# 02 Expressive Origami- Part 1

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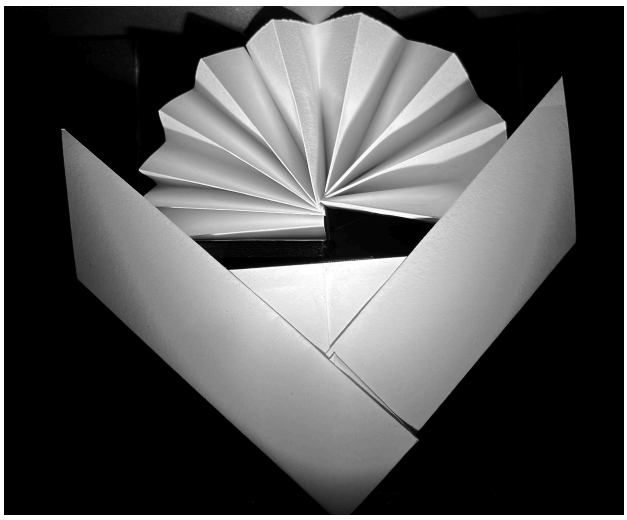
Course: DESINV 22 & 23



**Project description**

I began my project by conducting research and consulting "The Folding Techniques for Designers: From Sheet to Form" by Paul Jackson. In my exploration, I came across the concept of accordion pleats on page 90. Since accordion pleats offer the option of leaving them linear or rotational, they can be gathered at one or both edges. This gathering creates exciting possibilities for new forms.

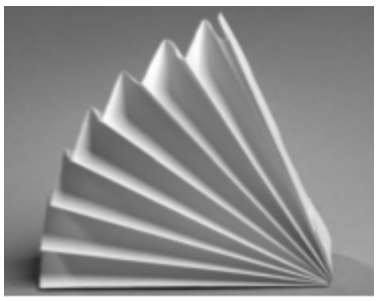


Figure 1: Accordion Pleats

Inspired by the elegance of flower petals opening, I was captivated by the idea of replicating that movement in my project. The flexibility and dynamic forms offered by accordion pleats perfectly matched this vision. By skillfully incorporating accordion pleats, I aimed to recreate the organic and rhythmic blooming process. The folds became petals, gradually expanding and unfurling, guided by the interplay of light and shadow.

Furthermore, a minor modification was implemented to eliminate the glue tab originally incorporated in Paul Jackson's design. Nevertheless, the overall design remained unchanged. Provided below is a diagram illustrating the folding process I employed for my pieces.

**Folding Technique:**

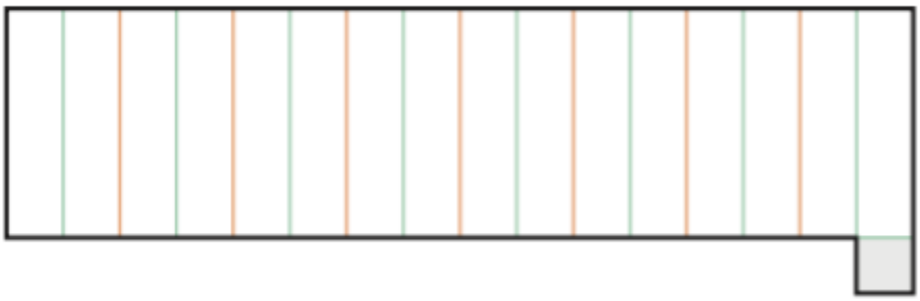
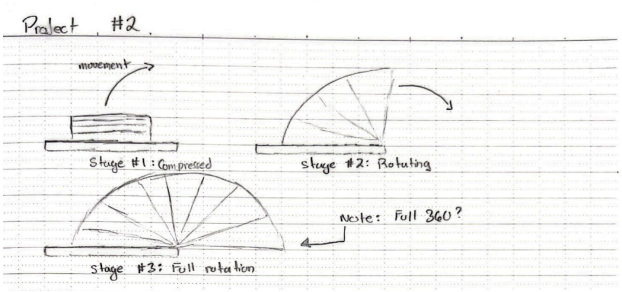
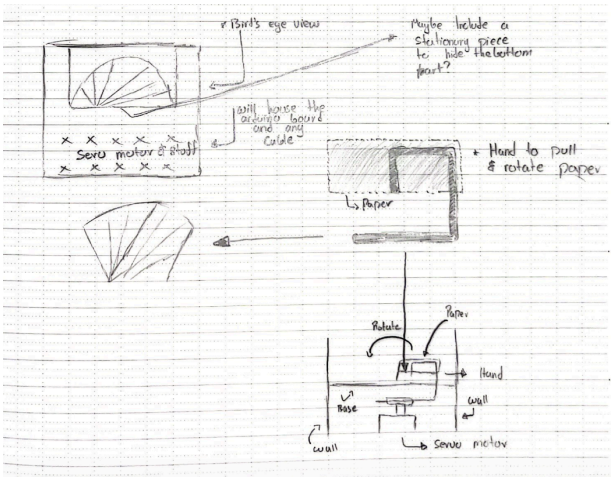


