Design Challenge II: Opportunistic DfAM

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ELECTRONICS OUTLET SUPPORT
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Charging a cellphone or any electronic device always ends up with messy wiring and laying electronics on the floor. What if the phone could simply be deposited on the outlet? Additionally, how about a charging cable organizer and a more sophisticated look for the outlet?

This design challenge consists of redesigning an "Electronics Outlet Support" (A. Smith, 2017, https://grabcad.com). The original outlet Support (Figure 1) includes three parts, printed separately and glued to the wall.

The redesign should incorporate part consolidation (decrease the part count to one, so the whole structure prints as one piece), weight reduction (decrease consumed print material), and be aesthetically pleasing. Moreover, the basic functions of a wall outlet support should be achieved (attaching to the outlet without the use of glue, securely holding the phone, organizing the charging cable, and adding an extra function).

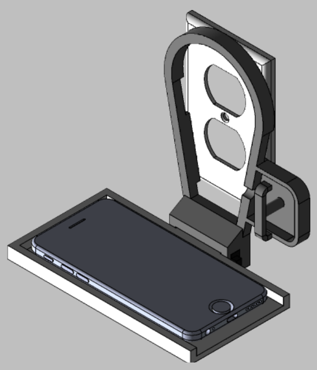

Figure 1: Original Electronics Outlet Support

Design

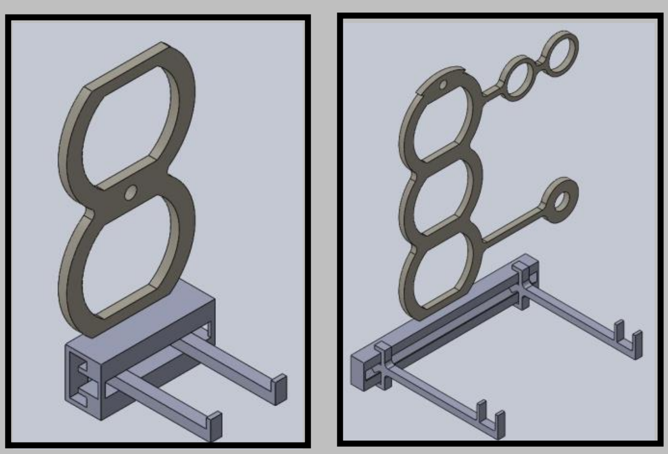

Figure 2: Isometric view of full structure: left represents the first iteration & right represents the last one

Various design iterations lead to the final product (Figure 2). Most iterations changed the sizing, while others completely changed the design as a whole. The goal was to maintain the role of the original file while adding a new function. This redesign has three outlet attachers with similar geometry to the wall outlet for a perfect fit. The hole on top of the attachers has a diameter equal to the outlet's screw (the screw helps keep the structure locked in and steady). Two rods with hollow circles serve as cable organizers. The bottom part of the structure (a printed assembly with two rods that can move back/forth) helps hold the phone.

Making this part using traditional manufacturing is extremely difficult (the printed assembly has the two rods enclosed inside the pathway). Additionally, it requires multiple elements, assembling them one by one, and possibly welding. The time and material saved using Additive Manufacturing (AM) are noticeable. Functional complexity (the ability to generate an assembly in one build) acts as an enormous time-saver, promoting efficiency. Furthermore, large solid sheets of material are tremendously reduced, especially on the support tray.

Incorporating new functionalities shouldn't be forced; missing ideas are more relevant than random ones. The new, useful functions, are listed below:

- The printed assembly accommodates several types of devices (phone, earbuds, watch, etc.). The moving rods can be used separately (to hang items, such as keys) or together (to deposit a device, such as a phone)
- The bottom cable organizer's (the rod with a single circle) role is to hold the cable at a specific location
- The three outlet attachers can have the outlet support hanging at different heights, allowing the user to decide depending on the outlet's location

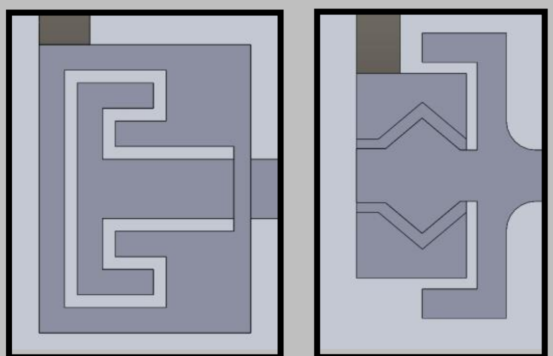

Figure 3: Cross Section of Assembly: left represents the first iteration & right represents the last one

Challenges

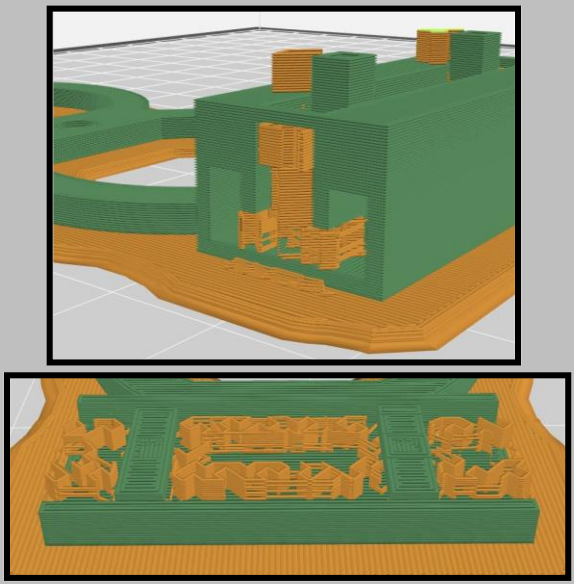

Figure 4: Lumpy surfaces caused by support material

The first set of iterations, which used the rectangular pathway (Figure 3), achieved all the needed functionalities. The issue was the post-processing phase; support material filled up the structure and made it extremely hard to clean. This fact decreased the structure's efficiency during production, making it time-consuming. The solution is the introduction of a new pathway (right of Figure 3). The new path uses self-supporting angles and greatly diminishes support material. A bit of bridging (on the outside) still requires post-processing but is very minimal. Consequently, the first iteration had very lumpy surfaces (Figure 4), making the motion far from smooth. This issue disappeared in the last iteration as well.

Creating and altering the 3D geometry was a smooth process, and issues only appeared while using nTopology (add-on for this project). AM caused the most problems when it came to support materials, and still needs to be perfected. The final printed design is illustrated in Figure 5

Comparison & Reflection

The original design, made of three parts (support base, support tray, and support pin), required 7 hours and 41 minutes, consuming 100.47g of material in total. The single print redesign needed 4 hours and 18 minutes, utilizing 29.32g of material.

Since this challenge only had a two-week work period, some extra functionalities were overlooked. The next steps would include :

- Hierarchical complexity (lattice structures rather than plane surfaces)
- Full independence from supports (even though supports are minimized, completely rejecting them is optimal)
- Reduced stress concentration (especially on the edge between the attachers and the sliding assembly)
- Compliant mechanisms design to the sliders for a deflection load

The functionality of this redesign, which was done in 2 weeks, already beats the original one (which took 2 years to design), and a lot of improvement can still be applied to it.

Figure 5: Final Printed Design