HYPERLOOP SEATING SYSTEM

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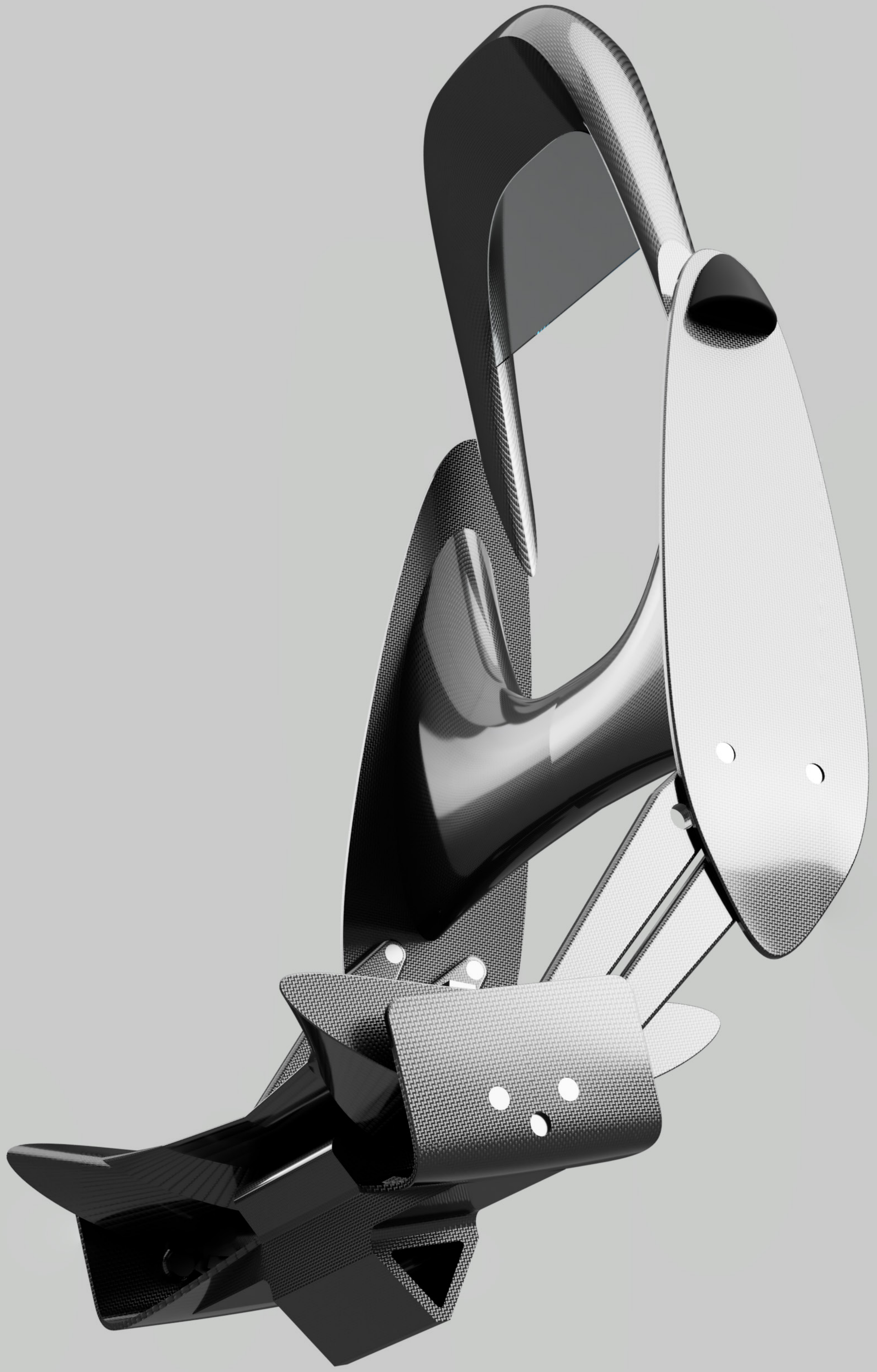
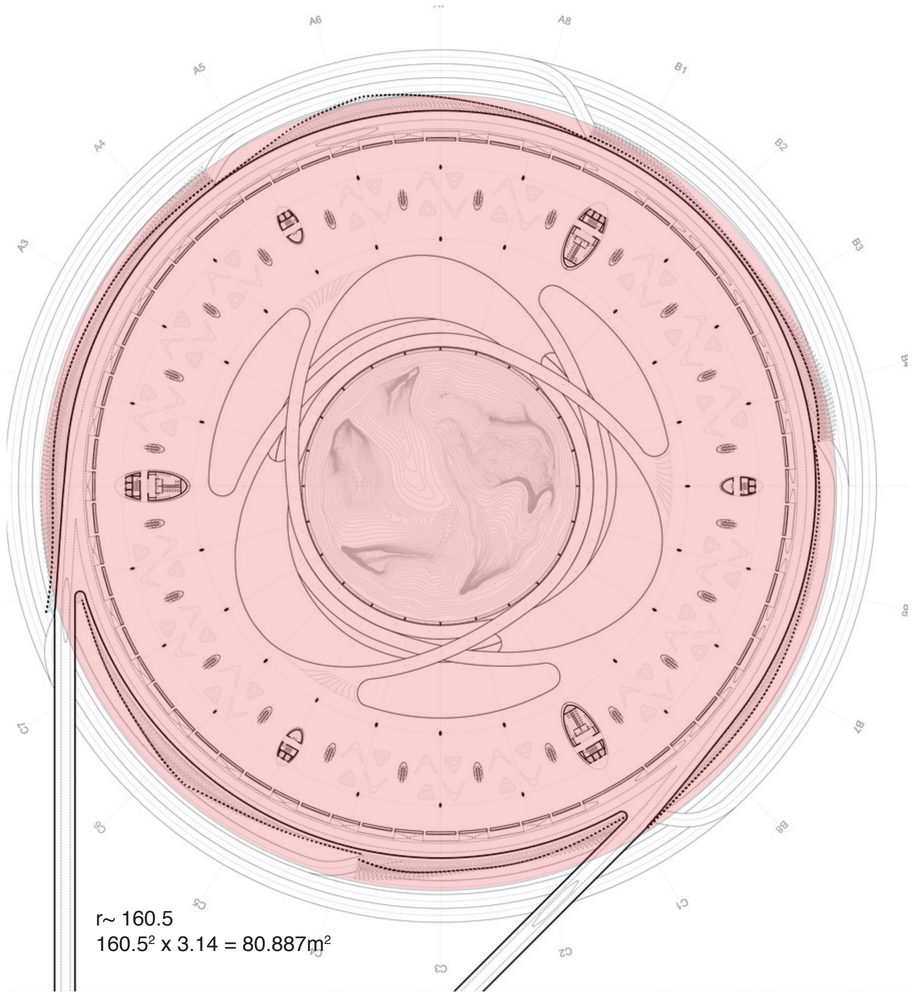


