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Design and Build of an Aircraft Smart Table Using Additive Manufacturing and Topology Optimization

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Aircraft cabin interior design is crucial for business jets as it directly impacts passenger comfort, productivity, and overall experience. Manufacturers are increasingly integrating electronics into cabin components to improve accessibility of the cabin control user interface. This integration poses a complex design challenge, accommodating space for electronics while meeting structural requirements. The objective of this work is to design and manufacture a business jet smart table using additive manufacturing and topology optimization to address these challenges. First, the smart table design concept and manufacturing methods are introduced. Topology optimization is performed to determine the internal stiffening structure to be produced with metal additive manufacturing. Results are interpreted into a CAD model, while considering additive manufacturing constraints. The design of the polymer shell and integration of internal electronic systems is discussed. Finally, the design is numerically validated to meet performance requirements, and a prototype is manufactured. The design concept produced in this work successfully incorporated additional electronic features into the business jet table through advanced topology optimization and additive manufacturing technologies.

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I. Introduction

The interior of a business jet must be elegant, technologically advanced, and convenient, while also meeting strict aircraft certification requirements. The Bombardier Global 7500 and 8000 have flight distances of 7,700 NM and 8,000 NM, meaning that passengers can expect to be in the air for up to 13 hrs and 14 hrs, respectively [1] [2]. Some cabin arrangements have a priority passenger seat that typically offers more space, enhanced comfort, and easier access to amenities or other exclusive features available on the aircraft. It is among the most important areas of the cabin for passenger comfort and was determined to be one of the crucial factors influencing a passengers' perception of value [3]. Whether working, sleeping, eating, or watching a movie, this area needs to adapt and support the priority passenger all within an arm's reach. While there are some controls directly on the seat to adjust ergonomic comfort, most of the controls for cabin features, such as lighting, temperature, entertainment systems, and communication, are designated to a limited console area or surrounding partition walls as shown in Fig. 1. The useability of these systems is therefore limited due to either a simplified user interface or inconvenient accessibility from the priority seat. The integration of electronics into a deployable smart table for the priority passenger seat allows for cabin feature controls to be moved from the console and partition wall to a more natural position. This improves ergonomics and allows controls to be more feature rich, improving the cabin comfort experience and ultimately expanding the area available for user interface controls.

a) b)

Fig. 1 *nice Touch CMS (Cabin Management System)* currently in Bombardier Global 8000 and 7500 aircrafts. a) Console touch dial. b) Partition wall suite controller [4].

Integrating electronics directly within the deployable table requires a complete redesign of its internal structure to accommodate additional internal cavities and wire routes between components. This can be accomplished with topology optimization (TO), which is a computational design tool used to optimize the layout of material within a given design space. The goal of TO is to find the most efficient use of material for a specific objective in a given design domain, while adhering to certain constraints such as loads, boundary conditions, and manufacturing limitations. Topology optimization is increasingly being used in the aerospace industry to design light weight structures that ultimately improve the performance and efficiency of an aircraft [5]. Applications of TO has been seen in a business aircraft seat [6], a landing gear assembly [7], and an aircraft wing [8]; collectively demonstrating the widespread application of TO in the aerospace sector and emphasizing its role in achieving optimal designs for aircraft components.

Additive manufacturing (AM) is a manufacturing method by which material is added layer by layer to construct an object, often called "3D printing". This contrasts with more traditional subtractive manufacturing methods such as drilling, milling, lathe, etc. This allows for more complex geometries to be produced compared to its subtractive counterparts. Paired with TO, this allows the geometry to be manufactured and perform truer to its original optimized design. Design for additive manufacturing (DfAM) is the process of designing components considering the constraints of a given additive manufacturing process. This typically involves design considerations such as overhang angle, print orientation, print bed volume, minimum wall thickness, etc. [9]. In the aerospace industry, AM can save resources, cost, and time [10]. While still a relatively new manufacturing method, AM is shown to provide many benefits through the redesign of aircraft components [11]. Previous work explored the conceptual design of a business jet smart table using metal and plastic AM, however TO results were not carried forward past the design exploration phase [12].

The objective of this paper is to design a deployable smart table for a business jet from concept to prototype, leveraging TO and advanced additive manufacturing techniques. First, an overview and outline of the problem definition is reviewed, followed by TO of the internal frame, interpretation of the metal and polymer components, and detailed design of the system integration. The design is then numerically validated, and the manufacturing process is showcased from the 3D printing of components to the prototype's installation in a mock-up business jet cabin.

II. Problem Definition

A. Feature Integration and Layout Configuration

The integrated electronics system was designed to provide enhanced cabin comfort controls, auxiliary lighting, handheld device charging, and improved speaker sound coverage. The smart table is physically separated into inboard and outboard leaves as shown in Fig. 2.

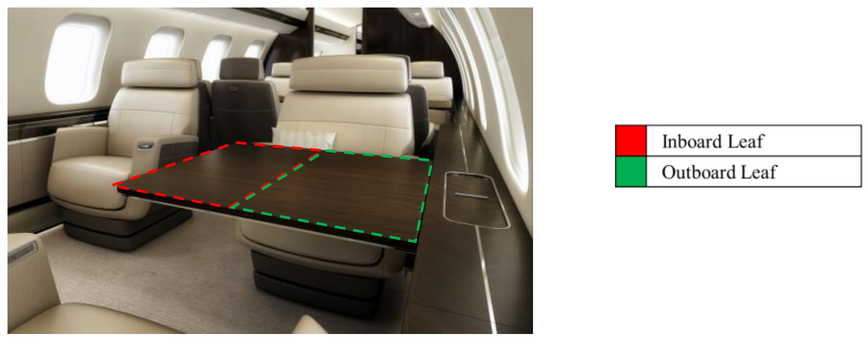


Fig. 2 Global 7000 Mock-up interior with inboard and outboard sections outlined. Adapted from [13]

Key features of the smart table include a touch display, magnetic position sensor and LED lighting in the inboard leaf, and a wireless charger, speaker and other supporting electronics in the outboard leaf. The layout and wiring of these components are outlined in Fig. 3.

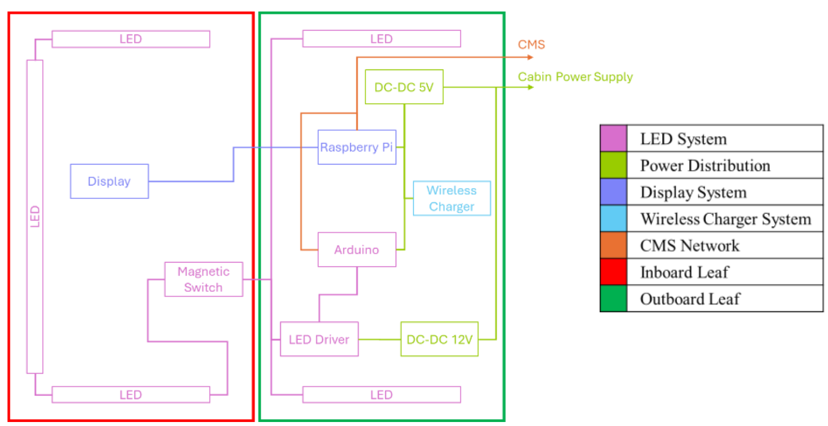


Fig. 3 Electronics configuration diagram.

Additional components such as a Raspberry Pi, Arduino with ethernet shield, LED driver, and DC-DC converters were integrated as support electronics. The display and wireless charger were laid out to be ergonomic and accessible to the priority seat while the table is being used during activities such as eating or working, for example. This places the display and wireless charger towards the perimeter to ensure accessibility.

