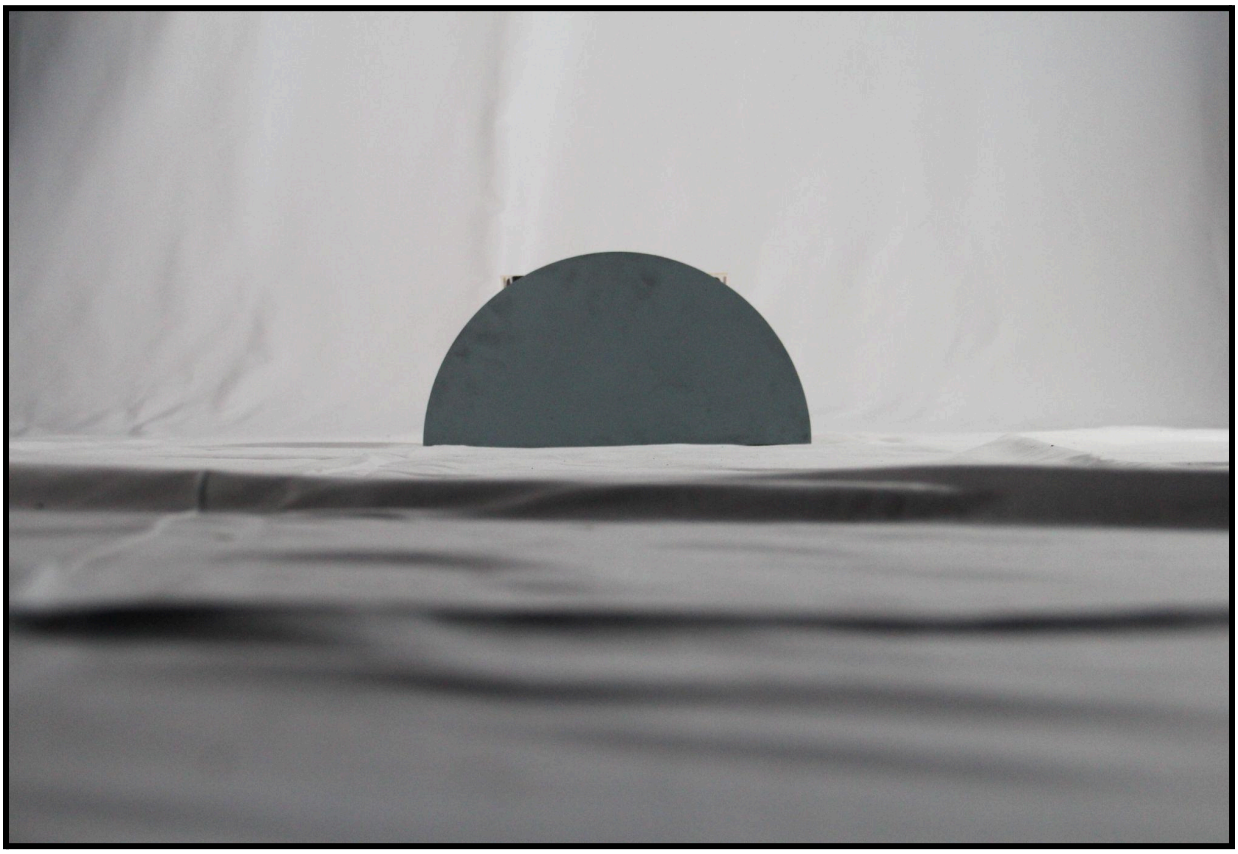
Rising Sun Shelf



Materials and Manufacturing

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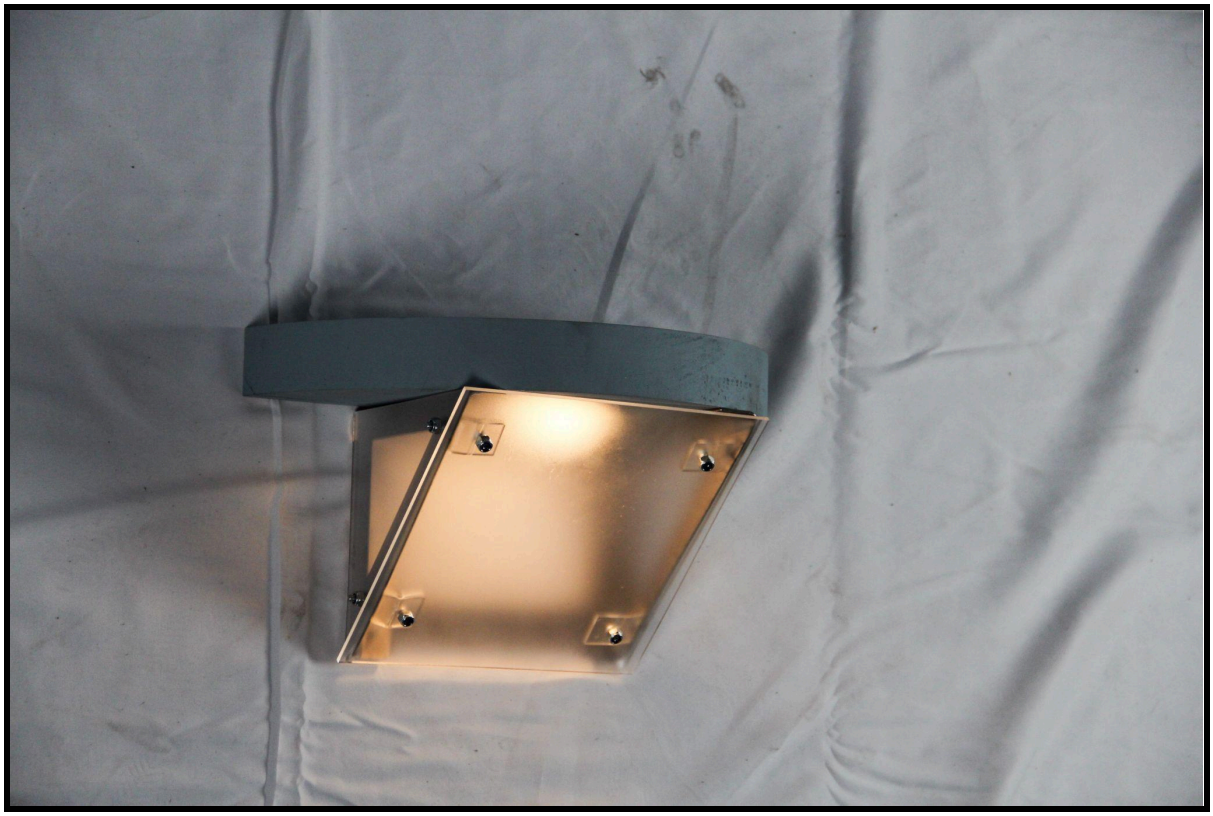
Initial Ideation and Methods Used

As a group of four, we set out to design a product that could function both as a light and a shelf. We intend it to be marketed towards a young consumer base of roughly 20-30-year-olds. We wanted to put our engineering design and production skills to the test, and we did just that. The product is generally simple, with only 3 different materials, and 4 component parts. In theory, the limited amount of material would be a contributing factor towards the lower cost. This combination of simplicity, with sleek and chic design contributes to targeting those young adults who are moving into their first rentals. Since most leases allow for the use of small holes for objects such as framed art, it is practical for installation. The simple drilling procedure also makes it easy to assemble and place. Many who are renting for the first time do not have easy access to furniture like those in more permanent living situations. This often results in a lack of lighting and surface space. Our product serves to contribute towards solving those issues. In theory, if our final product were to be sold and packaged, it would be sold with a small amount of spackle and a scraper to further alleviate the drilled installation. These product qualities fit