Figure 2: Folding technique for the accordion pleat design

The folds are done in an alternating manner where you would one piece to the front and the next piece on the other side.

**Ideating/Sketching**




Before designing, I created a few sketches of what i wanted to do. First the folded accordion pleats will be compressed and using and arm attached to one end, it will unfold the piece to the desired shape of a semi circle. Finally, a base will be added in between the servo motor and the folded accordion pleat to hide any wiring.

**Design #1: Description**

In my initial design, I opted for a standard 11" x 8.5" letter-sized paper as my base material. To achieve the desired effect, I proceeded to fold the paper horizontally, with each fold measuring 1 cm in length. This meticulous folding process involved executing a total of 34 folds (Figure 4), resulting in the paper being halved horizontally to yield two distinct pieces.

From the pair of folded papers, I selected one piece to serve as the primary component for my design, while the other remained as a spare. The final composition of my first design showcased a resemblance to a scallop shell (Figure 3).

Figure 3: Scallop Shell

Figure 4: Design #1 (1cm folds)

**Design #1: Difficulties and Challenges**

In my pursuit of achieving the desired effect, I tried to rotate the folded piece into a full circle. However, I encountered a challenge with the piece (Figure 4) as it wouldn't rotate completely. I had an idea of attaching a second piece for a longer version, but it would complicate things further. Another issue I faced with this design was the middle portion in Figure 4 bending back whenever I folded it repeatedly.

To address these challenges and maintain stability, I used string. I taped two pieces of string on each end of Figure 4 to hold it securely, preventing unwanted folding or unfolding. Additionally, I utilized additional pieces of string to reinforce and support the piece during folding, as shown in Figure 5.

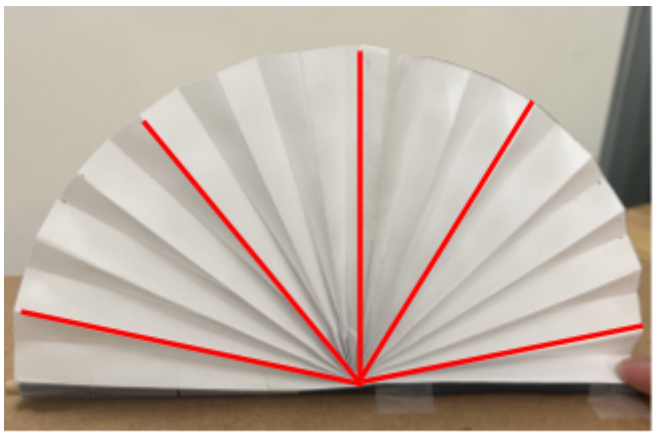


Figure 5: String locations highlighted in red

Despite the use of string, the folded paper piece still exhibited a tendency to sway back and forth when positioned vertically, and would fold up or loop back on itself when placed horizontally. To

document these challenges and the visual appearance of the first design, I recorded a video capturing the folding process, highlighting the issues mentioned earlier.

Video: Link

**Design #2: Description**

In my second design iteration, I made a deliberate decision to modify the length of each fold, transitioning from 1cm to 1 inch. Similar to the first design, I utilized the same 11" x 8.5" letter-sized paper, which was halved to create two separate pieces. However, in this instance, both pieces were incorporated into the final composition by securely taping one end of each piece together.

