 1.

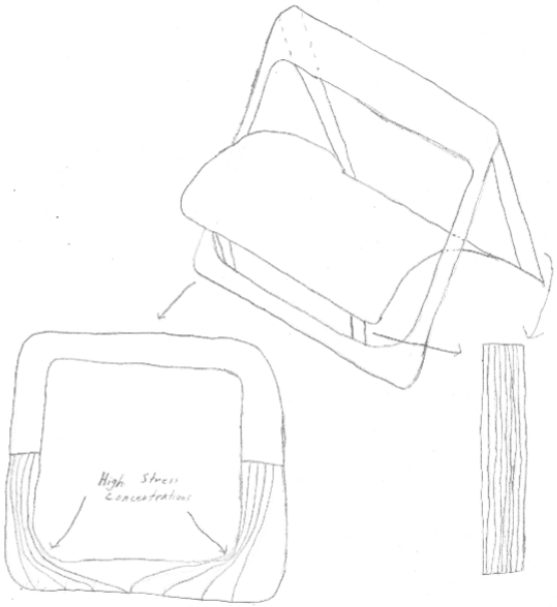


Fig. 3. Sketch of Chair Design 2.

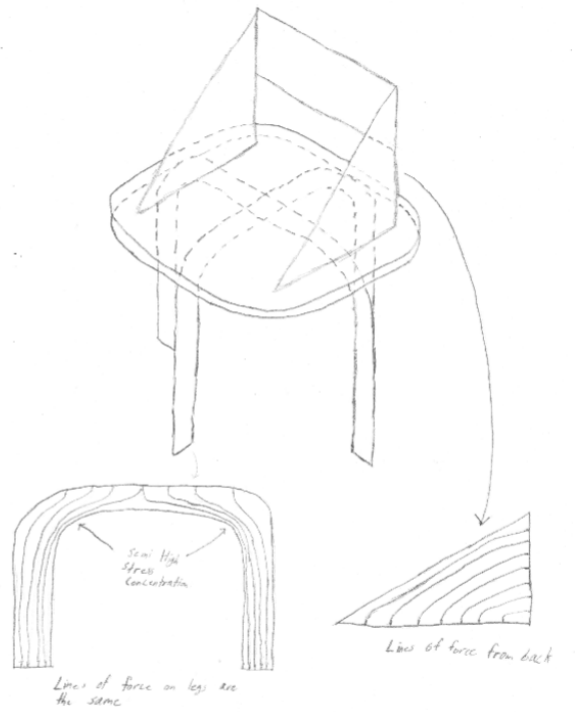


Fig. 4. Sketch of Chair Design 3.

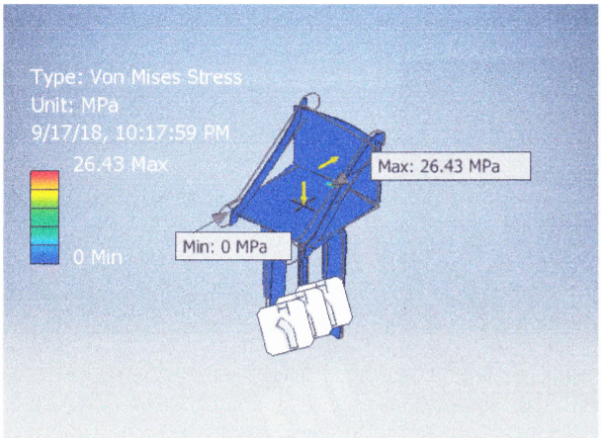


Fig. 5. Stress Analysis of Design 3.

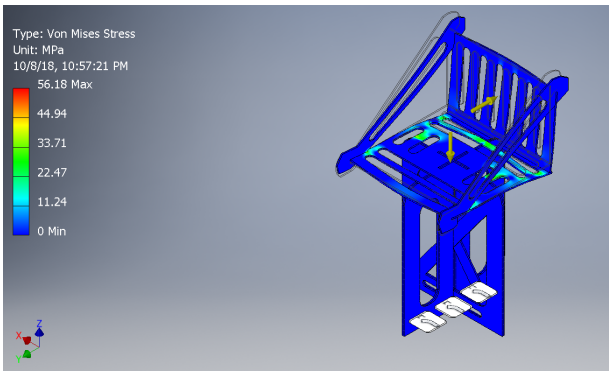


Fig. 6. Stress Analysis of Final Design.

cut into 3/16” foam core board and the parts were assembled to form the chair. My instructor tested the chair by sitting in it and the chair maintained its structural integrity.