B. Shell and Frame Performance Requirements

The table structure was separated into two main components: the external shell and internal frame as shown in Fig. 4. The external shell provides a smooth flat surface for the exterior finish as well as mounting for the electronic system inside, while the internal frame is primarily responsible for the structural rigidity of the assembly to meet the aircraft certification requirements.

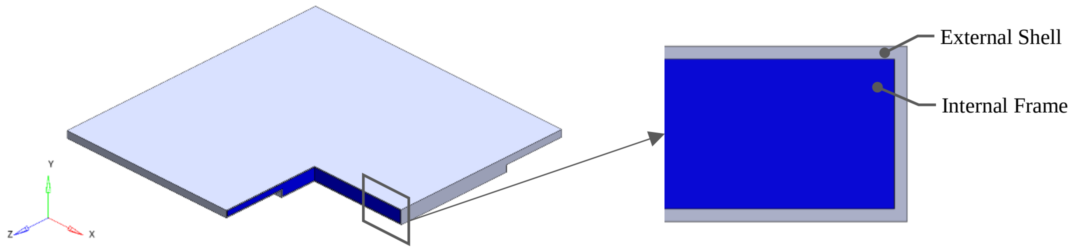


Fig. 4 Sectional view showing external shell and internal frame.

The outer geometric dimensions of the design space are 26.75 in x 27 in x 0.69 in (LxWxH) and were provided by Bombardier. These. Additionally, the table is mounted on two frame arms for the stowage mechanism. To maximize utilization of the space and provide an internal cavity large enough to fit the electronic system, a portion of the bottom face between the stowage frame arms was extruded to match the frame arms protrusion of 0.75 in. 2D drawings of the table envelope are shown in Fig. 5.

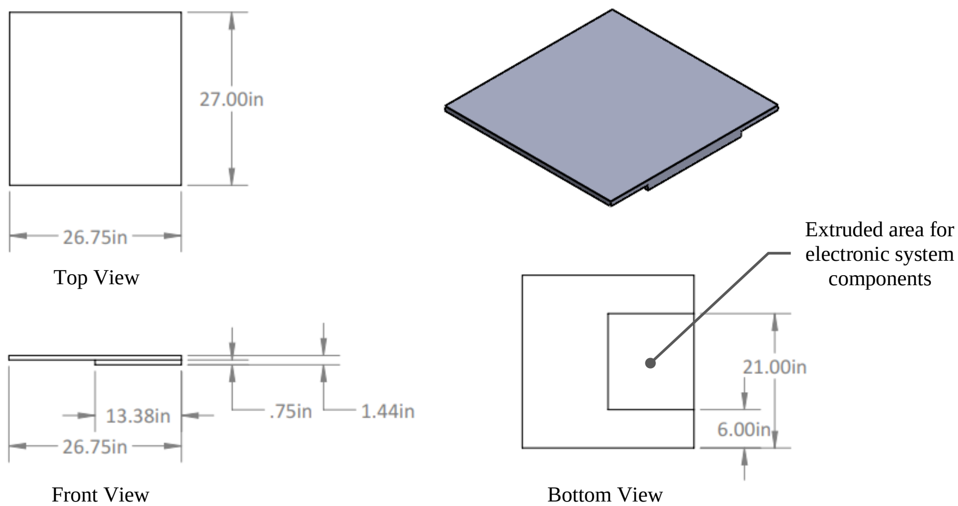
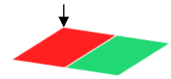
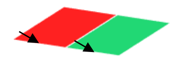
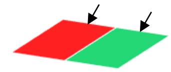
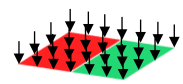


Fig. 5 2D drawing of table envelope.

Performance requirements were provided by Bombardier such that the allowable end deflection, when unfolded, under a 35 lb load applied on a 3 in x 3 in area at either inboard corner shall not be greater than 0.2 in. This loading scenario is represented as load cases 1 and 2 in Table 1. In addition to these load cases, four more cases were included to ensure a holistic design by simulating other common loading scenarios the table may experience during typical usage.

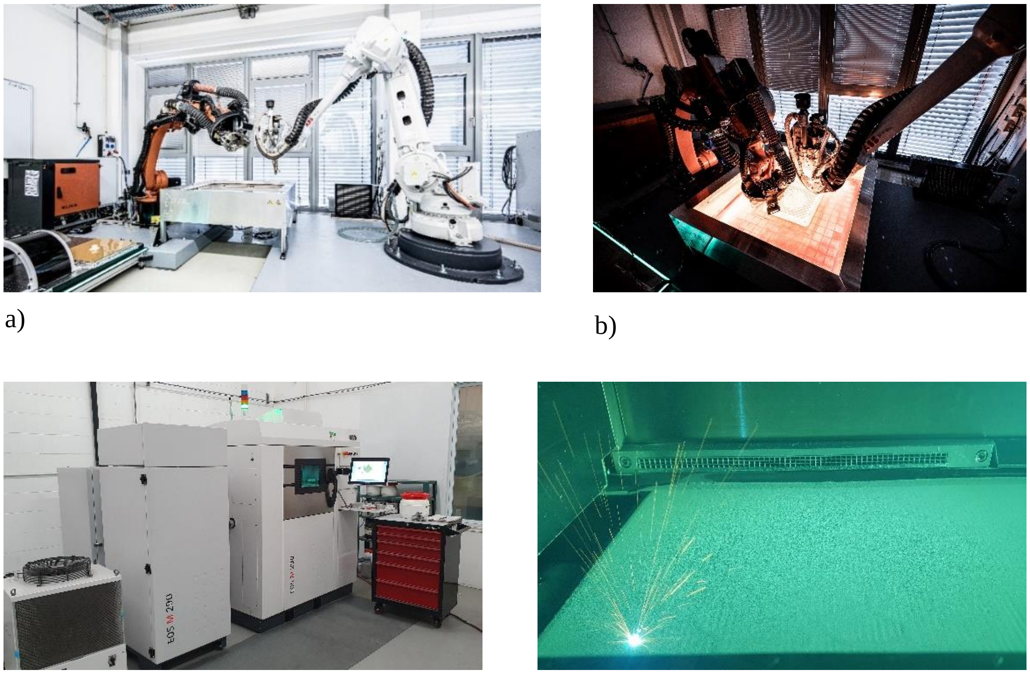
Table 1 Loadcases for TO and verification

Load case #	Name	Type	Magnitude per load (lbf)	Performance requirement	Graphical example
1	Corner 1	Force	35	End deflection < 0.2 in	
2	Corner 2	Force	35	End deflection < 0.2 in	
3	Edge	Force	35	N/A	
4	Elbow 1	Force	17.5	N/A	
5	Elbow 2	Force	17.5	N/A	
6	Tabletop	Pressure	35	N/A	

Inboard Leaf Outboard Leaf

C. Manufacturing Methods and Materials

The smart table was designed to be manufactured using polymer and metal AM processes. The polymer AM process was conducted by ZAL Center of Applied Aeronautical Research in Hamburg, Germany, while the metal AM process was conducted by FusiA Groupe in Quebec, Canada. The polymer AM printer featured a larger print volume and faster volumetric printing speed in contrast to the metal AM printer which had a smaller print volume but higher precision. The polymer printer utilized by ZAL was a customized ABB 6-axis robotic arm equipped with an AE16 extruder by Weber Maschinenfabrik / Kronach. It has a printing volume of 1,000 mm x 1,000 mm x 1,500 mm, can achieve a minimum layer height of 0.5 mm with a 1mm nozzle, and can print at speeds up to 100 mm/s. The metal printer utilized by FusiA was an EOS M290. It has a printing volume of 250 mm x 250 mm x 300 mm and for the material used to manufacture these components, it can achieve a minimum layer height of 30 µm, with printing speeds up to 7.4 mm^3/s, and has a 370 W power laser. Both printers are shown in Fig. 6.



a) b) c) d)

Fig. 6 a) Polymer printer machine. b) Polymer printing with infrared heat bed on. c) Metal printer machine. d) Metal print bed close-up during printing.

