Aisle Chair Design Proposal Informed by Survey of Its Occupants: Executive Summary

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This research effort engaged users of aircraft aisle chairs and collected usability feedbacks on the current designs while capturing what users wished to be addressed in future designs. Through the group’s independent research efforts, along with the findings of the combined class, it was possible to propose a redesign of the commercially available Aisle Buddy boarding chair by Scooters and More by incorporating revisions of specific design aspects that were called out in the findings. The Aisle Buddy (below) was the most favorably rated option in the survey and was selected because it provided a good starting point for addressing aisle chair usability from both sides of the user spectrum: from the occupant’s standpoint as well as the operator.

For the research performed by the team, the data collection instruments consisted of an online survey created in SurveyGizmo as well as a hard copy version (though no requests for paper variants were ultimately made). The target cohort for this study was aisle chair occupants, specifically those persons with physical disabilities, who have experience flying and have utilized an aisle chair to make the transfer in- and out of their plane seat for air travel. The survey asked these users to indicate their experiences with respect to transferring to airline seats from an aisle chair, their levels of comfort when using different models, and managing personal items, among other things. It was disseminated through both the CATEA Consumer Network (CCN) and disABILITY link communities through two primary contacts, with data being collected over a three-week period in March 2013. It solicited 188 complete responses.

After assessing the survey results, in addition to reviewing the different stakeholder engagement reports from the class, the team identified improvements that could be made to three key functional criteria: maneuverability, transfers, and postural stability. With respect to maneuverability, there was a general consensus among the past occupants that the prevalent designs have limitations, and that a redesign should allow maneuvering in tight spaces. For transfers, the occupant surveys additionally revealed that self-transfers were the most common transfer method in and out of aisle chairs (Chen, R., p. 7). Also, comparisons of transfer method and injury rate revealed that those who transfer themselves see a 10% lower injury rate than those who transfer with companion or airline staff assistance (Chen, R., p.8). Finally, in terms of stability, there were calls to redesign lateral supports (Chen, C., p. 7, 42) possibly through fold-down sides, a concave backrest shape, or adjustable armrests. Additionally, the respondents expressed a clear need for headrests and an overall increased stability and sense of security in the chairs (Chen, R. p.11).

Along with the stated stakeholder inputs, there were other data and industry regulations to consider when making design changes to the aisle chair. For one, the CAESAR database for the
anthropometry of U.S. populations (based on the stakeholder pool) was used in calculating percentiles. Considering aisle chair operators, shoulder-to-wrist arm length proved to be an important measure to index when determining the placement of handles. Measures of interest to manufacturers and chair occupants, meanwhile, include elbow height for placement of the armrest, headrest placement relative to occupant eye level, shoulder breadth for added support to the backrest, seated hip width to improve comfort and security while seated, knee height for a better footrest placement, and buttock to knee measurement to determine proper seat pan depth.

While most regulatory data was covered in the manufacturer stakeholder report, one additional regulation that can greatly influence the design of the aisle chair is title 14 CFR 25.815 within the code of Federal Regulations. Part 25 on airworthiness standards: transport category airplanes discusses aisle width in design and construction subpart D. This regulation states that the passenger aisle width at any point between seats must equal or exceed specific magnitudes for heights below and above 25 inches, where above that point the widths must be between three and eight inches longer based on the given seating capacity. By coupling anthropometric data with this opportunity to expand the width of the aisle chair, the redesign could meet the needs of a wider range of users.

The class report that dealt with aisle chair manufacturers revealed that the Aisle Buddy effectively surpassed regulatory needs (Eiring, p. 11). Additionally, the team’s survey of over 200 aisle chair occupants ranked aisle buddy as the best out of a selection of aisle chairs (Chen, R., p. 9). Despite this success, the manufacturers of the Aisle Buddy reported that user-centered design processes are frequently not incorporated into their designs (Eiring, p. 13). By incorporating the user-centered design process to this relatively successful aisle chair there is an opportunity to produce a breakthrough design that could meet user and operator needs even better than ever before.

The redesign consisted of two major improvement areas: those centered on the occupant that primarily concerned the seat of the aisle chair, and those centered on the operator that primarily concerned the chassis or base of the chair. At left is an isometric view of the proposed design showing the feature of completely raising an armrest to facilitate the transfer process.