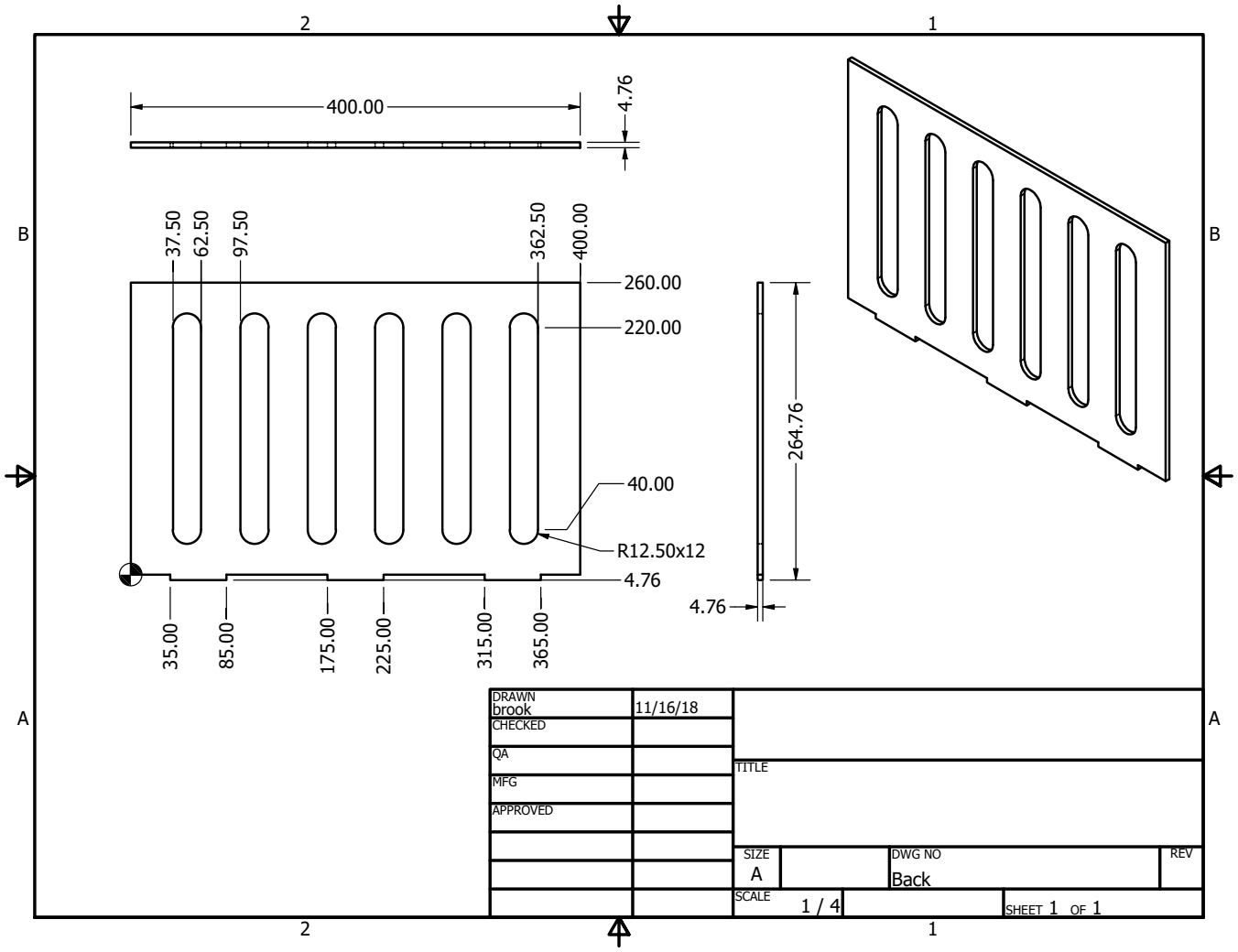
V. Discussion

A. Light Weighting Techniques Used

Three light weighting techniques were used. The most prevalent technique that was used was removing material. Removing material allowed me to lighten my chair, while maintaining the structural integrity. This technique was used to remove most of the weight from the seat and back, since those parts provided little strength to the structure, and some of the weight from the back supports, since they are in tension which lessens the material needed compared to if they were in compression. Another light weighting technique used was filleting, which helped remove some of the high stress concentrations in the legs. One truss was used on one of the sets of legs which added extra support to the legs, which most of the load acts on.