The materials used for polymer and metal AM processes are Bayblend FR3010 and AlSi10Mg respectively. Components manufactured from plate metal used 6061-T6 aluminum and the hinges were manufactured from 416 stainless steel. Properties of all materials considered in the design can be found in Table 2.

Table 2 Polymer and metal material properties

Material Type	Material Name	Young's Modulus [GPa]	Density [g/cm^3]	Yield Strength [MPa]
Polymer AM	Bayblend FR3010* [14]	2.34	1.18	44
Metal AM	AlSi10Mg* [15]	70	2.67	215
Metal plates	6061-T6 Aluminum [16]	69	2.77	275
Hinge	416 Stainless Steel [17]	200	7.8	275
Veneer	Veneer*	11	0.65	N/A

* Values found experimentally by manufacturer.

Given the properties of each material and considering the capabilities of each AM printer, the polymer material is best suited for the exterior shell that will have the largest dimensions and require less precision compared to the internal frame. Metal is best suited for the internal frame as this material has better mechanical properties to provide the most rigidity. It also has a higher printing precision required for the aligning and assembly of the internal frame, which will have to be separated into multiple parts for manufacturability and cost. Additionally, the metal AM process can produce finer details and steeper overhang angles, improving design freedom and ultimately reducing the amount of modification to the optimized design needed during the interpretation process. This allows the interpreted design to more closely match the performance achieved of the TO results.

III. Topology Optimization

A. Finite Element Model

To conduct TO, a finite element model (FEM) of the table design space was created. Cut-outs are included for the display, electronics cavity, cavity access panel, and hinges. Overall, the model contains approximately 3 million elements. The FEM is constrained by two pairs of bolts located at the base of the support arms represented as single point constraints (SPC) in Fig. 7. The support arms and bolts represent the stowage mechanism that the table is mounted to and are included to replicate the reaction forces more accurately when loading the table. The six loading cases from Table 1 are exerted on the table as outlined in Fig. 7, each as a separate load step. The first five loads are applied using RBE3 elements to distribute the load over a defined area while the tabletop load is applied as a pressure load across the entire top surface of the table.

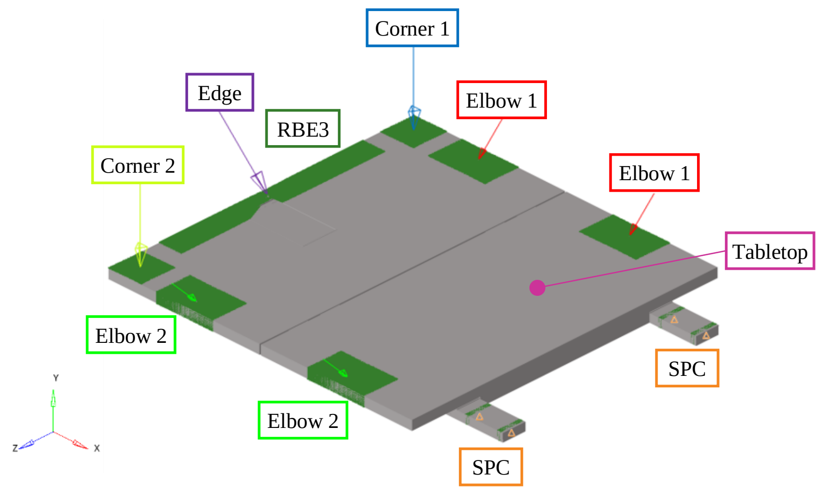


Fig. 7 Finite element model forces and constraints.

As previously discussed, the exterior shell is to be manufactured from polymer material and the internal frame from metal material. As the purpose of the shell is to provide a continuous exterior surface for the veneer and lacquer, and the polymer material provides minimal structural rigidity in comparison to the metal material, its use is minimized in the design. As such, the shell thickness is set as thin as the minimum allowable printing thickness, specified by ZAL. The exterior shell is specified as a non-design region while the metal internal frame is specified as the design region and is the component that will be optimized using TO. Also included in the non-design region is the veneer and hinges; as the veneer contributes tensile strength to the exterior shell, and the hinges connect and transmit a load on the inboard to the outboard leaf. To mount the hinges to the inboard and outboard metal frames, a non-design region denoted as “hinge block” in Fig. 8 is designed to help reduce deflection between leaves and is to be incorporated into the metal structure after TO. Lastly, the electronics system was not considered in the FEM as it is not load-bearing and its exact location was to be adjusted based on the TO results. The table assembly components are shown and outlined in Fig. 8. The mating layers are joined by freeze contacts to represent bonding between components during the assembly of the smart table.

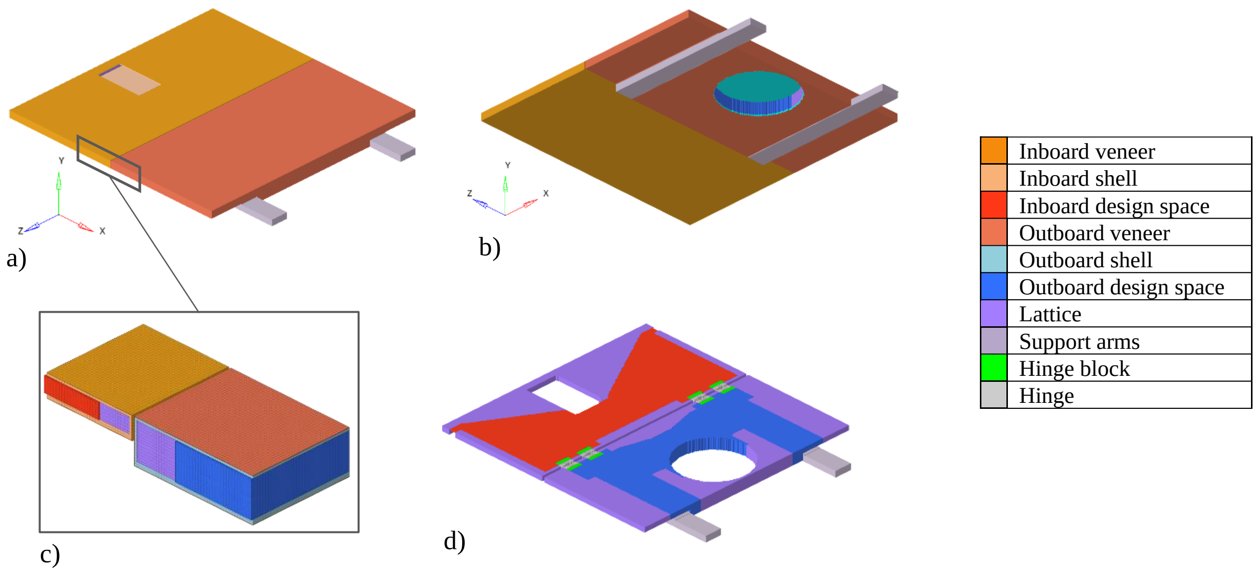


Fig. 8 a) ISO view of FEM top surface. b) ISO view of FEM bottom surface. c) Sectional view showcasing the layers of component elements. d) ISO view of top surface with veneer and shells hidden showcasing the layout of component elements.

