

Project 1: Rectilinear Form Design

DES202: Product Design Fundamentals

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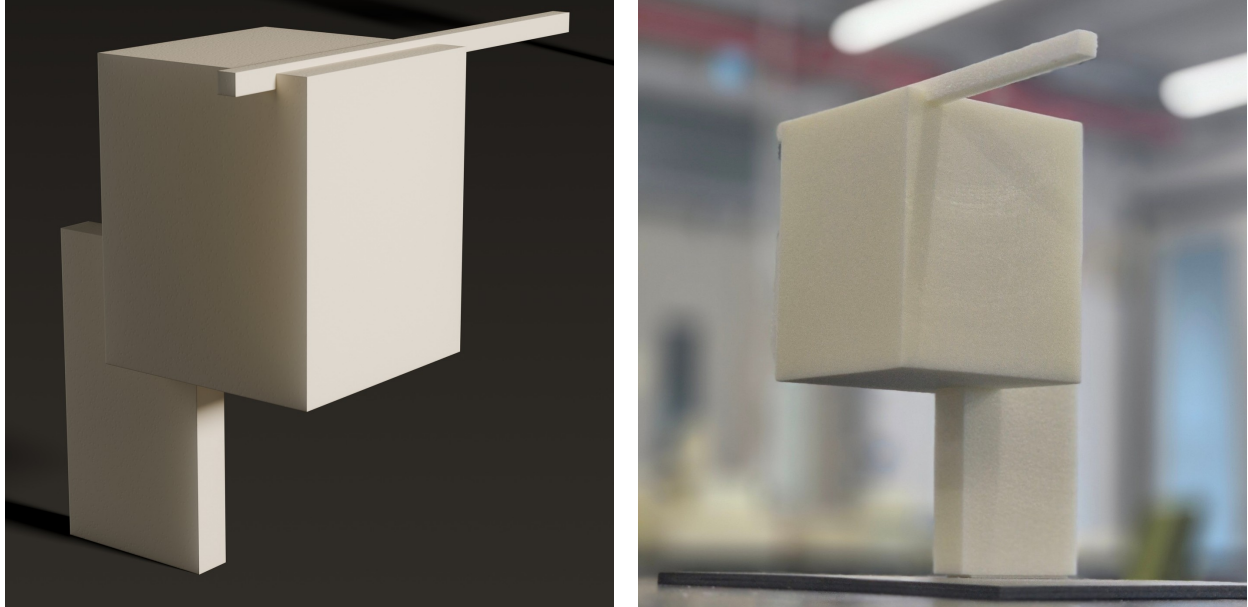


Fig. 1. The final composition, rendered for the concept board (left) and built at full size in foam (right).

1 INTRODUCTION

Project 1 asked for a composition of three rectilinear forms that expresses tension between similarity and difference. My design treats the space enclosed by the three forms as part of the composition, so that the empty space under the lifted mass can be read as a transparent block that steadies the group without removing its tension. The following sections describe the design problem, the design process, the final design and prototype, how the design was communicated, and its limitations.

2 DESIGN PROBLEM

In a rectilinear composition, similarity is largely given, since all the forms share right angles, one material, and one color. Difference must therefore come from type, proportion, axis, and position. In my early sketches, establishing a hierarchy was easy, but reaching a balance that still carried tension was not. When I pushed the directional forces further, the forms separated into three unrelated objects, and when I resolved them, the tension disappeared.

The problem I set out to solve was how to keep the tension created by the differences between three rectilinear forms while still reaching a balance that the eye accepts. I aimed for what Kostellow calls precarious balance, a state in which the composition is only just resolved and “the gesture is holding its breath” [4]. My approach was to make the empty space part of the structure of the composition.

3 DESIGN PROCESS

3.1 Explore: Metaphors from Existing Products

I began ideation with existing products rather than abstract boxes. The shape of a product is not determined by function alone. Its designers also made aesthetic decisions, so the silhouette of a familiar object already contains proportions that someone judged to work. I sketched products that are close to rectilinear, reduced each one to three forms, and then varied them. Examples include a desktop computer with its tower, monitor, and keyboard (Figure 2c), a flatbed scanner with its lid (Figure 2f), a camera with a protruding lens (Figure 2b), and a column rising out of a block and a plane, which I noted might read as a bush (Figure 2e). I used these metaphors only at

