AISLE CHAIR DESIGN PROPOSAL INFORMED BY FOCUS GROUP OF OCCUPANTS: *EXECUTIVE SUMMARY*

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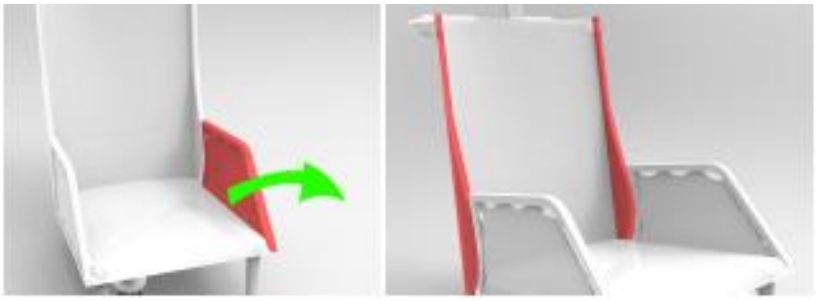
Envisioned Aisle Chair Design

The design objectives were driven by several problem categories that were assessed for how much of a concern they were to each stakeholder. The team decided to focus on maneuverability, lateral support, and a restraining system in order to make both the occupant and the operator feel more comfortable with the situation. Better maneuverability would make the operation easier and less pressurized in tight spaces, which would also keep the occupant from getting jostled. More lateral support would help occupants feel more secure, and would give them something to hold on to if needed. A better restraining system would make the operation easier and faster while also providing security to the occupant. All of these improvements would make the transfer process from wheelchair to aisle chair to plane seat and back more efficient and any other discomfort would be short-lived.

The base of the aisle chair design incorporates three wheels with a back single caster, rather than the traditional four wheels. The front two wheels also have locks for stability during transfers.

Lateral support is provided via a slightly cupped shape to the backrest and the addition of folding side panels that also act as armrests. The panels are made up of a rigid frame skinned in neoprene and can be folded completely away to make room for transfers or locked in a horizontal position to act as a transfer board. The envisioned restraining system would combine the usual multiple straps into a single X-shaped harness, which would come over the shoulders and hips. The system is retractable and has a simple buckle locking and unlocking mechanism in the middle of the torso. This enables operators to securely fasten seat belts in one step, without the need for additional adjustments.



Folding armrests and lateral support

A rounded headrest is included to provide comfort and some lateral support for the head. It can be flipped back through the gap in the two handles to create more room for the operator during transfers. The handles themselves are sheathed in rubber for a comfortable grip.

The seat and back of the aisle chair are covered in thin cushioning to add some comfort from the otherwise rigid frame. The footplate can be flipped back to be out of the way, and also has sides and a back to prevent the feet from slipping off the plate and getting caught under the wheels.

Rotating the current aisle chairs was identified as a key issue by both the operators and the occupants of the current models. The survey results of aisle chair operators indicates that one of the areas of most dissatisfaction is the ability of the wheels to maneuver sharp turns and corners. Issues in maneuverability was one of the most mentioned topics during the occupant focus group interview. *"It just doesn't turn....Making the turn from where the pilot is... that's just too complicated with some guys who gotta get in front of you and turn it"* - Occupants' response from focus group.

The team decided on a 3-wheel configuration for the aisle chair after investigating various forms of wheelchairs designed for sporting activities. It was found that the tricycle design was adopted over the traditional 4-wheeled versions for its tighter turning radius and thus easier maneuverability. The protruding third wheel requires less effort to be rotated to steer the aisle chair to a certain direction. There is also less rolling resistance with one less wheel, as well as decreased overall weight.

A single caster was placed in the back to help steer the chair when operators pull the chair backwards down the aisle, which is how they usually drive the aisle chair during boarding. The caster is also larger and textured to help go over gaps or uneven ground between the plane and the jetway. The team acknowledges that this configuration may be slightly less stable than 4-wheeled designs. In order to further develop this concept, statics calculations would be needed to ensure the tipping angle conforms to regulations.