VI. Conclusion

This project was to get me better acquainted with the design and light weighting process. After designing and redesigning my chair, it was able to fit all the functional requirements. This report was written in LaTeX.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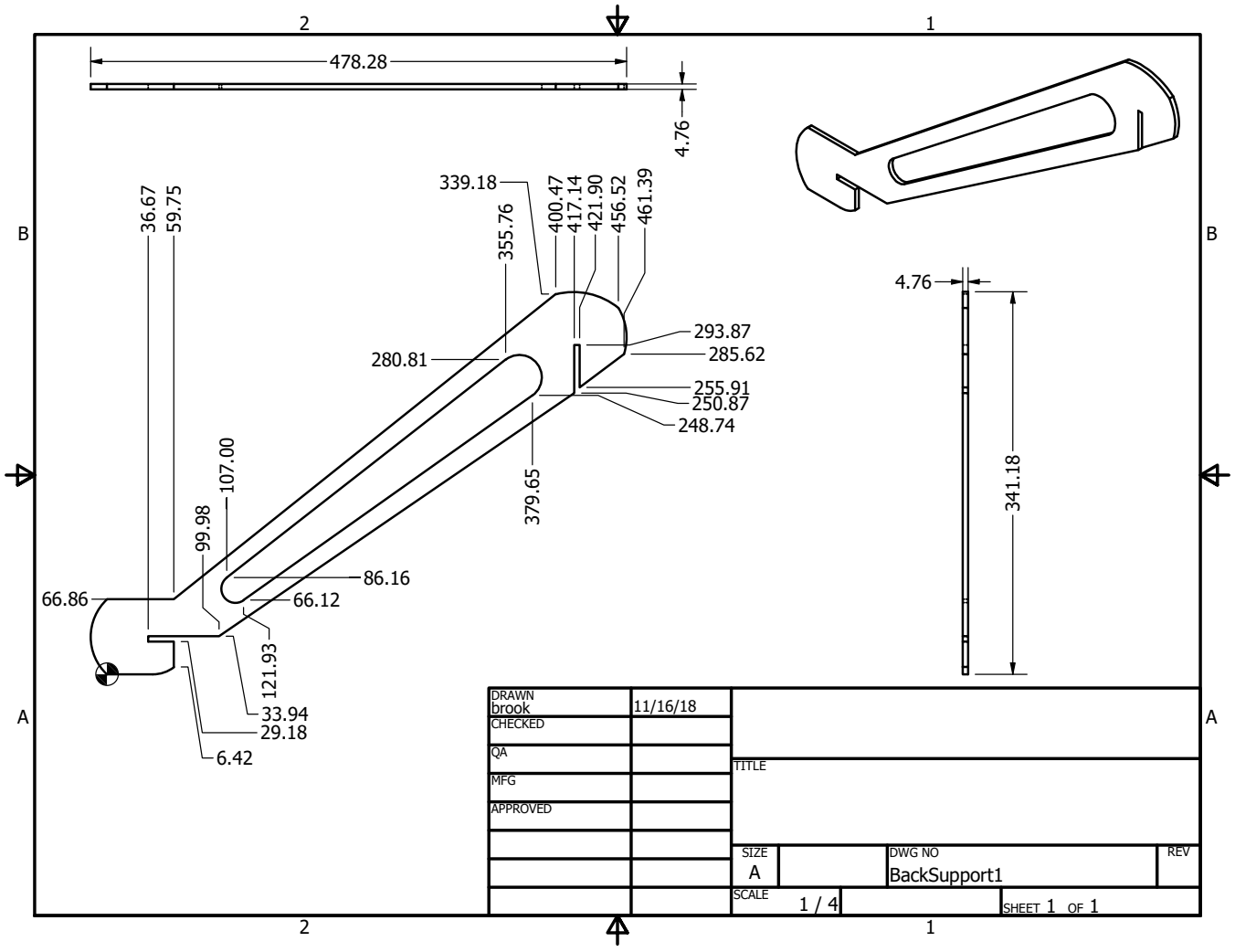
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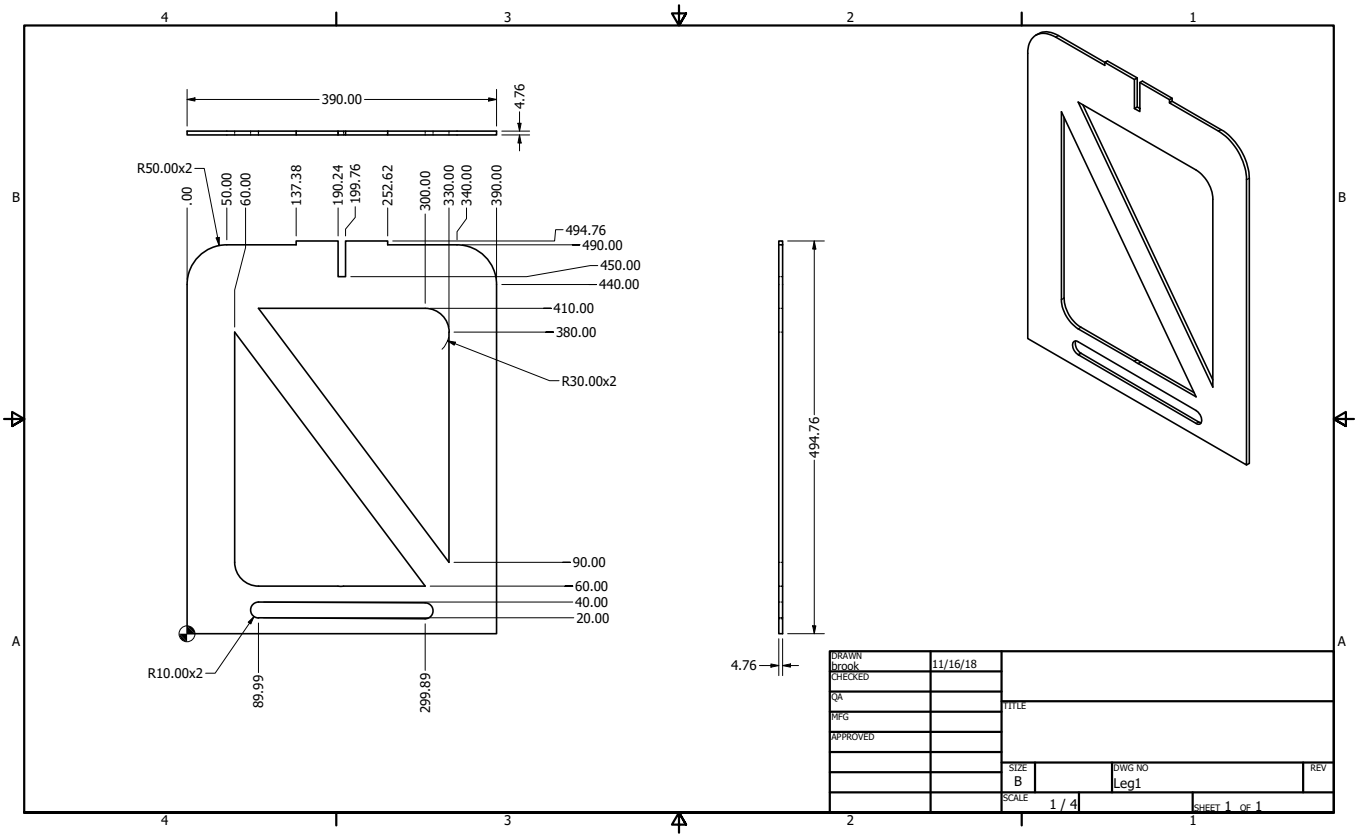
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