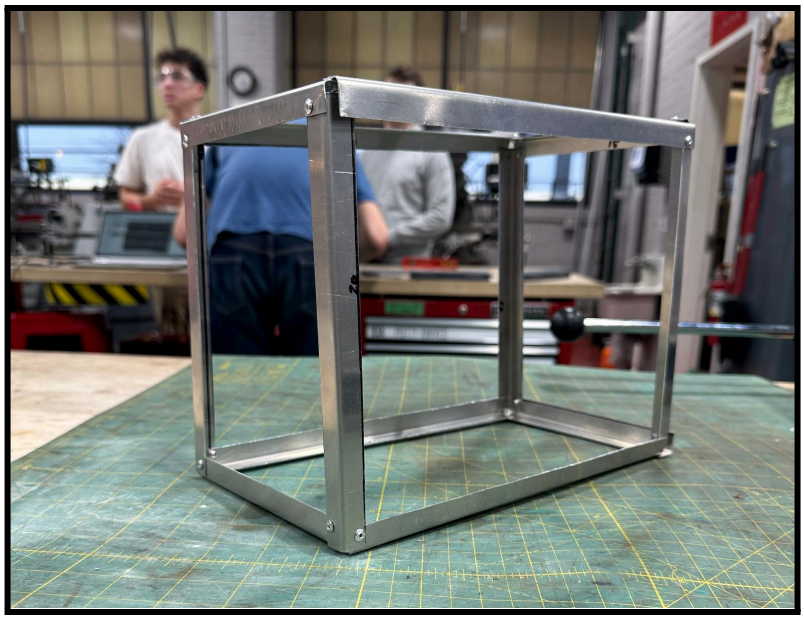
well with the target audience as young adults in temporary living spaces are often beginning to look at home improvement, but don't have the means or accessibility to make large investments. Our shelf helps fill in gaps in home improvement while being a small fiscal and physical investment.

Through discussion, repeated sketching and designing, prototyping, and meticulous machining, we reached our final product. Our shelf lamp consists of three main groups of components, each requiring different manufacturing processes. We used Adobe Illustrator (Acrylic Schematics), Trotec Ruby, SolidWorks, and Notability (for rough sketching) to design our shelf lamp. Our shelf-lamp uses several different manufacturing processes, namely: laser cutting (acrylic plates and 'L' brackets), acrylic strip heating ('L' brackets), waterjet cutting (support pieces), sheet metal bending (support pieces), jump shear cutting (support pieces), sheet metal cutting (vertical bandsaw), milling (acrylic plates and support pieces), hand drilling (support pieces), Computer Numerical Control (shelf), sanding (shelf), spackling (shelf), and spray painting (shelf).



Production Process:

We first started our production with a prototype of a bracket. Our initial bracket concept was based around a skeleton that allowed for modularity. While we found this design to be a little bit more clunky than we had imagined, we used the physical model to narrow down our dimensions. We settled on a slightly smaller bracket dimension of 20 cm by 15 cm by 20 cm. With these dimensions we were able to create a Solidworks Model of the shelf component, digitizing our initial analog sketches. Using optimization we were able to find the radius of the semi-circle shelf as it was the smallest length that could fit our 20 cm x 15 cm x and z dimensions. With a couple of extrusions, we created a model that consisted of a semicircle with a negative silhouette for the light puck to fit into.