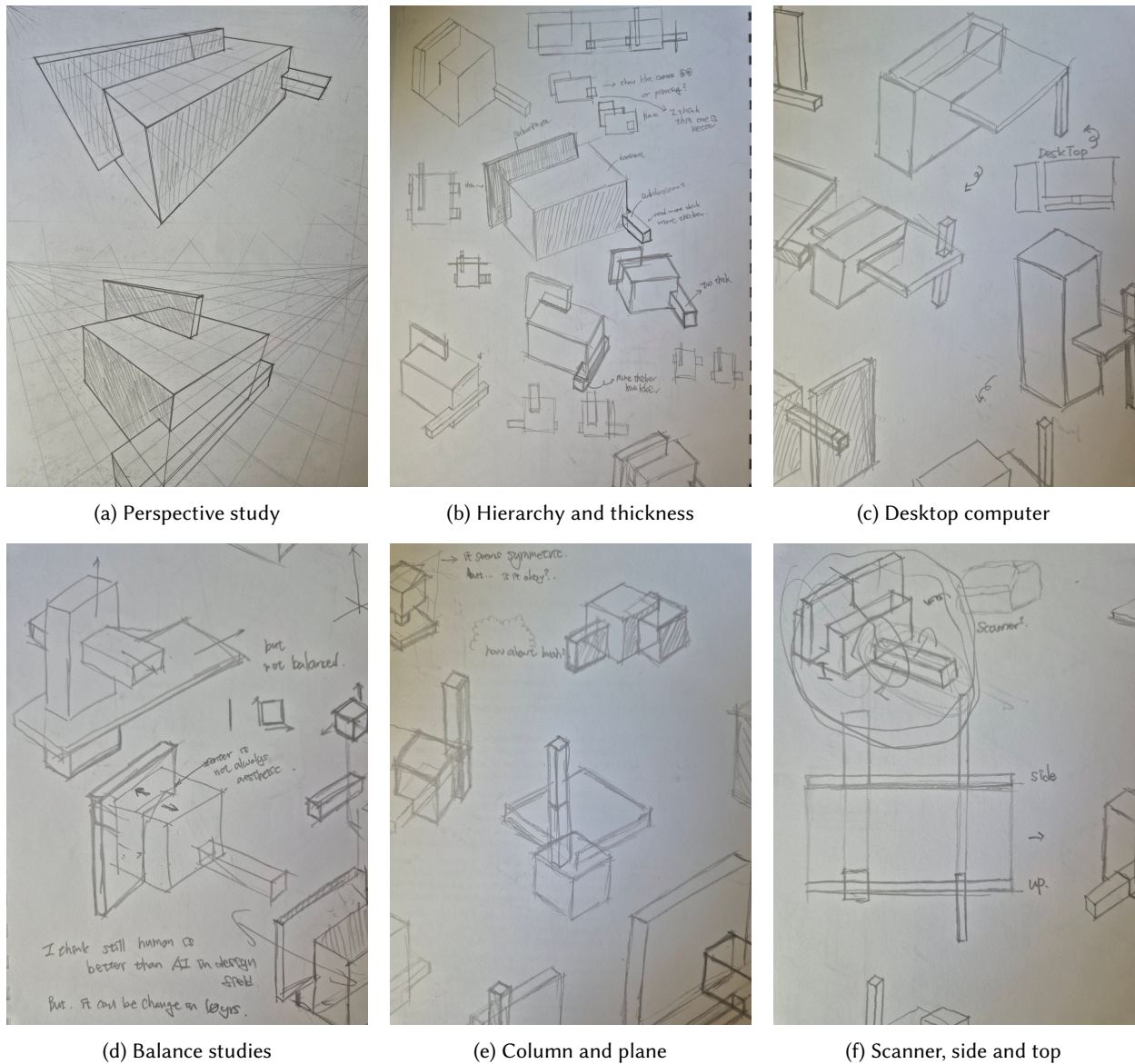


Fig. 2. Workbook pages. (a) Two-point perspective study of the developed composition. (b) Hierarchy labels, notes on the thickness of the line-like form, and a camera motif. (c) The desktop computer metaphor. (d) Balance studies. (e) A column rising through a block and a plane. (f) The scanner metaphor with side and top thumbnails.

the ideation stage, as a source of proportional pairings such as a tall body beside a low slab or a box crossed by a slender bar. From the perspective study onward, I worked with the forms alone, without reference to any product.

The notes on these pages show what I was learning. I labeled each form as dominant, subdominant, or subordinate directly on the sketches (Figure 2b). The thickness and length of the line-like form were the hardest decisions to settle (“need more thick,” “too thick”). Centered arrangements looked static (“center is not always aesthetic”), a symmetric variant raised doubts (“it seems symmetric... is it okay?”), and one page simply says “but not balanced” (Figure 2d). Next to several sketches, I drew small side and top views to check the idea orthographically (Figure 2f), and this habit later developed into the three-view drawings.

3.2 Explore: Vizcom for Rapid Prototyping

Early in the project, I used Vizcom [5] to turn line drawings of candidate compositions into short rotating videos and material studies (Figure 3). The tool was useful for rapid prototyping because I could see several candidates in motion within minutes and continue ideation from what I saw. It could also produce unrealistic color, material,

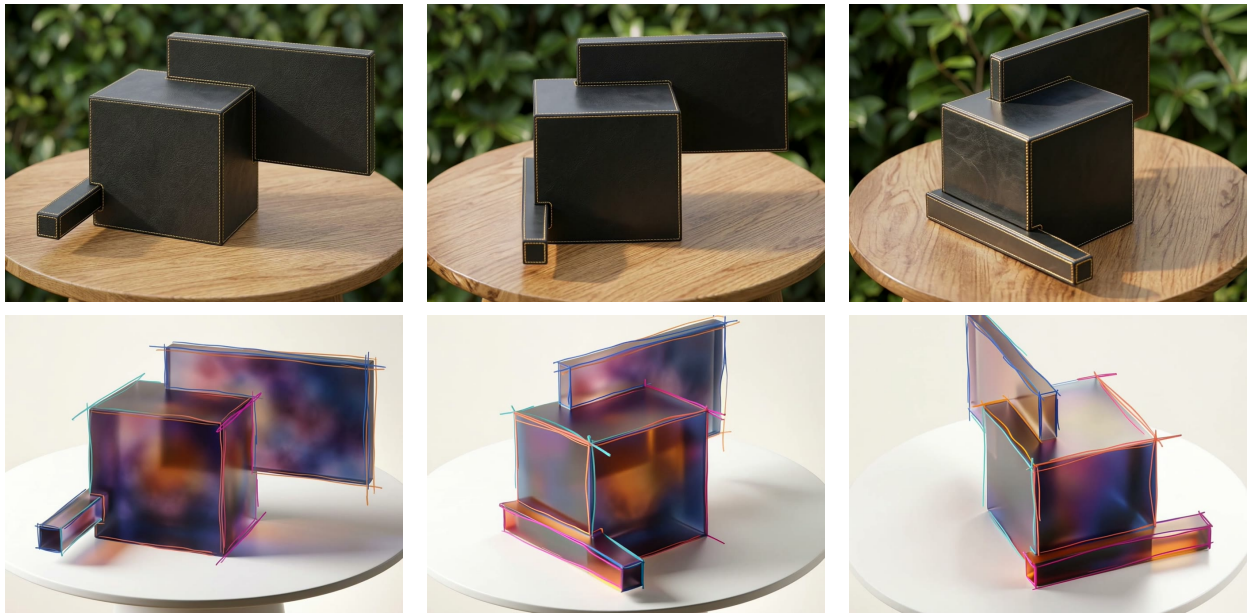
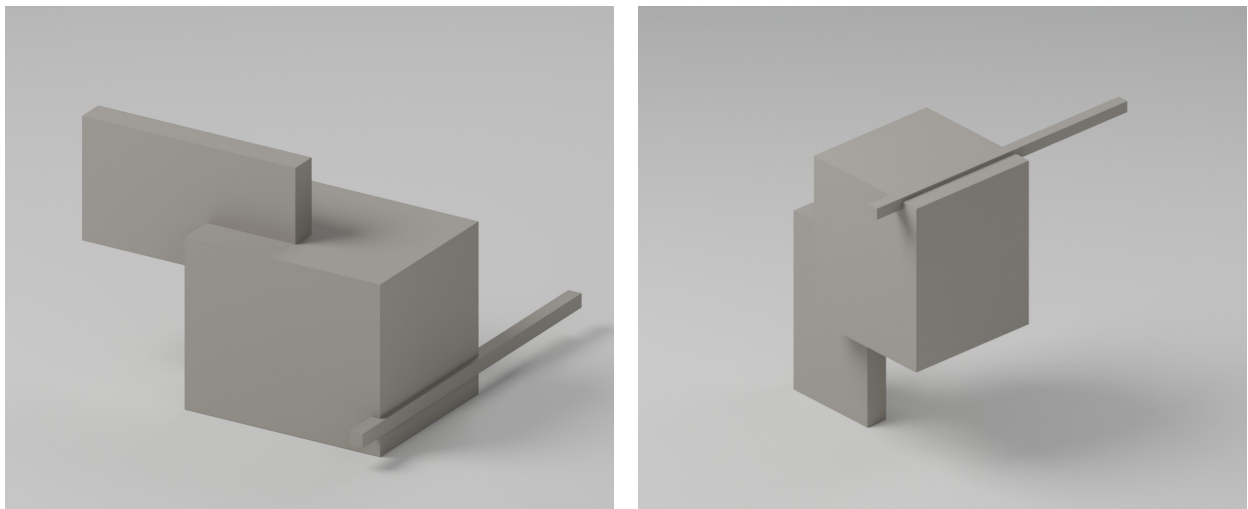