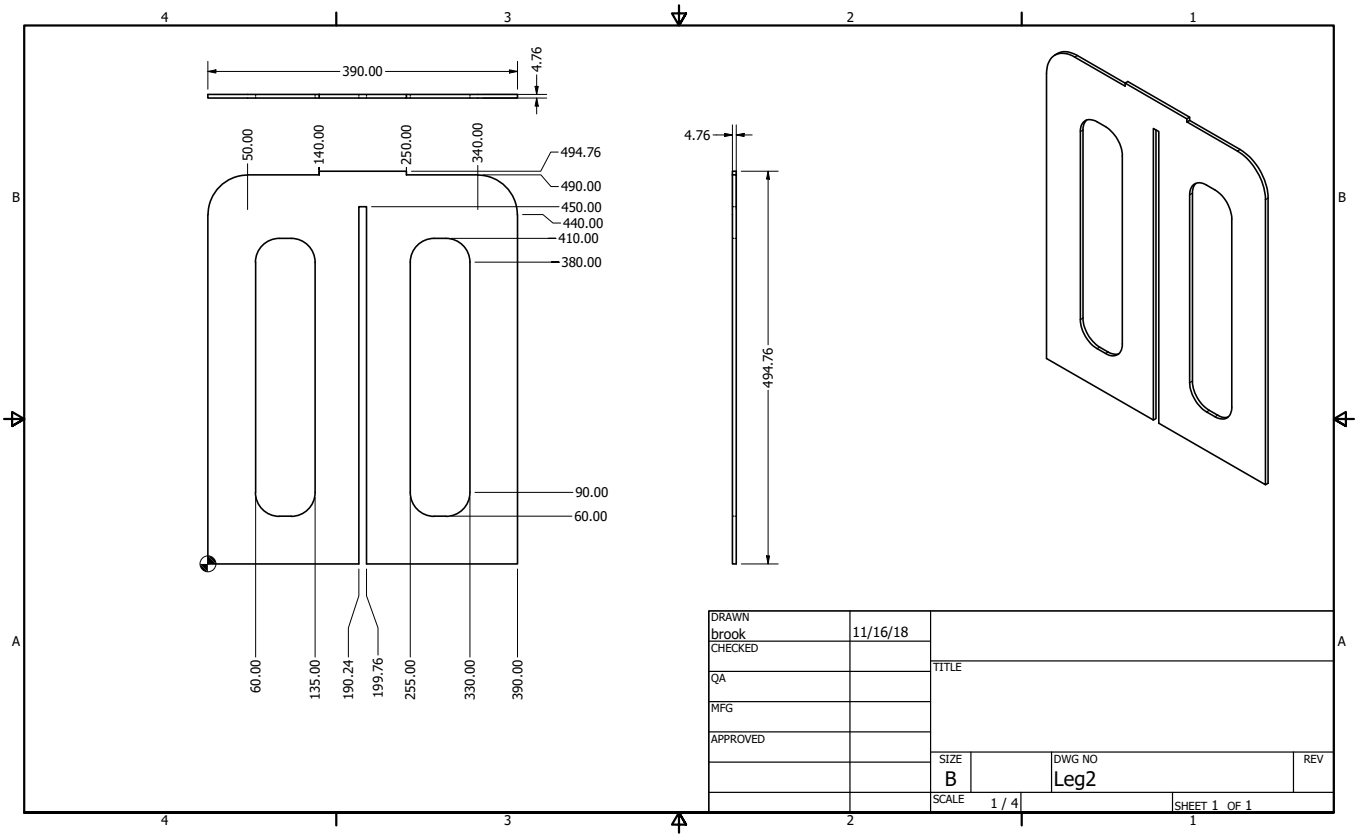
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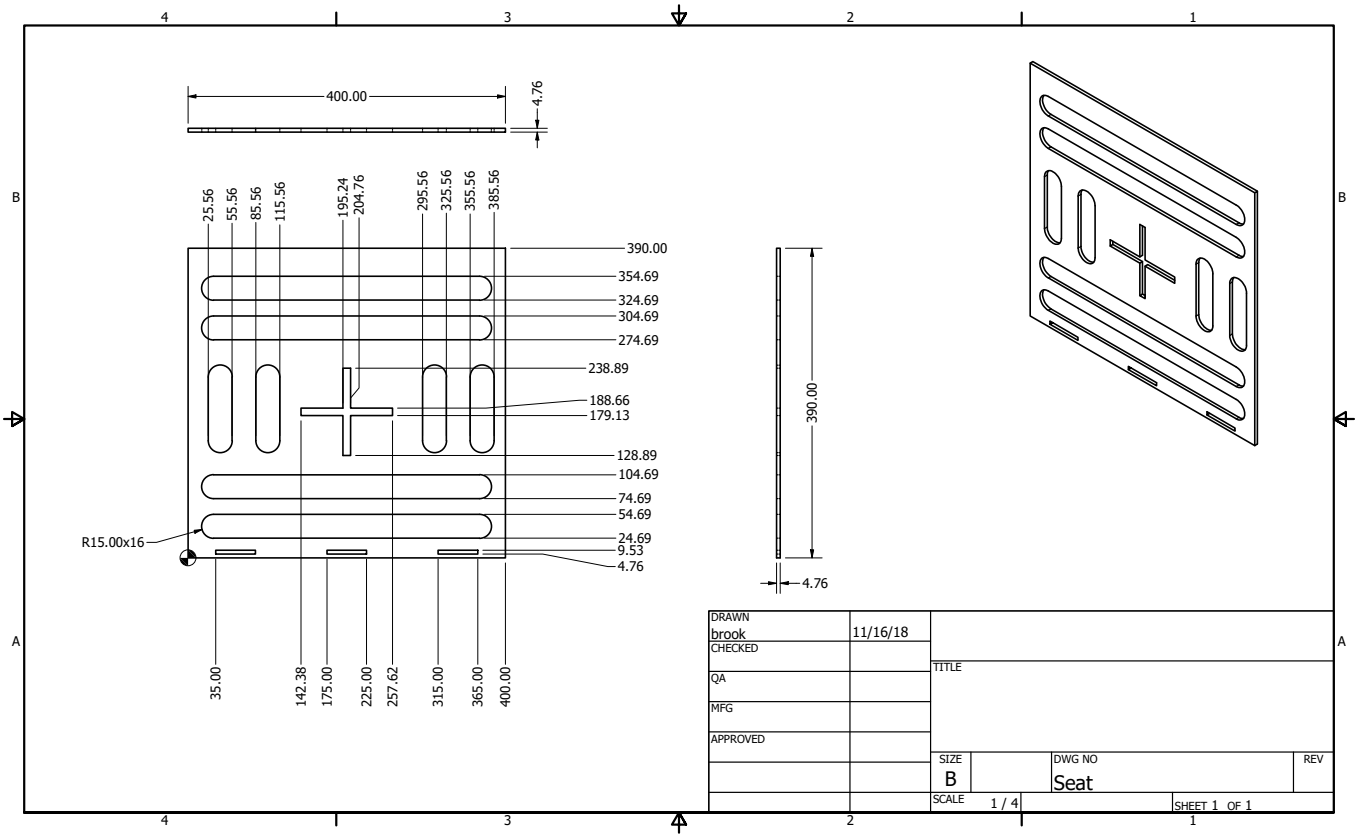
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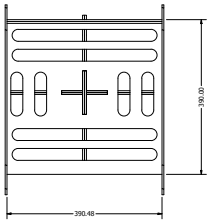