In this design, I aimed to address the issues encountered in the previous iteration. Fortunately, with invaluable guidance from my amazing instructor, Shm, I was able to resolve the problem of bending during rotation, which was prevalent in the first design. I learned that reducing the number of folds significantly improved the rotation capability of the sheet but string was also included to better hold the piece together. Additionally, the simplified folding approach resulted in a more visually appealing shape reminiscent of flower petals, aligning with my artistic vision as seen in Figure 6.

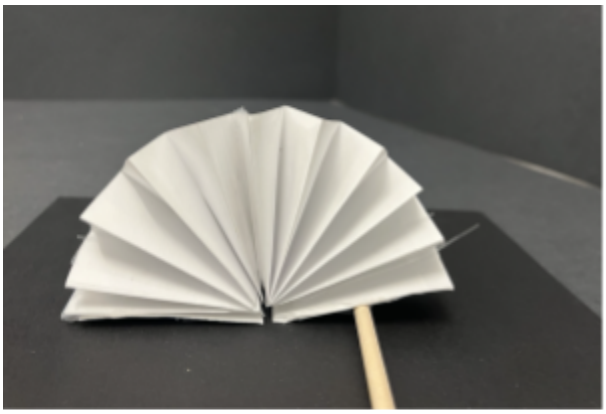


Figure 6: Design #2 (1 inch folds)

Given these advancements, design #2 emerged as my preferred choice for the implementation phase involving a servo motor. The enhanced rotation capabilities, coupled with the aesthetically pleasing petal-like form, made it the ideal candidate to bring my project to life and infuse it with dynamic movement and grace.

**Design #2: Difficulties and Challenges**

In design #2, I successfully resolved the challenges from the first iteration. The remaining obstacles primarily involved the craftsmanship of the folds and maintaining the cleanliness of the paper. Improved folding techniques and attention to detail addressed these concerns, while keeping the paper free from smudges or blemishes became a priority. The overall result was a refined and polished outcome compared to the initial design. Below is a link to a video highlighting the movement in design #2 without string attached. Overall, the movement was what was desired. String would be added to better hold everything with a similar set up as shown in Figure 5.

Video: Link

**Design #3: Description**

Finally, I embarked on an exploration of a new movement concept by incorporating a 270-degree angle rotation into the folded piece. Building upon the folding design employed in design #2, my objective was to achieve a nearly complete 360-degree rotation of the entire folded piece. To visualize the potential outcome, I experimented with the folded pieces created in the second design, envisioning how they would appear in motion. Figure 7 provides a glimpse of the intended visual effect if the rotation were to be completed fully.

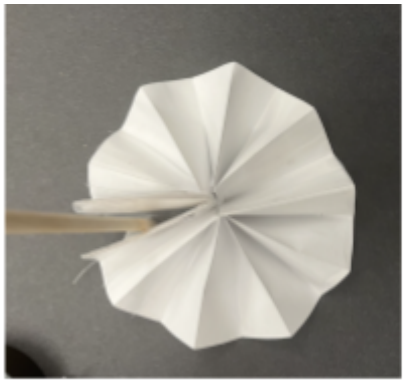


Figure 7: Design #3 (full rotation)

**Design #3: Difficulties and Challenges**

During the rotation of the entire piece, I encountered the challenge of balancing the application of sufficient force to move it without risking the detachment of the anchoring piece from its base. Despite this difficulty, the rotation yielded the desired outcome of opening the folds further, enhancing the overall aesthetic. Additionally, I faced the task of finding a way to anchor the rotating piece while ensuring that no tape, string, or any other visible elements were exposed. In

both design #1 and #2, tape was used, but in the case of design #3, the rotation consistently caused it to rip away from its base. To provide a visual representation of design #3, I have included a video demonstration below.

Video: Link

**Conclusions**

After thorough exploration and experimentation with three different designs, I have concluded that design #2 and design #3 showcase the most promising outcomes for my project.
Design #2 demonstrated significant improvements over the initial design, addressing the challenges faced in the first iteration. The modified fold length, along with the enhanced craftsmanship, resulted in a visually appealing shape resembling flower petals. Furthermore, its rotation capabilities proved to be smoother and more controlled.

Building upon the success of design #2, I also ventured into design #3, where I aimed to introduce a new movement concept. By incorporating a 270-degree angle rotation, I sought to push the boundaries further. Although this design presented its own set of challenges, such as the need for secure anchoring during rotation, it offered a captivating visual effect that was close to a complete 360-degree rotation.