B. Topology Optimization Results

The topology optimization was completed using Altair OptiStruct, with a computation time of approximately three days to complete on a Windows 10 PC (16 cores, 3.5GHz, 128 GB RAM). The optimization objective was to minimize mass subject to displacement constraints of 45 mm at each inboard leaf corner. Optimization results are shown in Fig. 9, with the external shell elements and support arms hidden to reveal the internal metal structure. Topology optimization of the inboard leaf resulted in a sandwich panel style design where the top and bottom are solid plates while a web-like structure is sandwiched in the middle. This web-like structure begins at the hinges and extends to where the elbow and corner loads were applied. Topology optimization of the outboard leaf resulted in a flat plate design starting at the hinges and extending along the support arms against the top surface of the external shell. Long thin members extend down to the external shell bottom surface, similar to the vertical web elements of an I-beam. These outboard sections are connected to each other by a thin arcing structure which also surrounds half of the electronics cavity. As expected, since the load cases are mirrored about the x-y plane, so is the TO result.

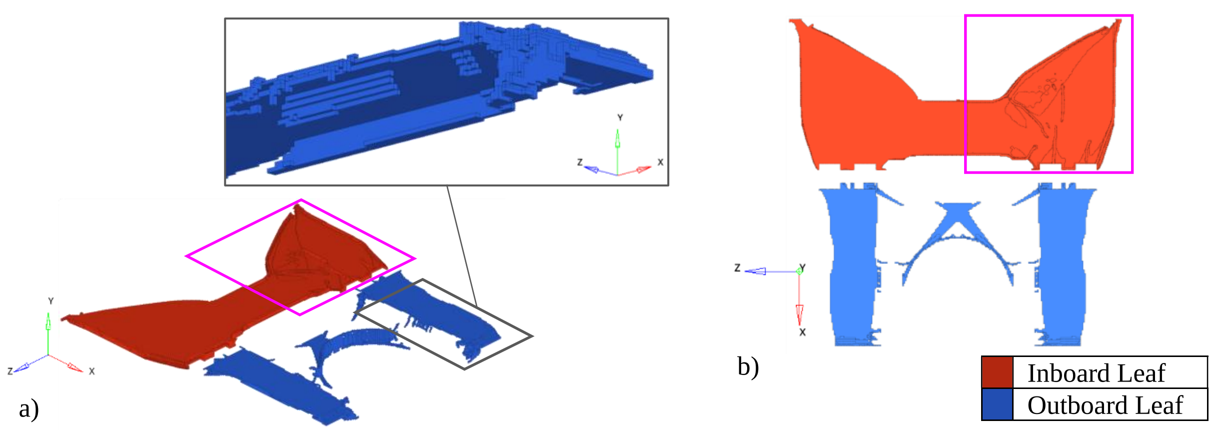


Fig. 9 Topology optimization results of inboard and outboard design spaces from Fig. 8 showing a) ISO metric view of top surface and b) top view of (a). Both with inboard surface elements removed from pink square area to show inner web-like structure.

IV. Metal DfAM Interpretation

The metal interpretation was done in collaboration with FusiA. The design was separated into eight parts using the constraints of the metal 3D printer such as the print volume dimensions of 250 mm x 250 mm x 300 mm, the maximum support overhang angle of 45°, and the minimum wall thickness of 1 mm. Large flat sections were designed to be manufactured from metal plates to reduce manufacturing costs. Five parts were designed for AM, and the remaining three for metal plates. Each part can be seen in Fig. 10, including the full metal assembly. An example of DfAM is seen through the part interpretation shown in Fig. 11 where modifications to the design for the overhang angle and part consolidation were done.

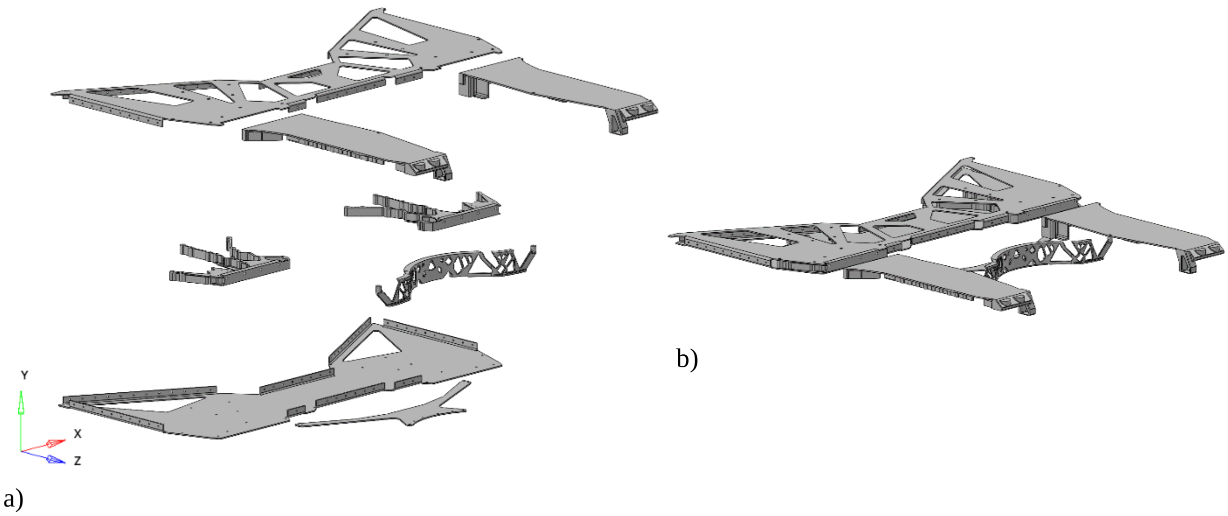


Fig. 10 Interpretation of metal parts showing a) exploded view and b) ISO view of top surface.

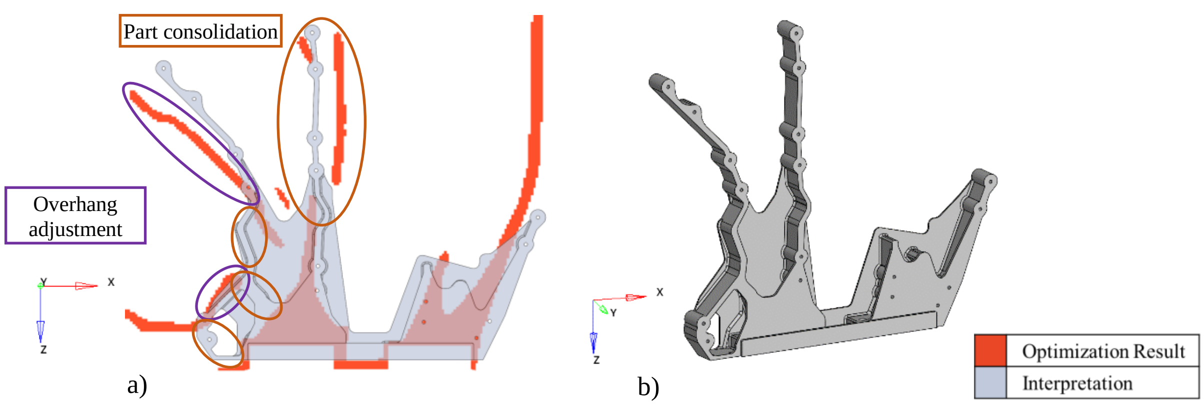


Fig. 11 DfAM interpretation of inboard structure exposed in hashed square from Fig. 9 with a) transparent overlay of interpretation and topology optimized result, with DfAM modifications circled and b) resulting DfAM interpretation design.

V. Polymer DfAM and Detailed System Integration Design

A. Detailed Design of Shell Structure

In collaboration with ZAL and F/LIST, the polymer shell was designed for the manufacturing capabilities of the polymer printer as well as with consideration for the finishing process. The polymer printer required a minimum wall thickness of 2 mm and could support an overhang angle of up to 30°. The finishing process involved applying a pressure of 0.8 – 1.0 kg/cm^3 across the entire surface requiring unsupported sections of the polymer shell to span no longer than 15 mm. The exterior shell was designed to support the veneer and lacquer as well as provide mounting locations for the electronics. The integration of these features into the shell design are outlined in Fig. 12.