Fig. 3. Early Vizcom explorations generated from a line drawing, sampled at 0.2, 2.0, and 4.0 s (left to right). Materials such as leather and iridescent glass could be tried within seconds, but as the view rotates, the line-like form grows longer and the plane-like form shifts.



(a) Lying study

(b) Standing study

Fig. 4. The same three forms before and after the composition was stood up, rendered from the CAD model under identical lighting. (a) The mass rests on the ground, and the group reads as a stable pile. (b) The plane lifts the mass, and a space opens beneath it.

and finish (CMF) and rendering effects, such as iridescent translucent glass or stitched leather, almost instantly, whereas building them in CAD would take far longer. This makes it valuable for special or surreal effects, and my first experiments explored exactly that. The generated frames, however, did not keep the geometry fixed. Within four seconds, the line-like form grew longer and the plane-like form shifted. Because the final deliverables had to show the exact forms and spaces, I decided not to use Vizcom for them.

Table 1. The three forms, in mm. W, D, and H are each form's own dimensions; its position is given in the last column.

Form	Role	W×D×H	Position and joint
Mass-like	Dominant	90×90×110	Lifted; underside 80 above the ground
Plane-like	Subdominant	65×15×120	Stands on the ground; wedged 40 deep into the mass, deep enough to read as cradling; extends 40 beyond its left face
Line-like	Subordinate	7.5×200×7.5	Notched 5 deep underneath to grip the mass top, 2.5 proud; overhangs 20 front and 90 back
Whole group		130×200×192.5	

3.3 Establish: Fixing the Composition in Perspective

From these explorations, I selected one arrangement. In it, the dominant was a mass-like form resting on the ground, the subdominant was a plane-like form wedged into its upper corner and extending outward along the same horizontal axis, and the subordinate was a line-like form running front to back near the ground. Drawing this arrangement in two-point perspective with construction lines (Figure 2a) made me commit to specific proportions and joint positions and judge the forms in depth, not only as a flat elevation.

3.4 Develop: A Thinner, Longer Line

To increase the tension, I made the line-like form thinner and longer, settling on a 7.5×7.5 mm section and a length of 200 mm, a ratio of roughly 1 to 27. At this proportion the line reads as a direction instead of a small block, and because it extends beyond the mass, it draws the eye outward. However, while the composition lay on the ground, it still looked settled (Figure 4a). Its broad footprint made it read as stable and flat, closer to a pile of blocks than a gesture, and the space around it played no part in the composition.

3.5 Develop: Standing the Composition Up

Because the tension was still insufficient and I wanted the negative space to take part, I stood the whole composition up. I rotated it 90 degrees about its depth axis and kept every relationship between the forms unchanged (Figure 4b). After this change, the plane-like form stands on the ground and holds the mass-like form 80 mm above it. Together, the plane and the mass form a vertical axis 190 mm tall (192.5 mm including the line on top), and the 200 mm line forms a horizontal axis, so the composition now has two strong axes. A space opened beneath the mass that can be imagined as a transparent block, and the outline of the whole group began to resemble the mass-like form itself, like a larger box around a smaller one, which restored a sense of stability and balance.

This observation became my design intent. The space enclosed by the three forms should be readable both as transparent blocks and as empty air. When it is read as blocks, it supports the mass and completes a stable whole, and when it is read as air, the mass appears lifted and precarious. I intended the possibility of shifting between these two readings to sustain the tension.

4 FINAL DESIGN

Table 1 and Figure 5 define the final composition. The concept board states the solution as follows:

Rather than balancing the three forms through solid mass alone, the composition uses the negative form beneath the lifted mass-like form as an active visual counterweight. The plane-like form raises the mass-like form into a precarious position, while the line-like form extends in the opposite direction and strengthens the directional tension. Together, these relationships define a negative form beneath the mass that reads almost as a fourth element, restoring balance without resolving the tension.

4.1 Configuration and Proportion

I kept the inherent proportions of the three forms far apart: approximately 1 : 1 : 1.2 for the mass, 4.3 : 1 : 8 for the plane, and 1 : 27 : 1 for the line. No dimension is shared between the forms. By volume calculated from the outer dimensions, before the joints are cut, the mass is about 8 times the plane and 80 times the line, which makes the hierarchy clear. The dominant form sits at the top, the subdominant plane is the only form that touches the ground, and the subordinate line crosses the top of the group in the depth direction. Both joints use wedging and appear structural. The plane is wedged deeply enough into the mass that the joint also reads as cradling, and the line grips the top of the mass through a notch cut into its own underside instead of simply resting on it.