# 02 Expressive Origami- Part 2

**Final Project description**

For my final design, I chose design 2 due to its simplicity and effectiveness. The integration with the servo motor worked as intended, with the arm smoothly following the desired path and folding the paper to resemble a blooming flower. To enhance the aesthetics, I added a stationary V-shaped origami piece in the last steps, effectively concealing the bottom section of the semicircle. This combination of elements resulted in a refined and visually pleasing composition, showcasing the beauty of the blooming process as seen in Figure 8.

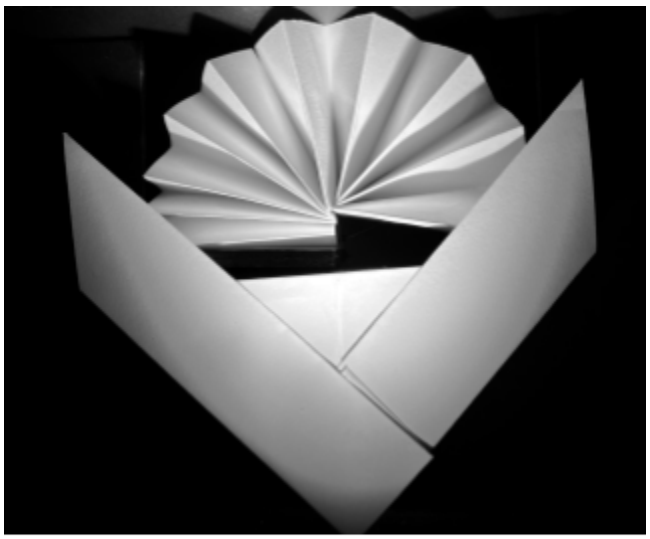


Figure 8: Hero Shot

Video: Link

**Final Design #2: Description**

To better understand the movement of the paper with a servo motor mounter I created a low fidelity version of the design I hoped to get at the very end and had it mounted on black foam to get a sense of how it would look. Also, i created a handle using metal wire that was sturdy enoch to move the piece without bending. Figure 9 depicts the handle used in the design. Overall, design #2 achieved what was originally intended with the first sketches in mind. Figure 10, 11, and 12 showcase the movement at certain points and the low fidelity version.

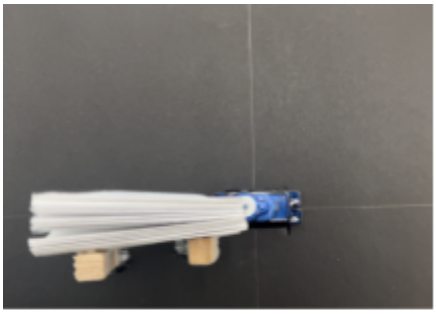


Figure 10: Compressed

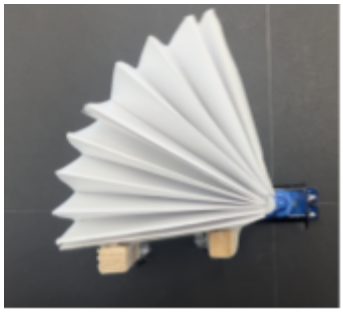


Figure 11: Rotating

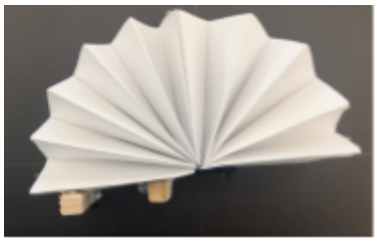


Figure 12: Full rotation

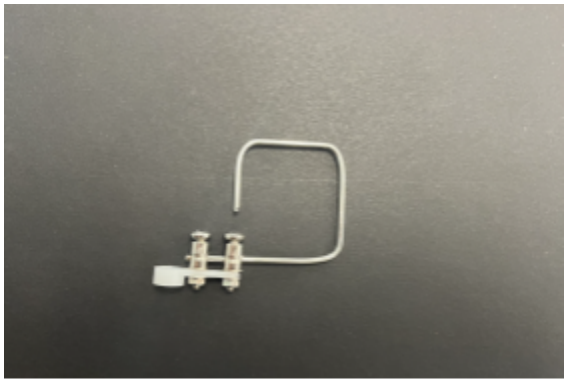


Figure 9: Handle/Arm

**Final Design #2: Challenges/Comments**

During the final stages of completing the design, I encountered the challenge of enclosing the structure. I used black foam to focus attention on the rotating section. A V-shaped component concealed the base, while a semicircular section facilitated arm movement. Figures 13, 14, and 15 showcase the setup from different angles, including the concealed semicircle and the rear with the Arduino board and servo motor. This medium-fidelity version was refined for the presentation.