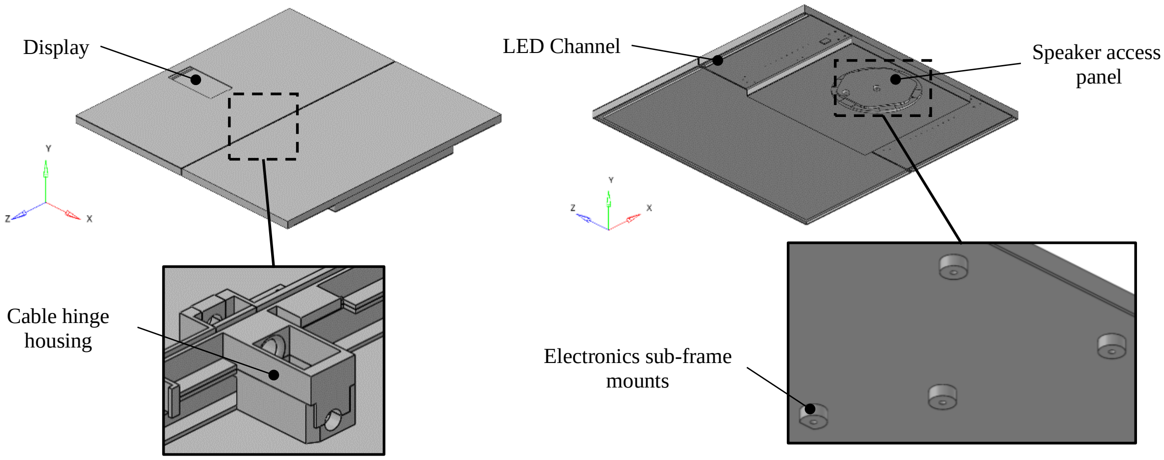


Fig. 12 Electronics feature integration into polymer shell design.

As the electronics mounting boss holes were too small of a feature for the polymer printer to produce, a separate subframe was designed to be printed from the same material on a smaller higher resolution printer on which the electronics system would be assembled, then mounted to the shell structure with larger screws. This subframe is discussed and shown later in section *V.B Electronics System Integration*. The display was mounted to a lip designed into the shell by double sided display adhesive. The speaker, which also served as the access panel, was mounted using magnets on the bottom of the shell. A channel for the LEDs was debossed in the bottom face around the perimeter of the shell. Lastly, a cable hinge was integrated into the design of the shell. Its purpose was to route and protect cables from the outboard to inboard leaves during opening and closing. Additionally, a sensor was integrated to detect the open or closed position of the table.

The polymer shell design was separated into seven parts in total to ensure good print quality and assemblability. Additional factors such as minimizing overhanging surfaces, surface finish, and print orientation were considered. An exploded view of the shell assembly showing all seven parts is shown in Fig. 13.

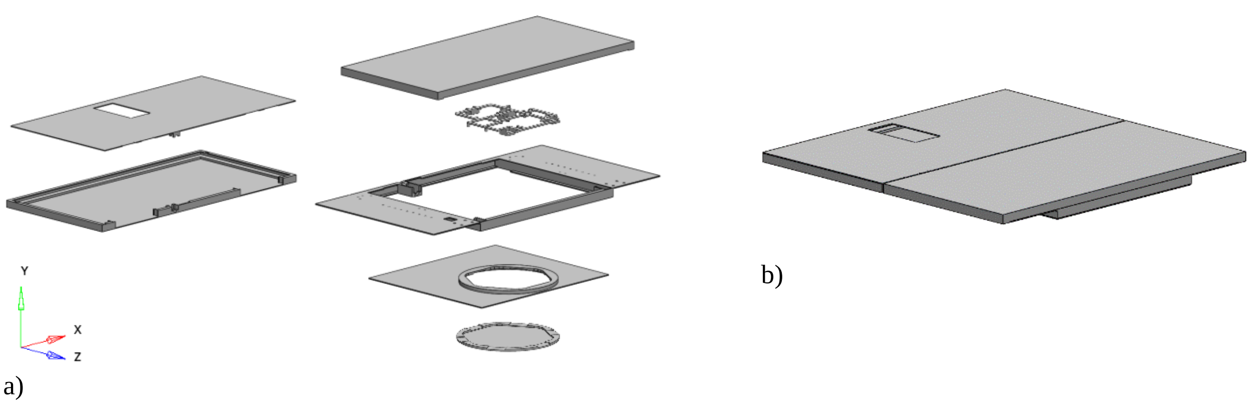


Fig. 13 Design of polymer parts. a) Exploded view. b) ISO view of top surface assembled.

B. Electronics System Integration

The electronics system integration was conducted by Queen's University and involved designing the cable hinge, automatic open and close position light switching, and electronics cavity packing. The cable hinge component allows wires to run from the outboard to inboard leaves of the table. These wires provide power and communications for the inboard electronics such as the lighting, and touch display. The cable hinge required minimized protrusion from the inner faces of the table when folded closed and to be fully concealed inside when the table is open. Additionally, the wires must be sheathed to protect against damage when exposed during stowage. As such, the cable hinge is integrated into the polymer shell design such that the sheath is fixed at the inboard leaf and has a clearance bore in the outboard leaf to allow the cable sheath to pass through the exterior shell and retract into the outboard leaf during closing and extend out when opening the table as shown in Fig. 14.

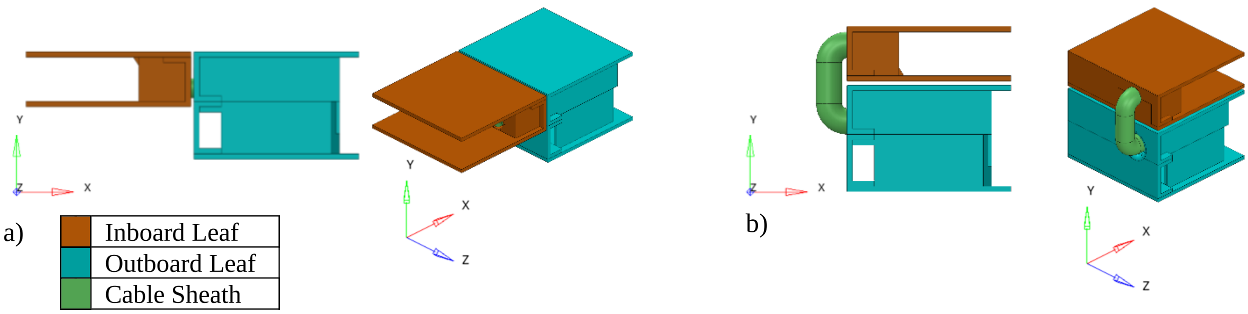


Fig. 14 Section-view of cable hinge integration within inboard and outboard polymer shells showing a) cable hinge retracted into outboard leaf for smart table in open position shown in front view (left) and ISO view (right) and b) cable hinge extended from outboard leaf for table in closed position shown in front view (left) and ISO view (right).

To disable lighting on the inboard leaf when the table is closed, a magnetic switch is integrated into the table shell and lighting circuit. As the table is opened, the magnet and switch are brought into proximity, closing the inboard lighting circuit, and powering the inboard leaf lighting. As the table is closed, the magnet and switch are separated, opening the inboard lighting circuit, and turning off the inboard leaf lighting. This design allowed the switch to be entirely concealed and improved its reliability.