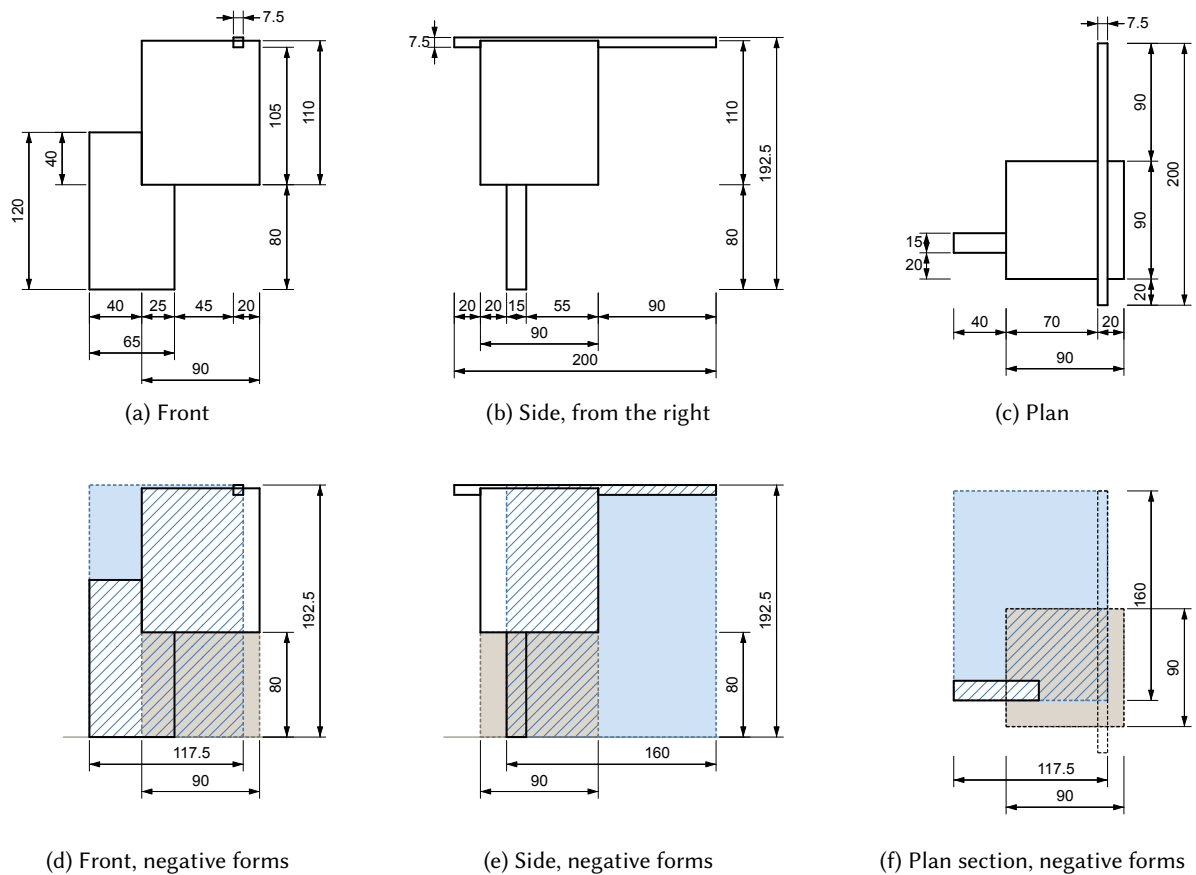


Fig. 5. Three-view drawings generated by the same Python script as the 1:1 A3 originals, redrawn here at 1:5.8 (dimensions in mm). The top row shows the three forms, and the bottom row shows the same views with the two negative forms. Gray is the footprint of the mass extended to the ground ($90 \times 90 \times 80$), and blue is the box spanned between the plane and the line ($117.5 \times 160 \times 192.5$). Blue hatching marks where the blue box overlaps the gray block or a form. The plan (f) is a horizontal section 40 mm above the ground, and dashed lines show the mass and the line above the cut.

Table 2. Where the similarity and the difference come from.

Similarity (consistency)	Difference (contrast)
One material and one color	Three types: mass, plane, and line
Right angles and perpendicular axes	Proportions from nearly cubic to linear
Two joints of the same kind (wedging)	A vertical stack against a line running in depth
An overall outline that echoes the mass-like form	Positions: grounded, lifted, and on top
Negative forms with mass-like proportions	Solid against void

4.2 Similarity and Difference

Table 2 lists where the similarity and the difference come from. Its last row extends beyond the three positive forms: the negative forms share the mass-like proportions of the dominant form, yet they are the only elements that are empty.

4.3 The Negative Forms

Figures 5d to 5f show how I read the negative space, which is organized by two negative forms. These are conceptual envelopes for reading the space, not measurements of empty space. The first, shown in gray, is the footprint of the mass extended down to the ground. This $90 \times 90 \times 80$ mm block lies directly under the lifted mass, and the plane passes through it to support the mass. The second, shown in blue, is a larger box spanned between the plane and the line. It extends from the outer edge of the plane to the outer edge of the line, from the front face of the plane

to the back end of the line, and from the ground to the top of the line, measuring $117.5 \times 160 \times 192.5$ mm. Because the plane marks one corner of this box and the line marks the opposite corner, the two thinnest forms define the largest form in the composition. The box has mass-like proportions of about 1 : 1.4 : 1.6, so the outline of the whole group reads as a larger version of the mass-like form, which was intended to give the composition visual stability. The mass sits mostly inside this box but projects 20 mm beyond it at the front and 12.5 mm at the side, so the box holds the mass without fully enclosing it. Beneath the mass, the two negative forms overlap (hatched area), and it is there that the reading of a supporting block is strongest.

This ambiguity is intentional. If the negative forms are read as transparent blocks, they carry the mass and the composition appears balanced; if they are read as air, the mass hovers 80 mm above the ground, held only at one edge. The line reinforces the second reading because it extends 90 mm behind the mass, so from the side, the top of the composition seems to be cantilevered into space. The tension between similarity and difference thus also becomes a tension between two readings of the same space.

4.4 Reading from Different Viewpoints

Because the plane and the line lie on different axes, the character of the composition changes as the viewer walks around it (Appendix B). From the front, the line is reduced to a 7.5 mm square at the upper corner, the plane reads as a broad panel, and the lifted mass and the dark space beside the plane dominate the view. From the side, this relationship reverses. The line becomes the longest edge, cantilevering 90 mm behind the mass, while the plane narrows to a 15 mm post, so the lift appears most dramatic. Oblique views show all three axes at once.

5 IMPLEMENTATION: PROTOTYPE

5.1 Making

I built the final prototype at full size from the three-view drawings, cutting each form from foam and joining the forms through two wedged joints. The plane enters 40 mm into the lower edge of the mass, and the line is notched 5 mm deep on its underside so that it grips the top of the mass. The prototype is one color throughout and is fixed to a separate dark gray foam board for carrying and display (Figure 6).

5.2 Trial and Error

Although the prototype looked simple on paper, it was difficult to make precisely, and three problems kept recurring.