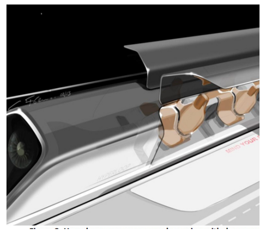
HYPERLOOP INVESTIGATION AND RESEARCH

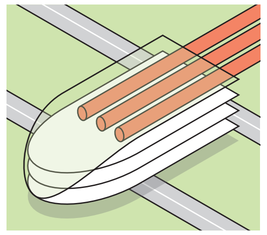
In 2013, Elon musk of Tesla and space x presented the world with a vision of high speed transportation. In this transportation mode, small pods through mostly evacuated tubes, travelling at speeds in excess of around 1,000 kilo meters per hour. the original proposal was to connect LA to San Fransisco in 20 minutes, which is currently a six hour drive.

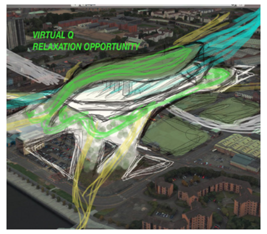
Hyperloop forms some very new and interesting challenges in the area of passenger accommodations and experience. The original passenger only proposal had pods only 1.35m wide.

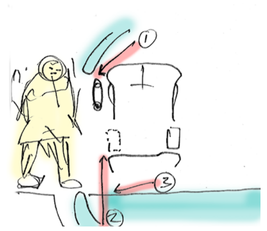
In addition, in order for the hyperloop to be operated at full capacity, then up to two pods a minute could leave the station. This implies that boarding must be either handled very quickly or at large numbers in parallel.