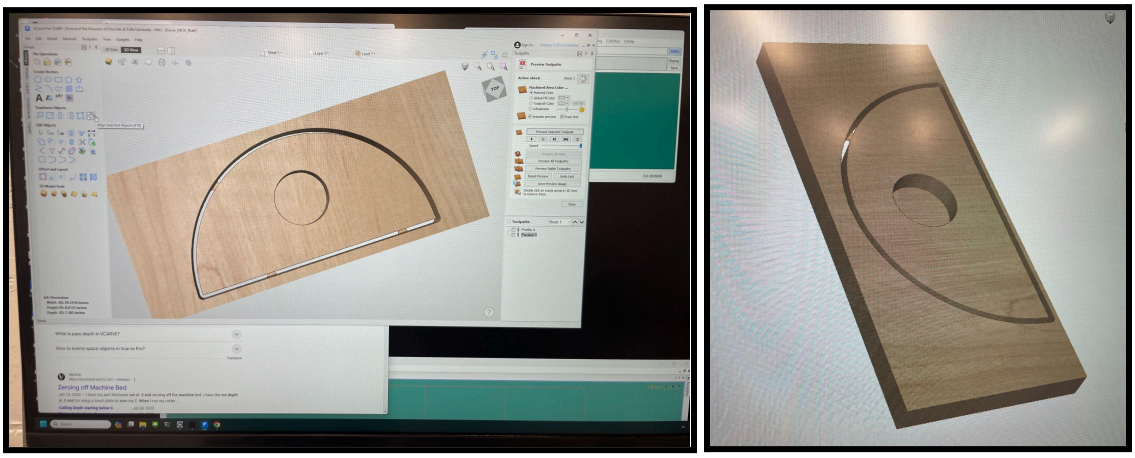
Initial Skeleton Construction

For the second and final iteration of the skeleton, we decided to redesign for simplicity. In our original prototype, we found that the weakness of the skeleton was in the poor riveting, rather than the strength of the metal. This time, we designed the skeleton to have a shape more conducive to supporting the top shelf, which we opted to make separately out of wood. From a low-carbon steel sheet, we cut two triangles and a rectangular plate: the triangles to support the sides of the shelf and the rectangle to serve as a bracket to be drilled into the wall and serve as a connecting point for each triangle. The steel proved much more challenging to work with than aluminum; punching and riveting were impossible due to the strength of the material - even using the jump shear took considerably more force. However, these challenges ultimately resulted in a much stronger support bracket than if it were comprised of aluminum. Where we could not punch and rivet, we drilled, milled, and secured lock nuts.

Working with acrylic materials and the laser cutter proved easier than working with steel, but we still encountered hurdles. To diffuse our light, we purchased a sheet of 3mm frosted acrylic from which we cut panels: one rectangle for the front, and two triangles for the sides of the bracket. Initially, however, we designed the three different panels to be made of a single piece of acrylic, bent around the edges of the skeleton rather than cut. This concept would have allowed for greater simplicity with the design and less mounting hardware to be used. In the

process of creating the unified shape, though, we made a mistake in Adobe Illustrator, causing the unified shape to be cut into a center rectangle and two different triangles. Where we meant to etch, we cut by accident. Given that we had limited frosted acrylic and not enough to have a second go, we worked with what we had. To mount the three pieces, we drilled four holes in the steel bracket, two on each side. We additionally designed and bent clear acrylic 'L' brackets to create a surface to attach the front acrylic panel that would not block the light coming out of the lamp. With these changes made, we drilled through the acrylic pieces and mounted them with screws and lock nuts to keep everything secure and rattle-free.

We chose to make the shelf component out of wood, as it is durable and easily manipulated both physically and visually. We opted to cut our piece using Computer Numerical Control (CNC) as it allowed our model to be produced with 99.9% accuracy. With past experience, Xavier led these efforts but did encounter many issues, as the software, Vcarve Pro, and the hardware, the Shopbot, are quite buggy and a bit antiquated. With proprietary software, it was difficult to upload the 3d model, and creating toolpaths around the existent geometry was not perfect.