- (1) *Sanding rounded the edges.* Making a face flat and square with sandpaper also wore down its edges, which made it difficult to keep the corners and vertices sharp.
- (2) *The line-like form broke easily.* With a 7.5×7.5 mm section and a length of 200 mm, the bar often cut unevenly or snapped when I notched it for the wedge.
- (3) *The notch depth had to be exact.* If the notch was even slightly too deep, the line sank into the wedged gap, and if it was slightly too shallow, the line had no room and bulged upward. More generally, keeping every face square in all three directions at once was much harder than making a single face flat.

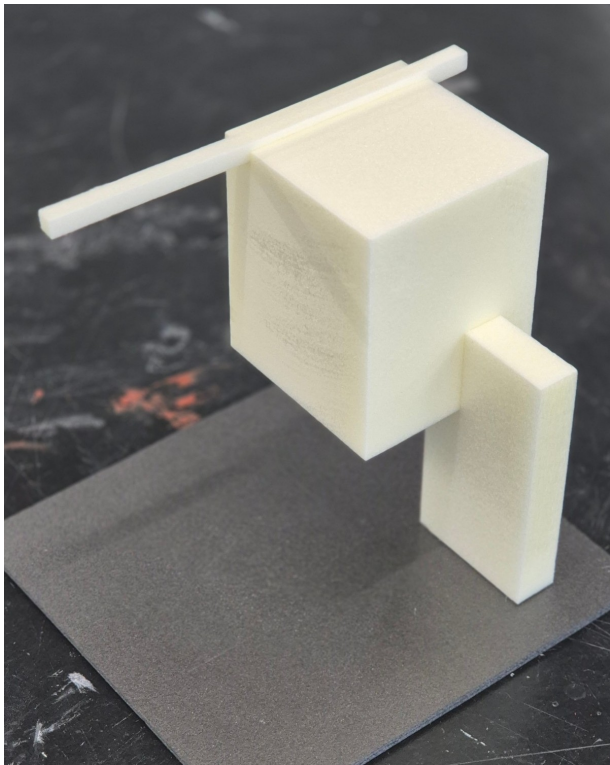
5.3 Changing the Method

Rather than persisting with the same tools, I changed them. I made as many cuts as possible with a hot-wire cutter, which leaves straight, square faces without crumbling the foam, cut the line-like form with a knife, and kept sanding to a minimum so that the edges stayed crisp. The result is clean and square at the scale of the whole composition, although parts of the finish still fall short of what I intended.

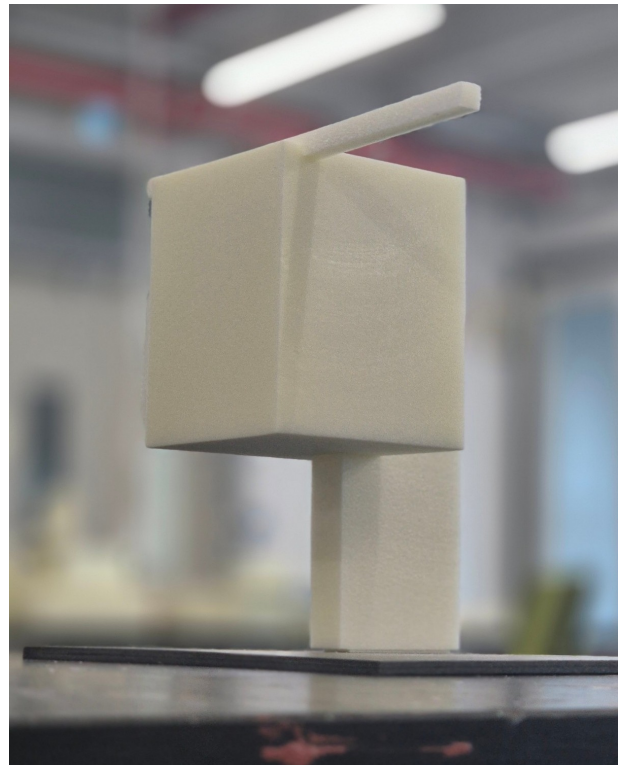
6 COMMUNICATION AND DIGITAL WORKFLOW

6.1 One Geometry for All Deliverables

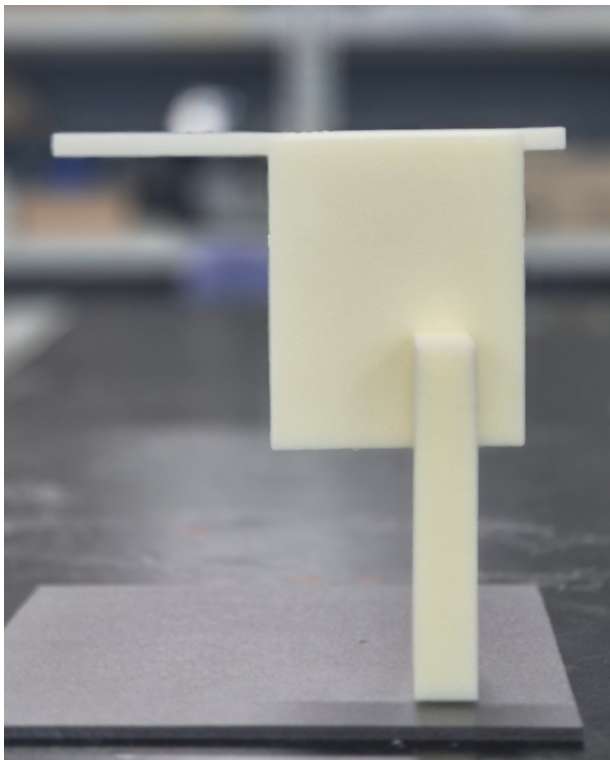
To keep the board, the animation, and the final prototype consistent, I used the dimensions measured from my initial foam study as the single reference for one fixed workflow (Figure 7). First, a Python script (matplotlib) generated 1:1 front, plan, and side drawings on A3 sheets, showing every dimension and only the visible lines. Figure 5 was redrawn with the same script, and I cut the final prototype from these drawings. Next, Claude, connected to Fusion 360 [2] through the Model Context Protocol [1], ran a Fusion API script that built the three bodies from the drawing dimensions, cut the joints, and exported F3D, STEP, and OBJ files. Blender [3] then rendered the same geometry, and during revisions I adjusted its material, light, and camera settings through a Blender MCP connection.