The electronics cavity is designed to be the central mounting location for all the support system electronics. Centralizing the electronics allows for a single access point for repair or maintenance of the electronics as well as improves the ease of electronics installation and reduces the length of wire routing. An electronics subassembly frame is designed for the electronics in the cavity to mount on for ease of assembly and installation, as well as to manufacture the fine details required for the electronics fasteners. Fig. 15 shows the empty and assembled electronics frame. In addition, the access panel for the electronics cavity serves as the speaker diaphragm. To achieve this, a ceramic piezoelectric transducer is mounted to the center of the access panel where it can vibrate separately of the table.

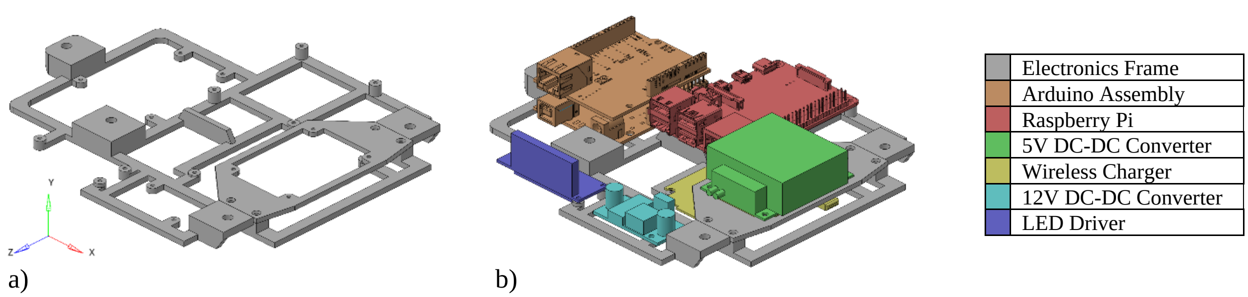


Fig. 15 Electronics subassembly frame a) empty and b) populated.

VI. Design Validation

To evaluate the performance of the interpreted smart table design, the resulting model was run through a linear static analysis. The model was constrained similarly to the TO model shown earlier in Fig. 7 such that two SPCs are applied at the base of each arm, representing the stowage mechanism arm mounting. Only the abuse loads, corner 1 and corner 2, were exerted on the table as per the technical requirement defined by Bombardier. The FEM of the completed smart table is shown in Fig. 16.

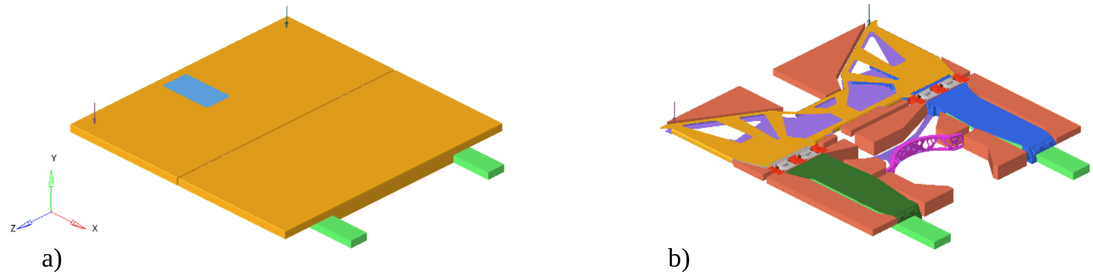


Fig. 16 Interpreted design FEM with a) complete smart table showing corner 1 and 2 loads and b) polymer shell removed to showcase internal components.

The technical requirements stated that under a 35 lb load applied on a 3 in x 3 in area at either inboard corner the table shall not deflect greater than 0.2 in. The results of the analysis are shown in Fig. 17 where the maximum deflection was 0.17 in (4.36 mm) at either inboard corner, which was within the acceptable range.

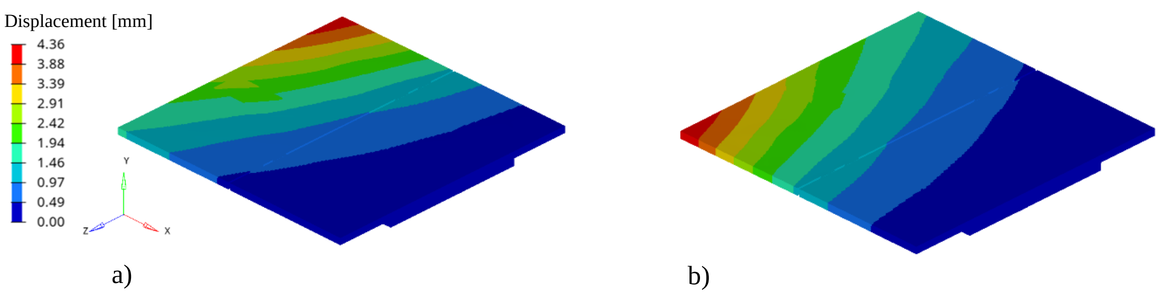


Fig. 17 Deflection validation results from load cases a) corner 1 and b) corner 2.

The stress was also calculated for all components to ensure no permanent deformation would result from loading. The maximum stress in the metal AM components was 125 MPa, the metal plate components was 34 MPa, and the polymer shell was 3 MPa. Each of these maximum stresses are below the yield strength of their respective material previously shown in Table 2. The stress contour of these components is shown in Fig. 18.

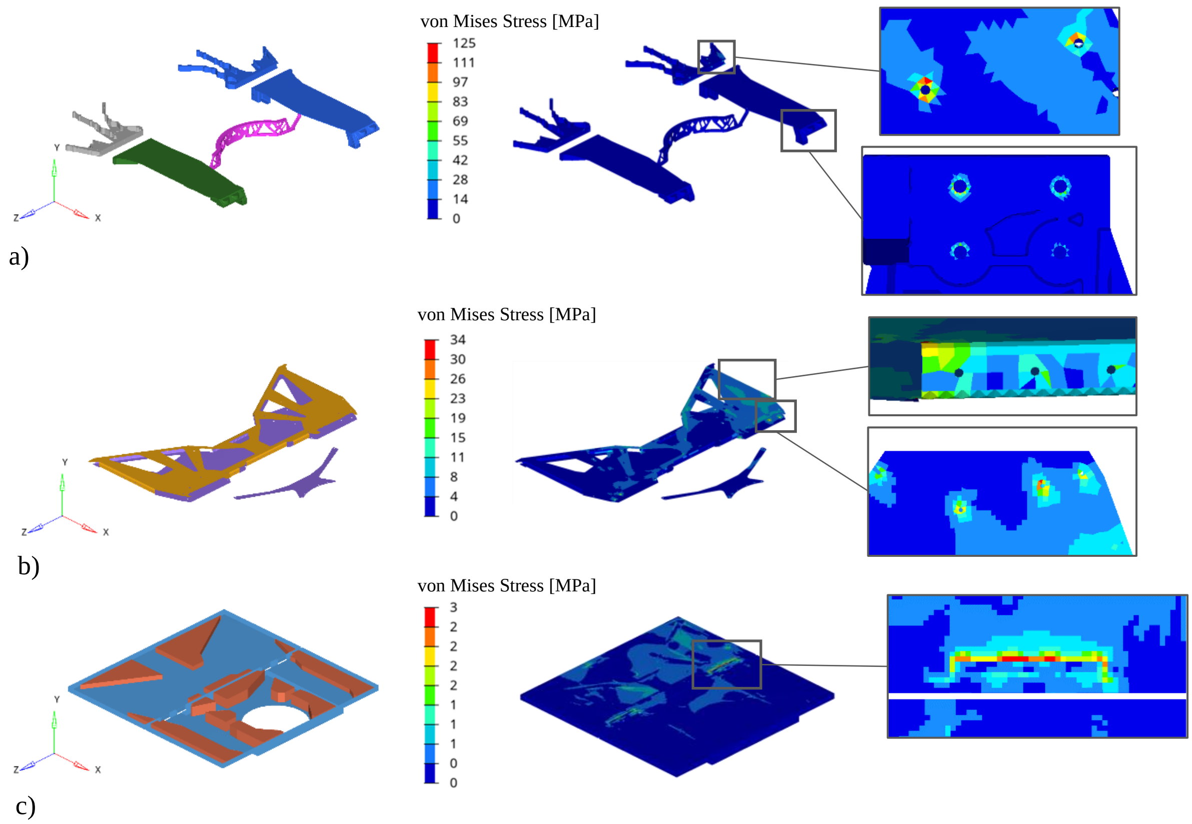


Fig. 18 Linear static stress analysis of a) metal AM components, b) metal plate components, and c) polymer AM components.

