SCOPE
Senior Consulting
Program for Engineering

Boeing Ultra Lightweight Seat

Team
Juliana Bernal-Ostos, Daniel Foran, Kori Haymore, Charleen Laughlin, Tomohiro Ryutani, Allison Schmidt

Faculty Advisor
Christopher Lee

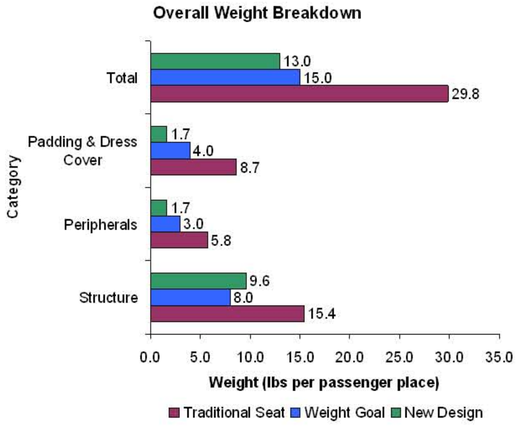
Liaisons
Jim Fullerton, Tyler LeBrun

Statement of Work

- "Conceptualize, define and validate new and novel light weight passenger support and retention system(s) (seats) applicable to commercial jet transport aircraft"
- Target 15 lbs per passenger place. Current best in class production is 24 lbs
- Meet FAA Regulations and Boeing Requirements
- Provide validation to support belief in concepts via demonstration models, CAD, simulations, etc.
- Focus on weight reduction. Aesthetics, ergonomics, and comfort should not be diminished

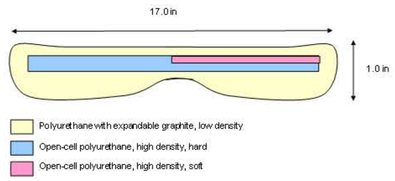
Design Space

- All structures must withstand operation, dynamic, and user abuse loads
- Spaces must accommodate large range of passenger dimensions
- Functionality of existing seat must be maintained – e.g., armrest and tray table functions



Padding

- The padding and dress cover on the traditional seat weighed over 8 lbs, while the new seat design calls for less than 2 lbs of padding and dress cover.
- The foam padding is a composite of three materials: a low density polyurethane foam with expandable graphite (traditionally used in aircraft seating), a soft high density open-celled polyurethane, and a hard high density open-celled polyurethane foam. The dress cover is made of lightweight woven PBI, a synthetic fiber which has no melting point and does not ignite.

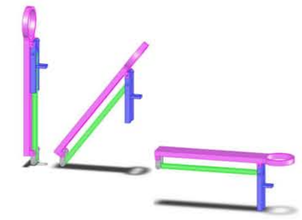


Seat Back

- Seat back of thin extruded tubing with a strong fabric stretched over it
- Modeled after efficient traditional seatback
- Tapered profile and straightened structure to reduce weight, accommodate armrests
- Redesigned recline mechanism allows for less weight in seat attachment
- Validated for 200lb aft load along top edge via ANSYS

Armrest

- Cup holder - replaces tray table for domestic flights that serve drinks but not food trays.
- Non-Cantilevered - A front support reduces the amount of overall structure required
- Automatic Lowering – A four bar linkage ensures that the front support lowers automatically.
- Finite Element Analysis – Complies with FAA tests.



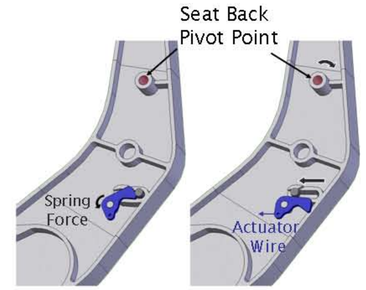
Recline

Hinge mechanism is actuated by button on the bulkhead. Wire pulls the bottom of the lock forward, allowing pin on seat back to slide forward.

Torsional springs in hinge and lock

Mechanism on both sides of seat to distribute load path

Validated via shear and bearing stress calculations



Peripherals

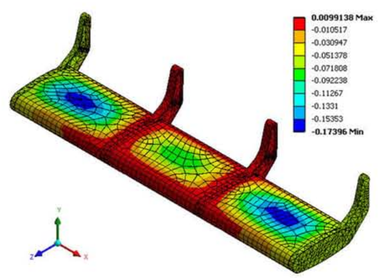
- Lit pocket & life vest holder - made of non-flammable mesh that is lighter than the traditional fabric and plastic (shown)
- Seatbelt – integrated lighter automotive buckle

Legs

- Optimized shape – Simplified load path of traditional seats
- Position – Leg position moved so all legs support the same load.
- Finite Element Analysis – Complies with FAA tests.

Transverse Beam and Spreaders

- Designed to maximize stiffness / weight.
  - Typical seat design used for metric.
- Model restricted to linear-elastic regime
  - System does not deform permanently as modeled.
- Dynamic testing was approximated due to modeling problems.

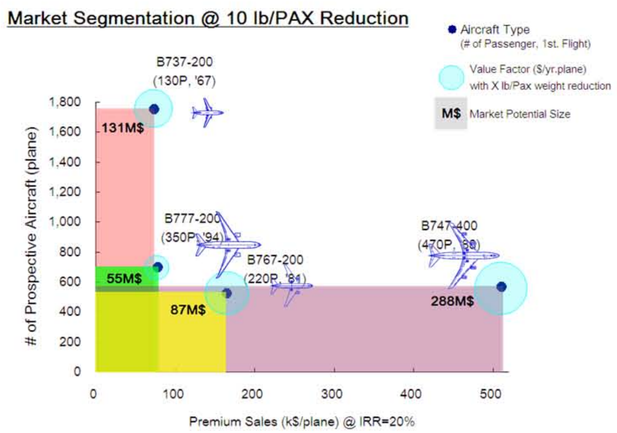


Y-axis directional deformation of the primary structure. Loading corresponds to ultimate downward static test.

Material Swaps

- Replace aluminum crossbeam for composite crossbeam.
- 33 msi carbon fibers and epoxy
- Weight savings
- Good mechanical properties:
  - Tensile strength: 65,000 psi
  - Flexural modulus: 18,600,000 psi
  - Shear strength: 12,500 psi
  - Density: 0.057 lb/in³

Picture from http://img.alibaba.com



Preliminary market study for Boeing's seat business

- The value of lightness is simply "fuel saving",
- Each aircraft type (market segment) has different fuel efficiency and market scale (number of seat and prospective aircraft).
- Completed financial simulation of investable amount on each aircraft type and summarized the quantitative characteristics of each market segment.
- Implications about marketing planning were also provided.