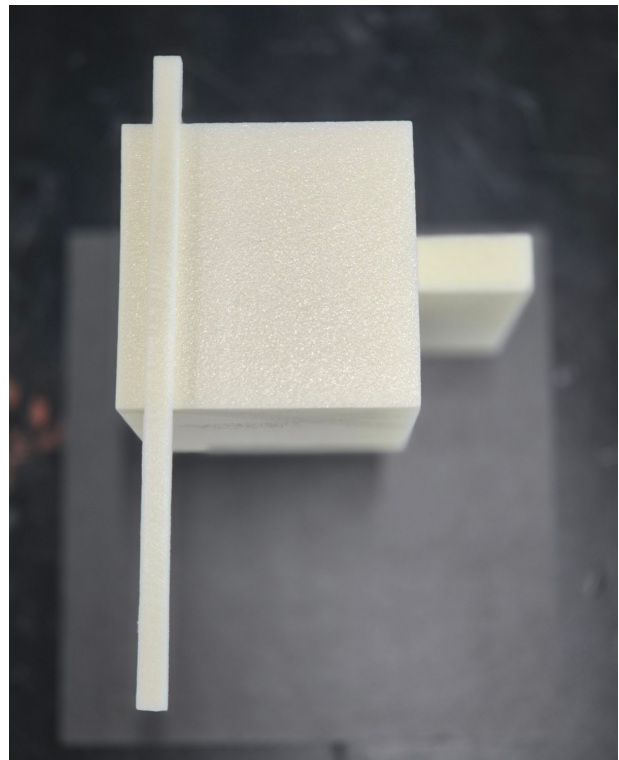
(a) Oblique view from above



(b) Low-angle oblique view



(c) Side



(d) Top

Fig. 6. The foam prototype, fixed to a separate board. (a) All three axes are visible at once. (b) The mass floats above the plane. (c) The line cantilevers beyond the mass. (d) From above, the line runs across the top of the mass and extends beyond it at both ends, while the plane projects to one side.

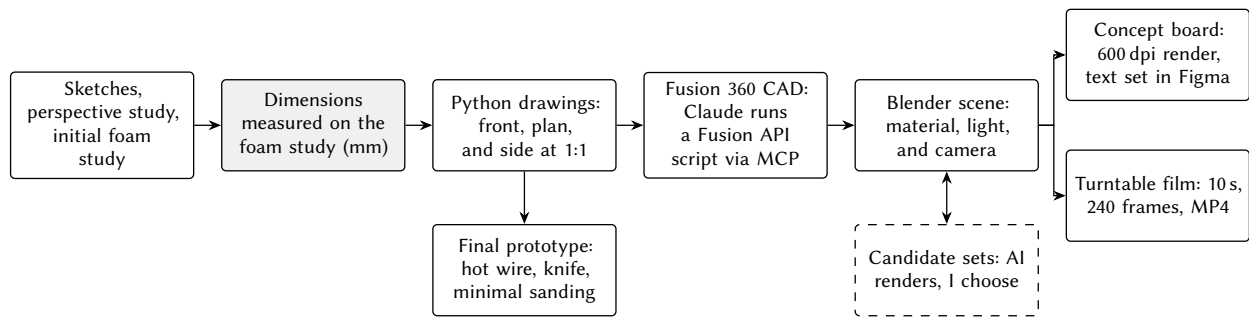


Fig. 7. A single geometry for all deliverables. Every output starts from the dimensions measured on the initial foam study, and the visual decisions were made in the candidate loop.

6.2 Concept Board: Hierarchy, Contrast, and Emphasis

The board (Appendix A) rests on three decisions about contrast, light and material, and hierarchy. I set up and rendered the image in Blender.

Contrast. The cream foam forms are placed against a near-black, warm gray background that darkens toward the top. A dark field gives the strongest figure-ground contrast for a pale model, and it turns the space under the lifted mass, which is the subject of the design, into a readable dark shape.

Light, shadow, and material. I wanted the render to look like a photograph of a real object in a quiet studio, not like a CAD image. A single warm light from one side gives each face a different tone, so the boundary between the plane and the mass remains legible, and long floor shadows place the forms on a surface instead of letting them float. A weak fill light keeps the shadowed faces from turning black, and a soft light on the plane keeps it from merging with the background. The material is a matte cream with the fine grain of sanded foam, neither glossy nor translucent, and a thin highlight along every edge makes the forms read as a physical model. The wedge on top casts a small shadow of its own, which makes the joint visible.

Hierarchy and layout. The design occupies most of the page. The main composition appears large and sharp, seen obliquely from the front right and slightly above its top, so that its front, right, and top faces are visible together. Behind it, the same composition, turned to show another side, appears smaller in perspective and very slightly out of focus, so that it reads as the same object farther away rather than as a smaller one. The text has its own hierarchy. The title, “Problem 1: Rectilinear Form Design,” is dominant, the headings and body text are subdominant, and the course name, my name, and my student number at the bottom are subordinate. I set the type in a thin, light weight so that it echoes the slender forms while remaining secondary to the design. The text blocks sit on a grid that I laid out with reference to the edges and vertices of the rendered forms, and the hierarchy is maintained within that grid.

Revision. In the first version, the light in my CMF setup was too strong and its effects too soft, which blurred the boundaries between the parts. After the professor pointed this out, I revised the board so that the form itself could be seen and evaluated clearly while still being appreciated aesthetically.

6.3 Candidate-Set Iteration

Many decisions for the board and the animation were visual judgments that I could recognize but not specify numerically, such as how long a shadow should be, how strong the foam grain should appear, or how wide an edge highlight should be. For these decisions, I used a simple loop. I asked Claude to render a numbered set of three to six candidates at the same framing, each changing one controlled parameter from the current best version. I compared the candidates side by side, chose one, and described what still needed to change. The next set then started from my choice, so the options narrowed with each round.

The board went through more than ten such rounds, first for lighting and shadow (Figure 8) and then for foam grain and edge radius (Figure 9). The final render combines lighting K3, grain Q4, and a 0.8 mm bevel (B8). The loop worked well because comparing concrete options was much easier than describing a look in words, and changing one parameter at a time made cause and effect visible. Recording every choice and its reason also kept it clear which decisions were mine.



Fig. 8. Selected steps from the lighting rounds for the board render, all at the final framing. (a) Rejected because the light looked harsh and the forms looked like poorly made CAD. (b) The first accepted direction, with a long, soft floor shadow. (c) A wider highlight on the lit edges. (d) A smoother background gradient. (e) Sharper shadows, cast farther forward. (f) The final version, with a soft light that separates the plane from the background.