As the load applied on the inboard leaf is transferred through the hinge mechanism to the outboard leaf, the hinge mechanism stress was also analyzed. The analysis showed a maximum stress of 109 MPa is experienced in the hinge, and 55 MPa in the hinge stopper shown in Fig. 19. These component stresses are both below their respective material yield strengths and thus, no permanent deformation will result from these loading cases.

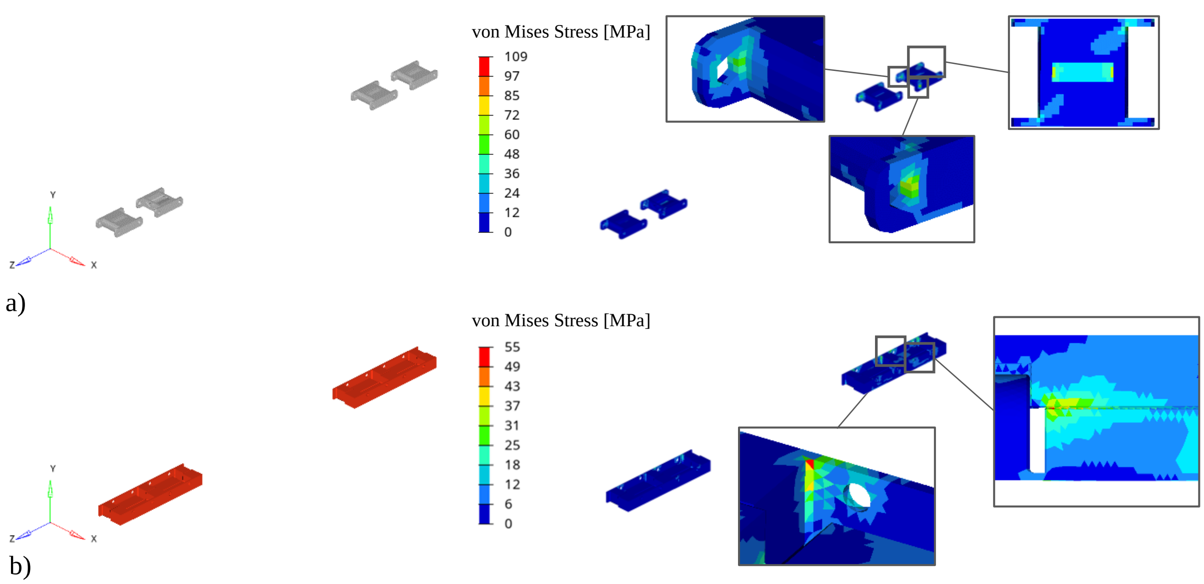


Fig. 19 Linear static stress analysis of a) hinge and b) hinge stopper components.

As the deflection at the inboard leaf corners for both load cases are below the maximum deflection specified in the technical requirements; and the maximum stresses for the metal frame, polymer shell, hinges, and hinge stoppers are below the yield strength of their respective materials, the design successfully passed validation and was suitable to begin manufacturing.

VII. Manufacturing and Assembly

The manufacturing and assembly process began with the manufacturing of polymer and metal components, followed by a combination of adhesive, electronics, and exterior finishing stages. These stages were conducted by ZAL, FusiA, Solaxis, Queen's, and F/LIST, respectively. An overview of the manufacturing stages is shown in Fig. 20.

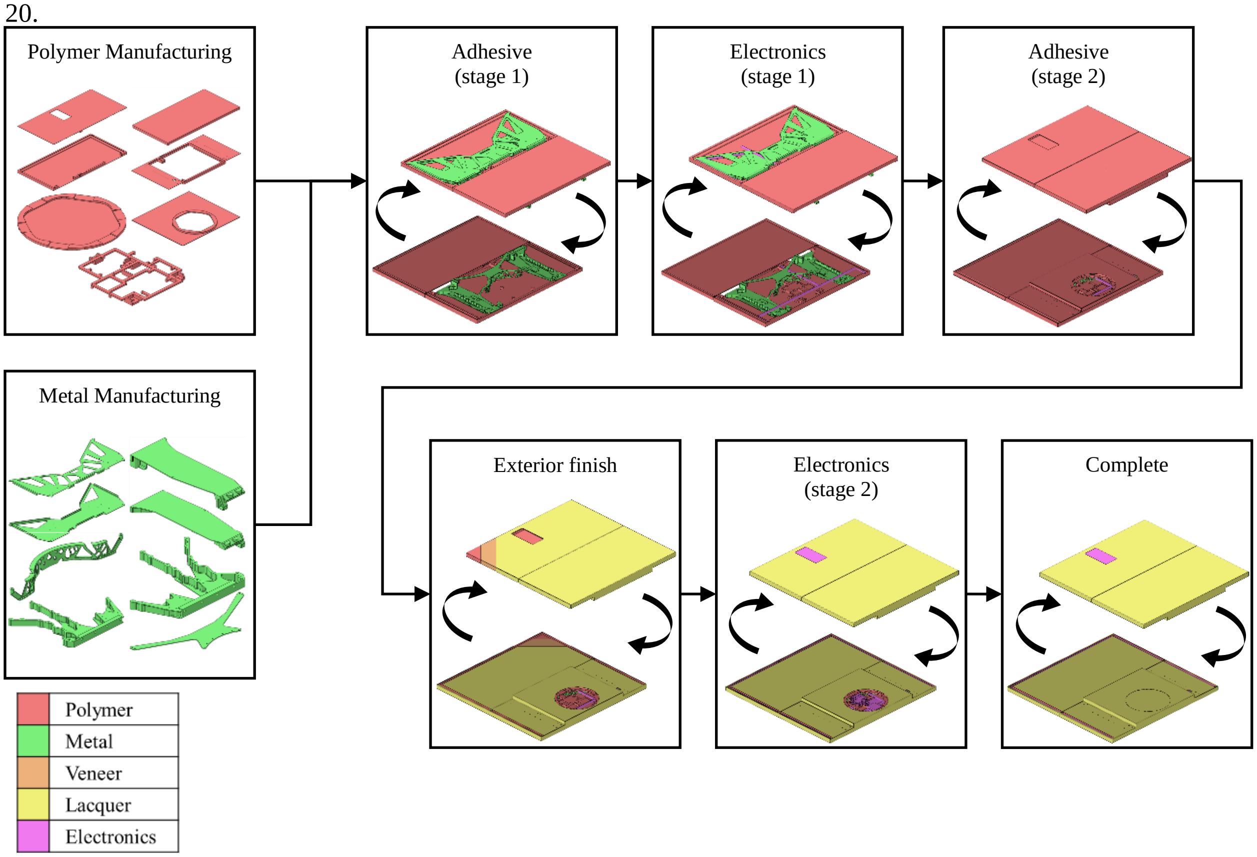
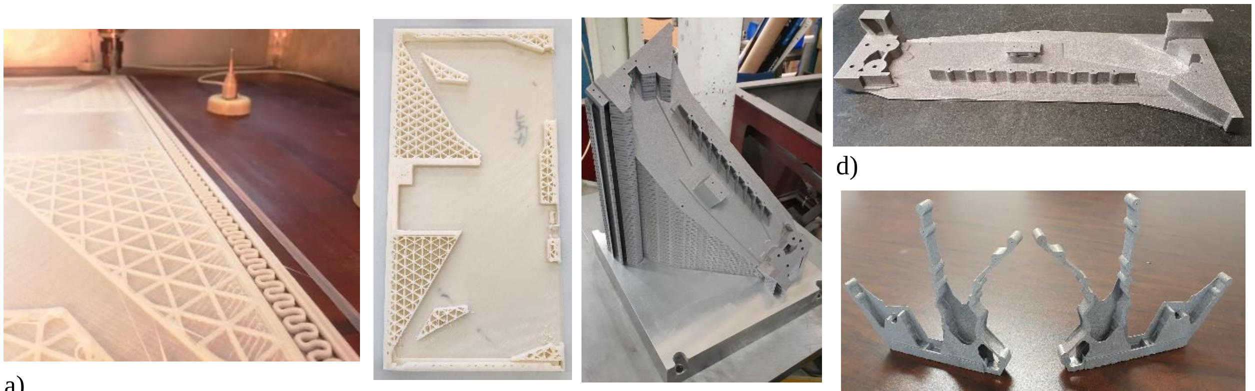