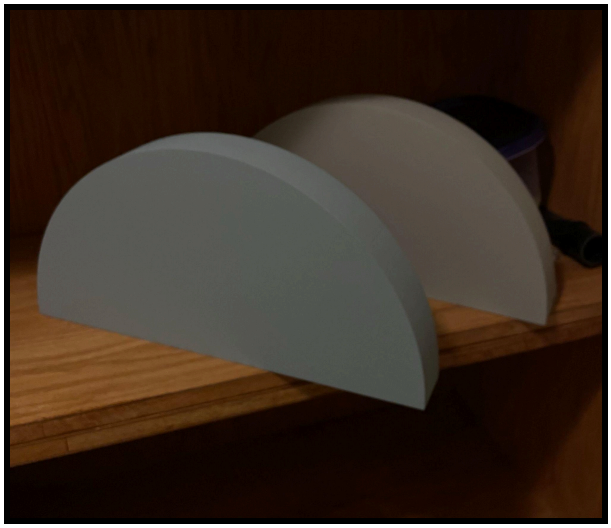
"Vcarve Pro 12" 3d Models

The .shp (Shop Bot File) initially consisted of three toolpaths. The first planed the semicircle down approximately .5 inches so that we could reach our desired thickness of 1.25 inches. The second toolpath was a pocket that created the circle into which the light puck fit. The final toolpath was a profile toolpath, which had 4 tabs, and aimed to cut the piece off of our larger material. On the first 3-4 attempts, the machine would not create the file as uploaded. On

the first two attempts, it began cutting much deeper than the desired planned amount and did not create a profile that was to the desired dimensions. After having both the studio manager and a member of the faculty who specializes in digital production look at the files and affirm that there were no mistakes, I decided to troubleshoot by placing the material on the machine bed with its zero point as the same zero point as the axis of the machine itself, so the bottom left most corner. This stopped the profile from being cut to a smaller x and z dimension, however, the machine still struggled with reaching the correct cut depths and accurately carrying out the planning tool path.

Machine Failure negatives with incorrect cut depth and successful CNC machine bed with negative material

To circumvent these issues, we decided to increase the thickness of our shelf, and I remade the Vcarve files, recreating the semicircle and circular lip with shapes in the software, according to the exact measurements from the Solidworks model. This allowed me to reach a highly accurate shelf on the fifth attempt, with the measurements exactly lining up with our schematics. Once the pieces were cut, they were sanded and spackled to mask any imperfections in the wood, and then taken to the spray booth to be primed and painted.



Painted Shelves

Post-Production Reflection and Future Steps

In the process of production, we went through multiple rounds of redesigning. An iterative design process allows your idea to develop as you experiment with different methods and possibilities. At the start, we designed the support as a skeleton of aluminum beams that form a rectangular prism. However, upon execution, we found the process of riveting and bending quite difficult to get precisely. Our second design used two round side supports and a top panel for the wooden shelf to rest on. This design integrated support, aesthetics, and functionality. However, the curved side makes it extremely difficult to attach the acrylic panels. Therefore, our final design incorporated all the advantages and disadvantages of previous designs and ended up with triangular side panels and one rectangular main panel. We also changed the design of the wooden shelf to be a semi-circular prism for aesthetic purposes. Ideally, this is a project we would like to return to, as we did not have enough time to execute all of the experiments that we had intended to do. We would like to try incorporating aspects such as producing the brackets with more specific schematics and with more digitized production methods, such as 3d printing. This would help solve the issue of human error in production, the overhang of the brackets, and simplify the connection of our acrylic, which helps diffuse the light. We would also experiment with slightly different shapes for our acrylic, as moving it further away from the brackets and light would help to further obfuscate the dark color of the

bracket, and make our piece appear to float. We would also like to model the brackets so that we could FEM test them in Solidworks, creating an assembly with the already modeled shelf.

With a more digitized process, iterating our design would also be easier, as changes could be made in a file, circumventing re-creating altered components from scratch. Furthermore, it would allow for the reproduction of our product, which could allow for sales and physical testing, as we could easily produce models to conduct stress and strain tests to measure the maximum load capacity.