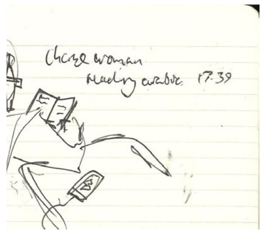


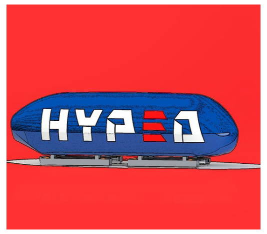


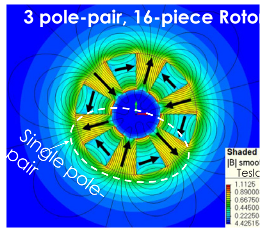


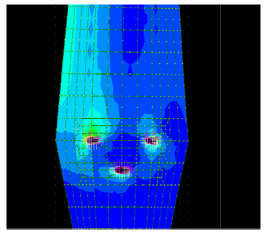


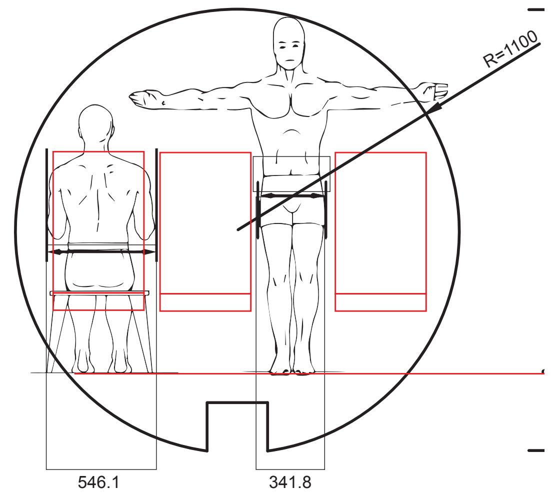












MARKET, FEASIBILITY AND COMMERCIAL OPPORTUNITY

A range of opportunity identification invetigation activites were carried out. Firstly, an in depth academic review saught to explore the fesibility of hyperloop systems in general.

Specific proposals were then analysed to look for room for further development and improvement. Througout the project, paralell products in other transportation and seating solutions were used for inspiration and benchmarking

USERS AND CONTEXT

Context was extremely important to this concept because it was required to be created in a future scenario. This was done by expanding technical limitations and ideas into a system proposal.

User profiles and journies were created to explore the context and use case of any hyperloop seat, which aided in rationalisation and ideation. Train users were interviewed and the context and limitations of current transport modes was analysed.

EXTERNAL COLLABORATION

I sought collaboration and feedback from various parties. Edinburgh Hyped help to inform and flesh out the initial concept design.

Martin Darbyshire, a prominent expert in consultancy airline seating design provided process guidance and design concept feedback. Lukasz Kaczmarczyk guided appropriate simulation testing.

Glasgow hypeloop have been a constant partner and will help exhibit my concept after degree show.

DETERMINATION OF KEY DESIGN CRITERIA

From all these reasearch activities, key criteria were brought forward. It was found that there existed an opportunity to design a system with high cost effectiveness.

This established the specification for a seat which was designed for small stations, cross sections and quick boarding, and which would minimise overall energy costs.