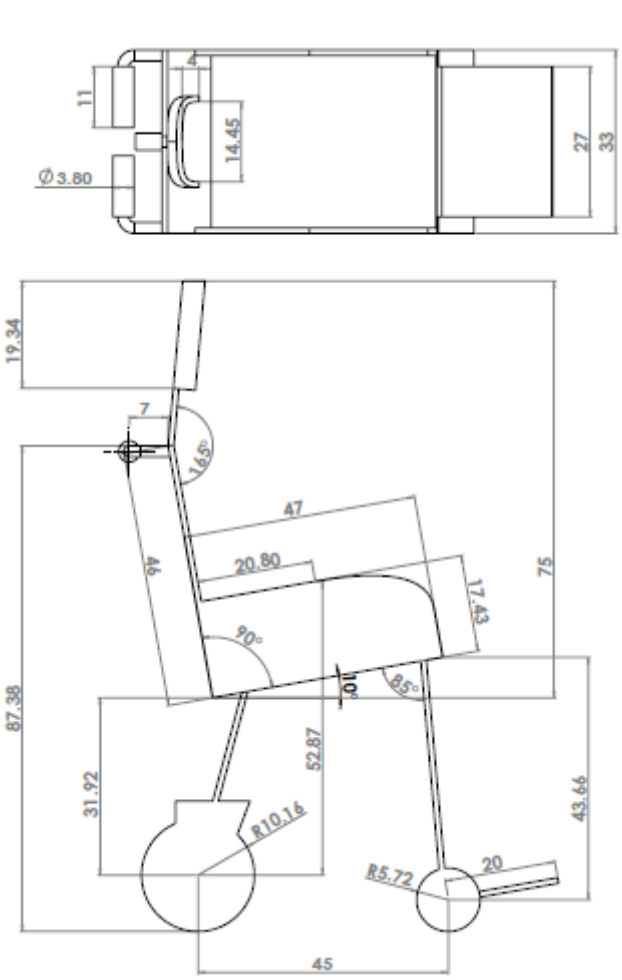
From the focus group interviews and surveys with occupant, the lack of lateral support emerged as a major concern about the current aisle chairs. *"Very uncomfortable no armrest feels like you are about to fall off the seat"* - Occupant response from survey Occupants stressed the need for lateral support to keep them from tipping sideways out of the chair, or hitting objects on the sides of the aisle, especially if the occupant had spasms. It was sought to provide this, but also make sure that the support could be folded away to make room for transfers. The team then had the idea to use the lateral support on the seat as a transfer board when locked into a horizontal position. It was also decided to give the back a slightly cupped shape to cradle the occupant without getting in the way. The support consists of a rigid frame covered with a thin layer of malleable material in order to accommodate as many occupants as possible while still keeping them in the chair.

The lateral support also acts as an armrest for the occupants to hold onto if needed for stability, a feature that was stressed as highly important from the stakeholders. *"Armrests are useful for adjusting my body in the chair and creating a barrier-handhold when transferring"* - Occupant response from survey. The height of the lateral support is limited by the height of the airplane seat armrest. This is to ensure that no extra height is added if the airline seat armrest is fixed, and transfer is required over the fixed armrest. As

the lateral support extends all the way to the knee, an occupant's legs are prevented from swing out of the seat, therefore reducing the chance of injury during transportation.

Many of the operators and occupants found the straps to be overly complicated and requiring too much time to secure. *"Many straps are very frustrating... they tend to get entangled"* - Response from operator focus group. Both the occupant survey and focus group also revealed that occupants too felt that the straps were also cumbersome in design.