Fig. 20 Manufacturing process chart including pictures of the completed assembly at each point.

A. Additive Manufacturing

The polymer printing process was conducted by ZAL in Hamburg, Germany using their customized ABB 6-axis robotic arm printer. It took approximately 52 hours to print all the parts using approximately 4 kg of material. The polymer parts then underwent post processing which entailed removing support material and refining any imperfections from the printing process. The metal printing process was conducted by FusiA in Quebec, Canada using their EOS M290 printer. It took approximately 112 hours to print all the parts and approximately 1.4 kg of material. The metal parts then underwent post processing which entailed separating the print from the print bed, removing support material, and coating the parts in a non-corrosive coating. Both polymer and metal printed parts can be seen in Fig. 21.



a) b) c) d) e)

Fig. 21 Polymer and metal printed parts with a) inboard polymer shell being printed by ZAL, b) completed inboard polymer shell from picture (a), c) outboard metal arm attached to print bed printed by FusiA, d) outboard metal arm post-processed from picture (c), and e) inboard metal AM parts post-processed.

B. Adhesive Bonding

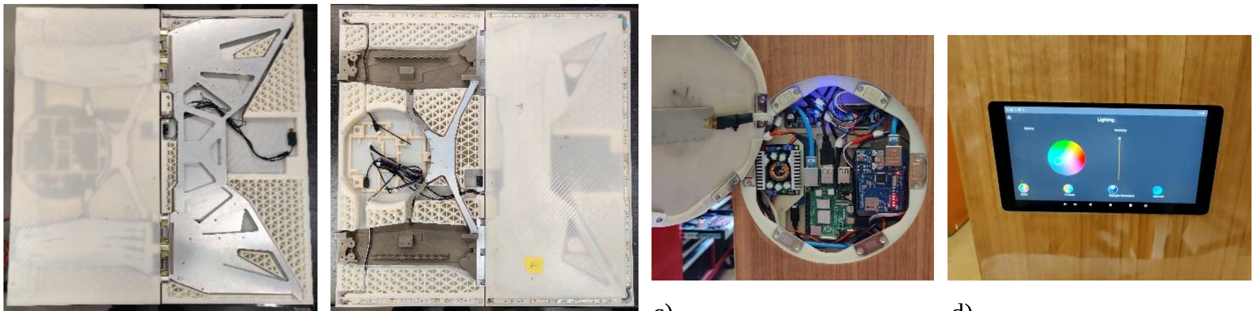
The adhesive bonding process was conducted by Solaxis in Quebec, Canada and took place over two stages. The epoxy adhesive 3M EC-2815 B/A FR was used for all bonding in these two stages. The first stage was done after both polymer and metal parts were manufactured. During this stage, the table leaves were partially bonded leaving access to the interior for embedded electronics such as cable harnesses and magnetic sensor to be installed. These embedded electronics were installed during stage one of the electronics installation. The second stage completed bonding of the remaining parts which concluded the assembly of the polymer and metal parts. After the second adhesive stage, the remaining tasks were to apply the exterior finish and install the remaining electronics. Pictures of the table during both adhesive stages can be seen in Fig. 22.

a) b) c)

Fig. 22 Adhesive stage 1 a) inboard and b) outboard leaves, and c) adhesive stage 2 outboard leaf.

C. Electronics Installation

The electronics installation was conducted by Queen’s University in Ontario, Canada which took place over two stages. The first stage was done in between adhesive bonding stages for components including the magnetic position sensor, cable harnesses, and LED strips, which lacked access once the table was fully sealed. The second stage was done after the exterior finish and was the final stage of assembly. During this stage, all remaining components such as the electronics sub-frame, speaker, and display were installed. Pictures for both stages are shown in Fig. 23.



a) b) c) d)

Fig. 23 Electronics installed during stage 1 a) top view and b) bottom view. c) Electronics on sub-frame and d) touch screen installed during stage 2.

D. Exterior Finish

The exterior finishing was conducted by F/LIST in Thomasberg, Austria and involved applying the veneer, lacquer, and polishing. A eucalyptus veneer was applied and sealed with a high gloss polyester lacquer before finally being polished. After this process, the table was shipped to Queen's University in Ontario, Canada for the final step of installing the electronics. Pictures of the veneer and lacquer application as well as polishing are shown in Fig. 24.

a) b) c)

Fig. 24 Exterior finishing process overview for a) veneer application, b) lacquer application, and c) polishing.

E. Mock-up Installation

The completed smart table prototype was presented to Bombardier and all project partners in Quebec, Canada. The smart table prototype was temporarily installed in a Global 7000 series mockup cabin for the purpose of demonstration and powered by a bench DC power supply. Data communication for features such as LED and the touch screen controls were connected through a network switch and managed by an external raspberry pi on the same network simulating the business jet cabin management system (CMS). Fig. 25 shows the completed smart table prototype installed in the Global 7000 series mock-cabin and powered on.

Fig. 25 Smart table prototype installed in Global 7000 series mock-up cabin.

VIII. Conclusion

This paper outlines the development of a business jet smart table prototype. The goal of this project was to design and fabricate a smart table prototype with integrated electronics utilizing additive manufacturing processes as well as topology optimization and designing for additive manufacturing (DfAM). Development of the smart table prototype is overviewed starting from the conceptual design and problem definition, to the manufactured prototype's installation in a Bombardier Global 7000 series mock-up cabin.

The design process started by identifying the functional, geometry, and performance requirements as well as the manufacturing methods and constraints. Topology optimization was conducted, and the result was interpreted considering DfAM. Finally, the interpreted design was validated before manufacturing. The manufacturing process began with fabricating the metal and polymer components. Metal components were fabricated using a combination of additive and conventional manufacturing processes to optimize manufacturing time, cost, and capability. Polymer components were designed utilizing additive manufacturing as many intricate details and features were integrated within the design for assembly and for the electronics system integration. Assembly of the smart table was then conducted through a combination of adhesive, electronic installation, and exterior finishing stages before finally being demonstrated in a Global 7000 series mock-up cabin.

Future iterations of the smart table could benefit from improved material selection and electronics consolidation. Improved material selection such as carbon fiber reinforced polymer could reduce the overall mass, thus improving the fuel economy of the aircraft. Electronics consolidation such as a custom printed circuit board would make the electronics design more compact and potentially modular. This could reduce the assembly complexity through reducing the number of polymer shell components and subsequent assembly stages. Additionally, this could improve the repairability of the smart table by making the electronics more accessible, reduce the weight of the assembly, and improve the power efficiency.

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