With respect to the seat, one of the first considerations was the widening of a portion of the seat back, which would help with both the comfort and postural stability for those individuals being transported in the chair. Also, because the majority of the seat back is above the 25-inch threshold, it was possible to widen the back by a whole five inches to a width of 18 inches, while still maintaining the same amount of aircraft compatibility as the existing Aisle Buddy ES model. Instead of a solid, flat vinyl cushion for the seatback, a breathable solution via venting holes at the shoulder blade locations on the backrest is proposed, along with a slightly concave surface.

For other improvements to the seat, the positioning of the headrest was another well-documented concern from the survey that lead to the change of making it more adjustable by increasing its range (from 16 to 18 inches) in order to accommodate a much larger U.S. population (97.7 percentile versus 50). This change was combined with also giving the headrest concavity to provide lateral head support and reduce
neck stress during transfer. The seat pan was another area that was addressed to increase postural stability of the occupant, for security and transport safety. A material change in the seat cushion would substitute a high density memory foam for the standard material, while its cross-sectional profile is another one for imparting with concavity.

The beneficial aspect of movable armrests and accordance with DOT regulation 382.21.a.4.iii was maintained. However, because the widened portion of the seat was moved, this made for a conflict when the current straight armrests were raised up. To compensate, an offset pivot design that allows the armrest to fold up and sit against the seat back was made. Additionally, to minimize the intrusion when folded up, a wider, lower profile cross-section than the current one is proposed. The footrest, meanwhile, saw a greater departure in design due to not having the option to easily remove it or fold it out of the way, which were identified as very important features in the survey. Both actions are made possible in the new design. Just as importantly, the fixture of the footrest was changed to be supported by the seat frame instead of the chassis (which could result in dangling legs), so as to move with it when the height is adjusted. Finally, four inches of adjustment were added to the footrest, allowing for an effective seat height of 16 to 20 inches that would accommodate 100% of the target population. These changes are illustrated by the renderings below:

![Footrest when folded](image1)
![Footrest when high](image2)
![Footrest when low](image3)

The original chassis of the current design already worked well for utilizing an electrically assisted height adjustment mechanism, and not to mention accommodating the narrowest aisle width (20-passenger or less crafts) allowed by DOT 14 CFR 25.815. The electrical adjustment makes transfers much easier by being able to achieve the optimum height, as well as reducing strain on airline personnel by eliminating any mechanical force necessary to raise or lower the occupant. Its larger diameter, poly-filled wheels allow for mild shock absorption and thus increase comfort over longer hauls, such as between terminals. Still, the team did arrive at one major change to be implemented for an upgraded Aisle Buddy ES design: making the chair’s footprint expandable so as to reduce the higher prospect of tipping the chair due to its being so narrow.
The team believed it beneficial to allow the operator to widen the wheelbase when aisles permit, or for transferring an occupant between terminals in the airport. To achieve this the front casters were designed to allow the each one to extend outward by an additional one-and-a-half inches, as shown on the preceding renderings. Since these casters pivot as well, a sweeping side-to-side motion is enabled while an occupant is in the chair, which was assessed as being desirable for transfers.

By focusing on human-centered-design, the revisions make the aisle chair accessible for a greater portion of the population. That said, compromises still had to be made. For one, the armrest height could
only suitably accommodate 50% of the population, a compromise that made it possible to accommodate the greatest number of users despite excluding the upper and lower percentiles. Compromises also had to be made in regards to chair width and seated hip width measurements as there is simply not enough room in a 15-inch aisle to accommodate hip widths above the 50th percentile mark. An attempt was made to compensate for this by having moveable armrest and widening the seat back, but larger users will still have problems with the chair. The issue is difficult to address until airline aisles are made wider. Length constraints also came into play when deciding on an overall system tilt, because as tilt increases so does the chair length, which becomes unacceptable when impacting the chair’s maneuverability in tight spaces. In the end a 15-degree tilt was judged to provide adequate support without overly lengthening the chair. Finally, consideration of alternative materials for the seat back were restricted by airline regulations as well as the seat width, where customary construction techniques would not work. Despite these constraints, the redesign attempts to improve function of the successful Aisle Buddy design.