To mitigate this issue, the team decided to provide a retractable cross body harness that would come over the occupants shoulders and hips and buckle in a similar manner to car seatbelts in the center. The buckle is used as it is a more secure alternative to velcro, which can become loose when going over bumps. The retractable property of the strap would mean that it remains out of the way when not in use, thus not interfering during the transfer process. Also, the strap would automatically adjust to ensure a secure fit to varying occupant body sizes, therefore eliminating the task of adjustment by the operators. The one step locking and unlocking action would streamline the process as well, since it would be easier and more intuitive for operator use. Also taut straps will not snag on airline seat armrests when the aisle chair is being wheeled through the aisle.



Measure	Dimension
Headrest Height	19.34cm
Headrest Width	14.45cm
Headrest depth	4cm
Angle of Headrest to Seat Back	165 degrees
Seat Back Height	46cm
Seat Pan Depth	47cm
Angle Seat Back to Seat Pan	90 degrees
Seat Back and Headrest, Total Height	75cm
Seat Width (Outside)	38cm
Seat Width (Inside)	33cm
Distance Between Seat Pan and Footrest	43.66cm
Tilt Angle of Seat	10 degrees
Height of Armrest (At Highest Point)	17.43cm
Length of Flat Region of Armrest	20.80cm
Handle Bar Radius	3.80cm
Length of Handle Bar	11cm
Height of Handle Bars	87.38cm
Distance between Handlebar and Seat Back	7cm
Footrest Depth	20cm
Footrest Width	27cm
Radius of Front Wheel	5.72cm
Radius of Back Caster	10.16cm
Distance between Wheels	45cm

Technical dimensions and specifications

The current designs have little or no cushioning on the seats, which can aggravate pressure points. The seat and backrests on the design are covered in thin cushioning to alleviate some of the discomfort, but are not meant for prolonged use. Ideally, no occupant would be left in the chair long enough for this to be a serious issue. During the class' field visit to the Delta headquarters, it was noted that the aisle chairs used did not have headrests, which contributed to the discomfort of occupants. *"My head fell back and it hurt my neck."* - Occupant response from survey. A headrest was included to increase the comfort level for occupants as well as reduce injury to the neck. The headrest has a slight curvature to provide some lateral support for the head. The tradeoff of having a headrest is its interference in the transfer space, as it adds extra height that the operator must clear with their arms. To mitigate this issue, the headrest was designed to be flipped back, and remain flush behind the seat back when not required. This would ensure the clearance height remains as low as possible during transfer.

The seat and backrest were tilted back by 15 degrees to increase postural stability and decrease sliding tendency. The maneuverability is also increased as the center of gravity is moved back with respect to the rear wheel. The tradeoff to including the tilt in the design is that the stability of the chair may be decreased. However, the team felt the loss in stability is mitigated by the fact that the aisle chair is used in a tight environment among the presence of multiple airlines personnel, who are able to provide manual stability to the chair.

The frame of the aisle chair is made of extruded hollow aluminum for both structural stability and lightweight. The seat and back are covered in closed-cell foam cushioning for both comfort and traction, since the material of current designs have been described as lacking traction. *"Material on seat very slippery and I will slide from side to side."* - Occupant response from survey. As the seat width is restricted by the aircraft aisle width, the chair width is not extended to accommodate the extra space off cushioning. Therefore the tradeoff to including cushioning is that it decreases the width of the seat surface. Since comfort was heavily stressed as an issue by the occupants, including the cushioning was more important even if it causes a snug fit into the chair. The lateral support is a rigid aluminum frame skinned in neoprene for malleability and postural stability. The handles are covered in rubber for comfort and grip for the operator.

One of the main concerns with occupants and operators was the difficulty of setting up the aisle chair. From the focus group with occupants, participants stressed how much the staff ease of use accounted greatly for the user's comfort. Through the discussed design decisions, the team attempted to ensure that the setup of the aisle chair is achievable in as few steps as possible. As the aisle chair is not intended to be an on-board chair, it is designed as one rigid structure that does not require folding and unfolding. This greatly decreases the complexity of setting up. There are a limited number of movable pieces: headrest, lateral support, straps and footrest, which means that the configuration of the chair can be quickly and easily altered during the different stages of transporting an occupant.