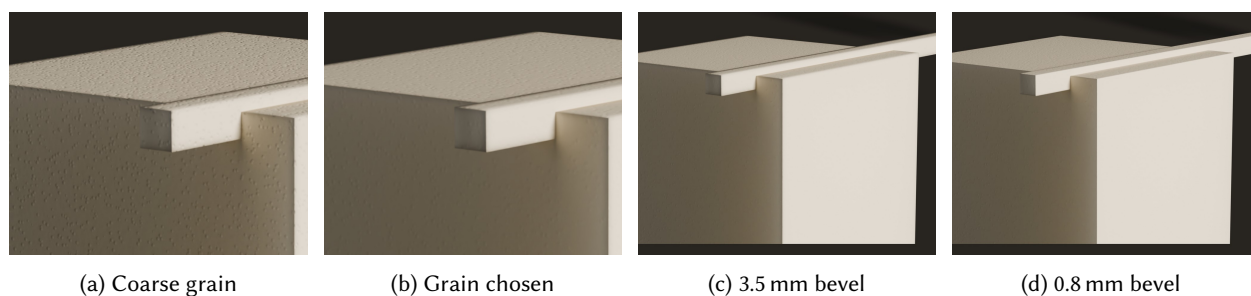


Fig. 9. Material and edge details: the finer grain (b) reads as sanded foam, and the 0.8 mm bevel (d) keeps the edges crisp.

6.4 Animation: Rendering Instead of Generating

To remove uncertainty, I rendered the animation in Blender from the exact CAD geometry. My early tests had shown that generated motion can alter the forms within seconds, whereas this concept depends on the precise negative space within the composition. In the final film, the camera and lights remain fixed while the composition makes one full turn in 10 s about a vertical axis through the center of the mass, like an object on a turntable. The film begins and ends at the board's viewpoint, eases in and out, and was rendered remotely on a desktop GPU (NVIDIA RTX A6000, 48 GB VRAM) with a fixed sample count and strong denoising to prevent flicker.

An earlier 5 s version turned the composition only about halfway, so I extended the film to 10 s to show a full turn. I then refined the lighting over four candidate rounds (Table 3, Figure 10), aiming for light that looks natural: the shading on each face should change gradually rather than abruptly as it turns toward or away from the light,

Table 3. Lighting rounds for the 10 s animation. Each round started from the candidate chosen in the previous round.

Round	What changed	My choice and reason
V0 to V3	Fill and ambient light, and the size and height of the key light	V2, for the best overall balance. V3 had the best shadows but washed out the top face against the sides.
W1 to W3	Key light split into a small, sharp light and a large, soft one	W3 (recommended: W2), for darker, clearer shadows under the line; mass and plane still merged at 5 to 7 s.
X1 to X4	Contact shadows, and a fill light moved closer to the forms	X4 (recommended: X3), for the strongest separation between mass and plane.
Z1 to Z3	Stronger and wider contact shadows, and a closer fill light	Z3 (recommended: Z2), for the strongest separation; accepted as final.

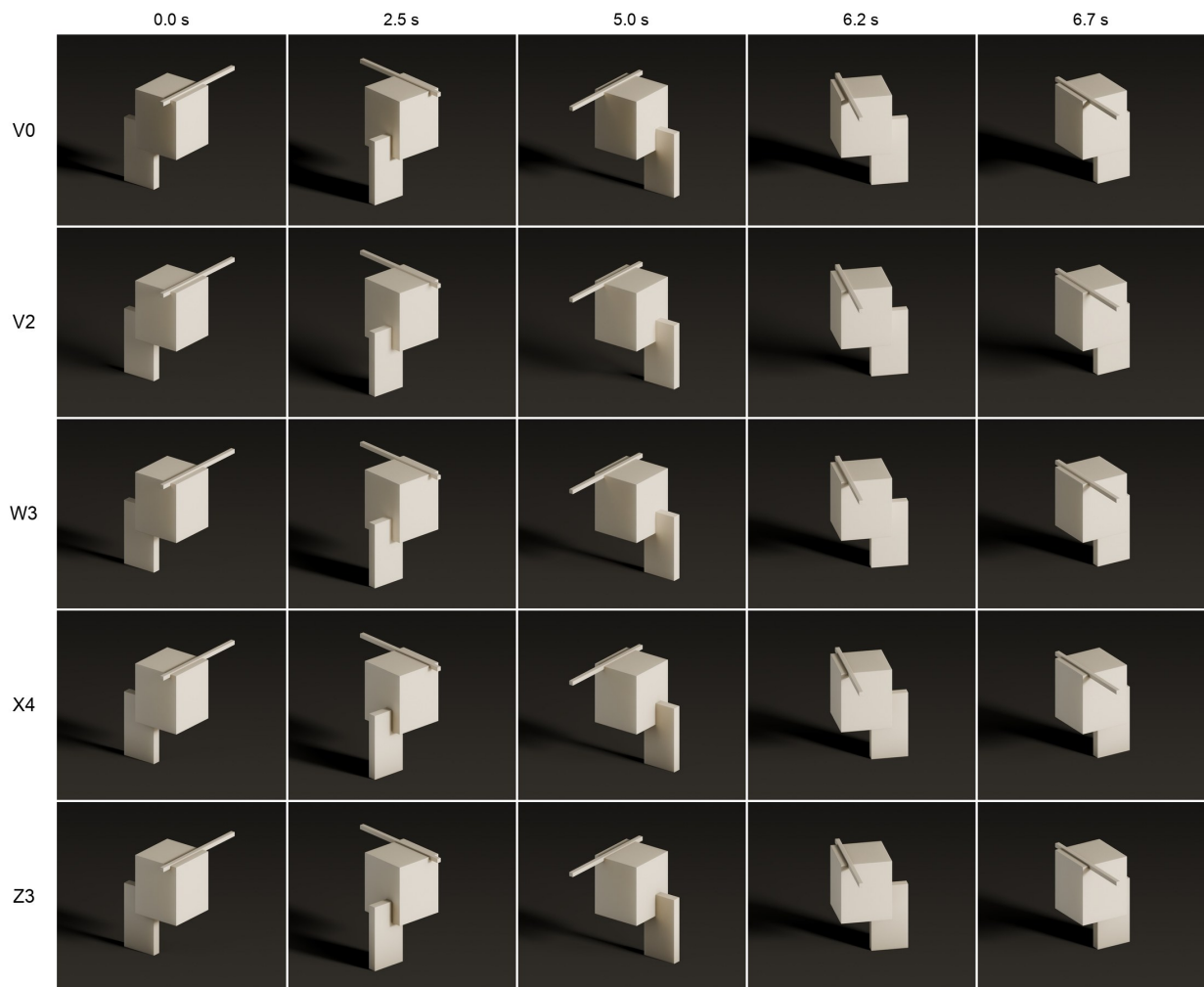


Fig. 10. The chosen path through the lighting rounds (rows) at five moments of the 10 s turn (columns). In Z3, a darker plane and a contact line separate the mass and the plane at 6.2 and 6.7 s.

while the outlines stay visible enough to keep the forms clearly separated. In each round I chose the most promising candidate by eye. When no option was clearly better, I discussed the candidates with Claude, gave feedback on each, and decided from the preview frames that promised the best result before rendering the final film. In three of the four rounds, my choice differed from Claude's recommendation, favoring stronger shadows and clearer separation over slightly smoother light.