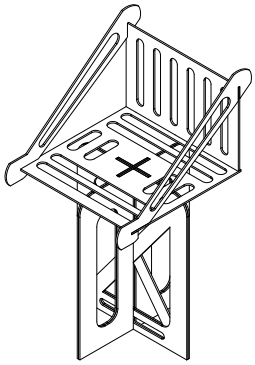

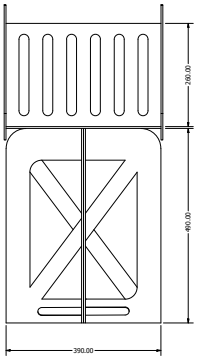

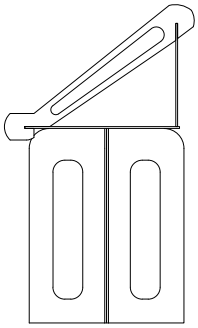

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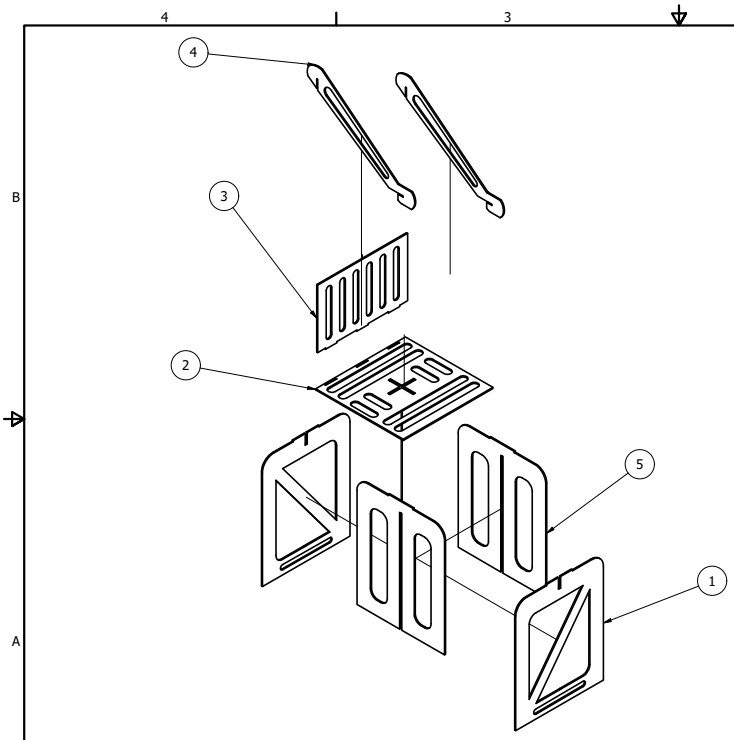

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