Figure 13: Top View

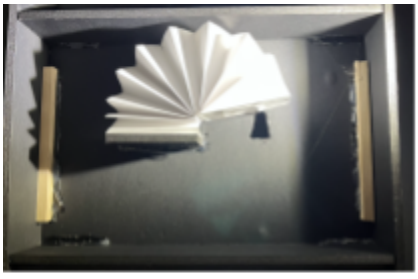


Figure 14: Top layer removed

Figure 15: Side view

**Final Design #3: Description**

The third design for this project used a continuous servo motor to control the movement of the folded paper by making the servo move clockwise for a second and counter clockwise for 2 seconds as an example. In addition, a second version using a rack and pion mechanism as shown in Figure 16.

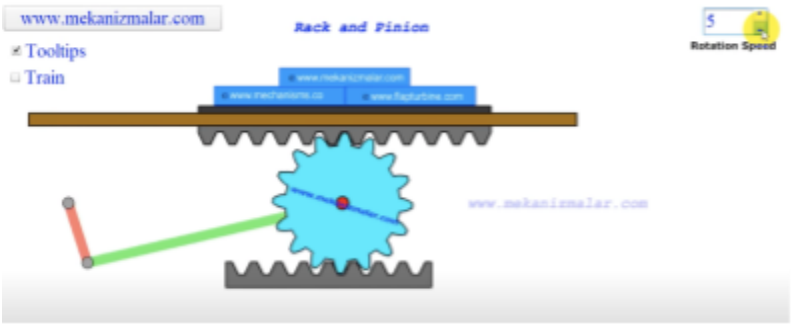



Figure 16: Rack and pion mechanism

Video: Link to simulation

**Final Design #3: Difficulties and Challenges**

Using a continuous serco proved to be difficult, After a couple of rotations, the starting point kept shifting which would prove to be a problem if it continuously occurred. Furthermore, using the rack and pion mechanism did not yield the expected results. From figure 16, the green arm moves up and down which was something my version as shown in Figure 17 did not do. Overall, this design was scrapped and design #2 was chosen as the final decision.

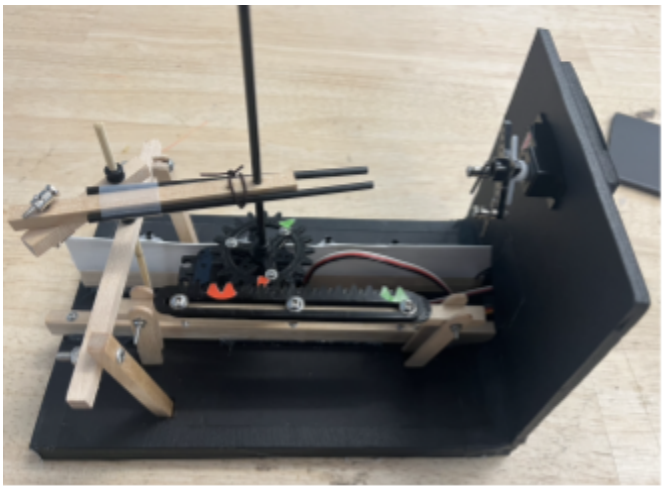


Figure 17: Rack and pion mechanism

**Conclusions**

In conclusion, design 2 emerges as the optimal choice for several compelling reasons. Its simplicity, coupled with the successful integration of a servo motor, results in a visually captivating representation of a blooming flower. The refined folding technique and the smooth rotation achieved by design 2 contribute to its overall aesthetic appeal. Additionally, the strategic addition of a V-shaped origami piece effectively conceals the lower section of the semicircle, adding to the design's sophistication. Through careful consideration and experimentation, design 2 stands out as the embodiment of elegance, functionality, and artistic expression, making it the clear frontrunner for the final project.