6.5 Human-AI Collaboration

Throughout the project, I considered, as a designer, which tasks could be automated. Tasks that could be expressed as rules, such as building the geometry, drawing, rendering, and generating candidates, were assigned to AI, while the concept, the forms, the proportions, and every aesthetic choice remained mine. Dividing the work in this way led me to think carefully about how humans and AI should collaborate in design.

This experience led me to question how far AI can support the parts of design that depend on value judgments and aesthetic taste, on abductive reasoning that goes beyond deduction and induction, on the kind of thinking that leads to paradigm shifts, and on tacit, embodied knowledge. In this project, as the lighting rounds show, I still relied on my own judgment to decide which results matched my intentions, and on hands-on making, such as the feel of cutting foam with a hot wire, to understand the forms. During ideation, I had already noted in my workbook that humans are still better than AI at design, although this might change within ten years (Figure 2d). Paradoxically, AI could automate as much as it did here because the rectilinear brief is so constrained. Since everything follows right angles and fixed rules, AI could build the geometry by rule, and the three-view drawings were produced accurately with little trial and error. I expect this to be much harder in the upcoming curvilinear and organic projects.

7 CRITICAL EVALUATION

The negative space is too large. The professor observed that the space around the mass was so large that it no longer read as negative space and that the mass simply appeared to float. I agree with this assessment, and the dimensions help explain it. The 80 mm lift is 42 percent of the total height. From the side, the plane shrinks to a 15 mm post beneath a 90 mm deep mass, so about 80 percent of the band beneath the mass is empty. By volume calculated from the outer dimensions, the blue envelope is about four times the mass, and the gray block beneath the mass is about 70 percent of it. A negative form larger than the dominant positive form competes with it. With so little to close the space, the eye stops completing a block, and the intended ambiguity collapses into a single reading, that of a floating mass. The space was active but not shaped tightly enough.

The dark base board hides the shadow. I mounted the prototype on a dark gray board because I considered only its contrast with the cream foam. On such a dark surface, the shadow of the mass barely shows. A lighter foam board would have caught this shadow and given the negative forms a visible footprint on the ground, helping the space read as a shape rather than a gap.

Balance is visual, not physical. Assuming uniform foam density and excluding the display board, the combined center of mass lies about 15 mm beyond the plane's footprint in width and about 9 mm in depth, so the prototype cannot stand on the plane alone and is fixed to its board. I intended the negative forms to supply the missing support visually. When that reading fails, as described above, the composition shifts from precarious toward impossible.

8 CONCLUSION

This project aimed to hold tension and balance in a single rectilinear composition by letting the enclosed space, read either as supporting blocks or as air, do part of the work. The main views communicate the intended lift and directional tension, but the negative space does not consistently read as a supporting form, because a space this large is seen as a gap rather than a form. If I were to do this project again, I would pay closer attention to the size of that space. I would reduce the lift and consider wedging the line-like form into the lower part of the mass instead of its top, so that the line helps enclose the space beneath the mass and the negative space reads more concretely. The project has also changed how I work. I now treat negative space as something to be shaped as carefully as the solid forms, I generate every representation from one exact geometry, and I use AI for speed and comparison while retaining responsibility for the final design decisions.

ACKNOWLEDGMENTS

I used generative AI (Claude Opus 5.5; 23 September 2026) mainly for LaTeX conversion and ACM typesetting.

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A CONCEPT BOARD

The A3 concept board as submitted, showing the main composition seen from the front right, with the same composition turned to show another side behind it (Section 6.2).



Fig. 11. The concept board.

B ANIMATION KEY FRAMES

Twelve frames from the 10 s turntable animation, which begins and ends at the board's viewpoint. The side views at 3.8 and 8.3 s show the space beneath the mass at its widest.

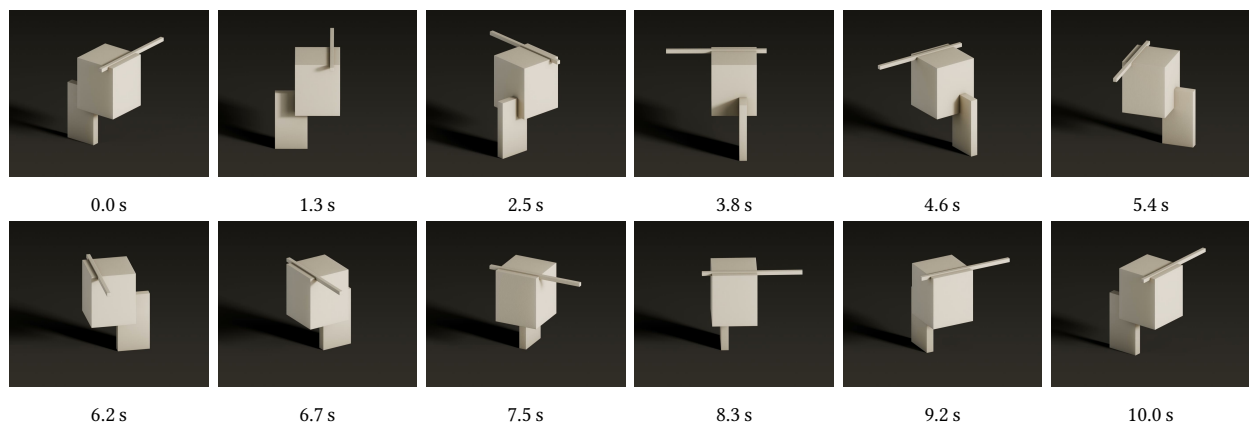


Fig. 12. Key frames of the 10 s animation.