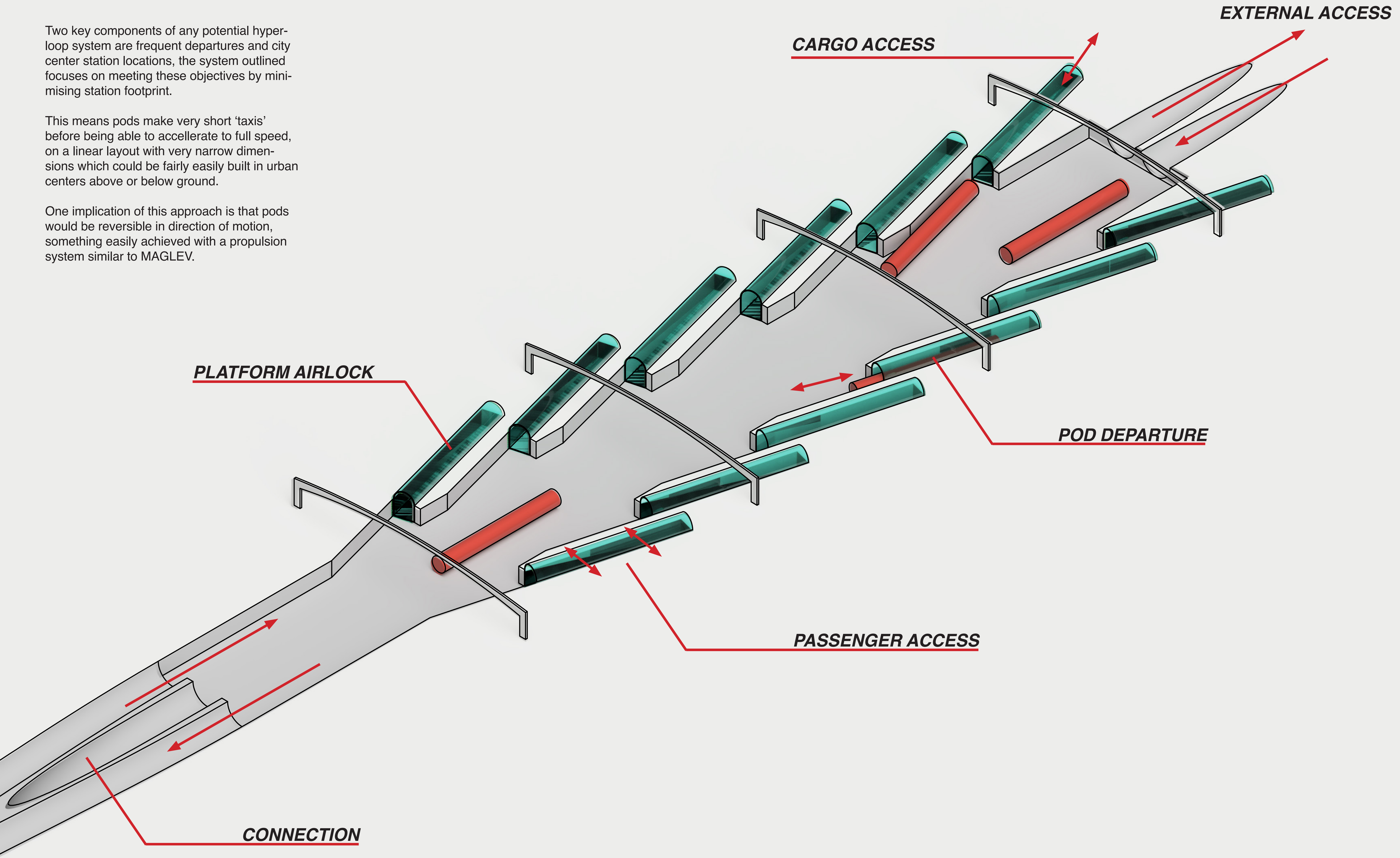
STATION ARCHITECTURE

Interim Concept

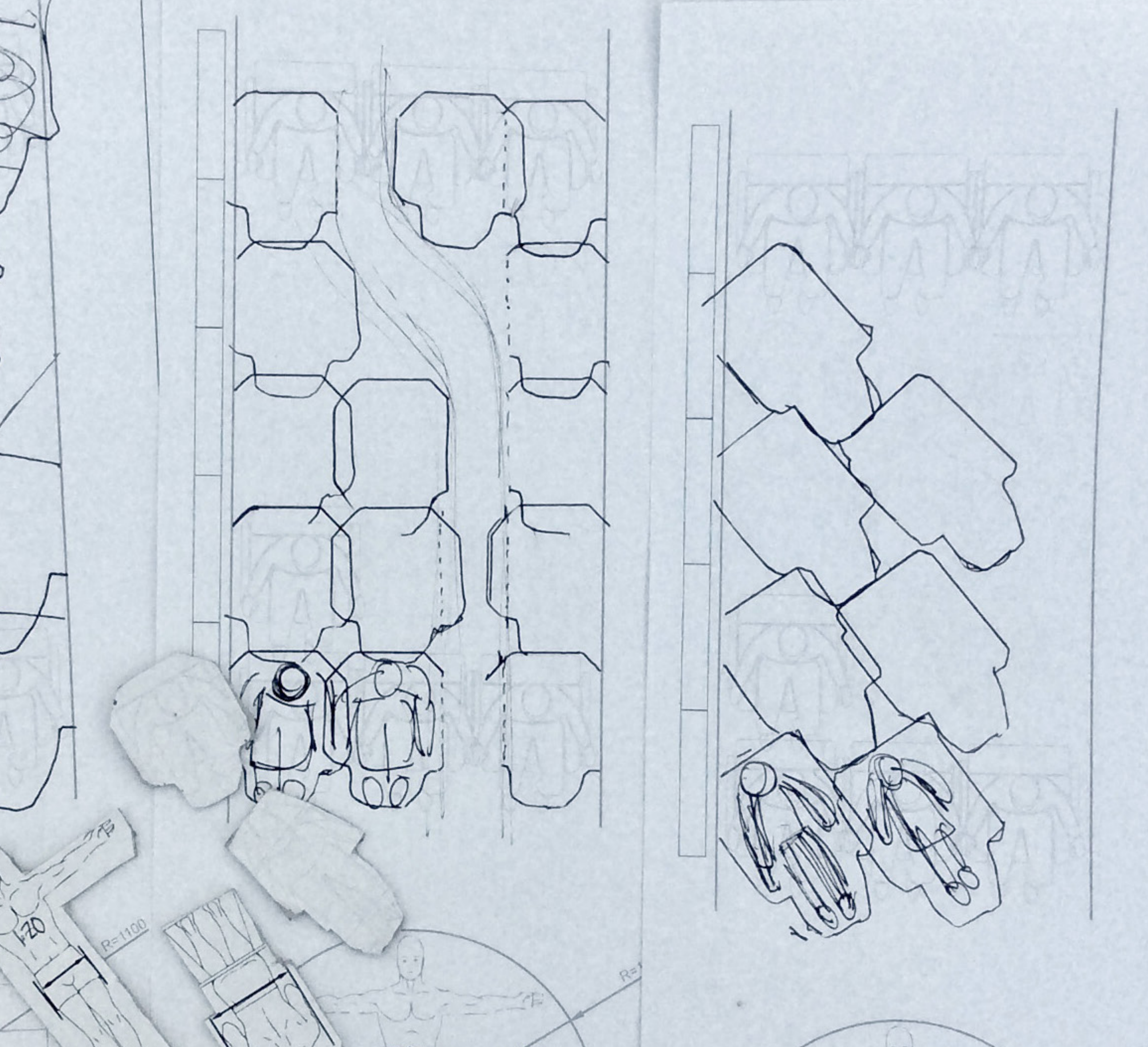
Two key components of any potential hyperloop system are frequent departures and city center station locations, the system outlined focuses on meeting these objectives by minimising station footprint.

This means pods make very short 'taxis' before being able to accellerate to full speed, on a linear layout with very narrow dimensions which could be fairly easily built in urban centers above or below ground.

One implication of this approach is that pods would be reversible in direction of motion, something easily achieved with a propulsion system similar to MAGLEV.



EXPLORING LAYOUTS



LAYOUT GENERATION

The Layout Of Passenger Accomodations (LOPA) is the cornerstone of any seat design. The orientation and packing of any seat layout is fundamental and is the connection between the craft and the seat itself.

Before moving into 3D, many LOPAs were tried in 2.5D models at 1:10 scale to ensure that a wide scope had been taken on idea generation.

FULL SCALE PROTOTYPING

In the technical research summary, the pod was defined at 2.2m dia. internal section. I created a test section from MDF parts which can was used to gain a considerable understanding of the limitations of the cross section. It was tested out out in real life with real people in different scenarios.

LAYOUT INSIGHT GATHERING

One main finding was that people preferred having an aisle. This enabled efficient entry and egress with a minimum number of doors, it also allowed for toilet breaks and prevented groups feeling isolated.

SIZE, SPACE AND ERGONOMICS

One aim was to have a proposal which was indifferent to the orientation of the direction of travel. Facing groups were attempted but these layouts led to inefficiency in spacing. For this reason, seating options which were reversible were pursued .

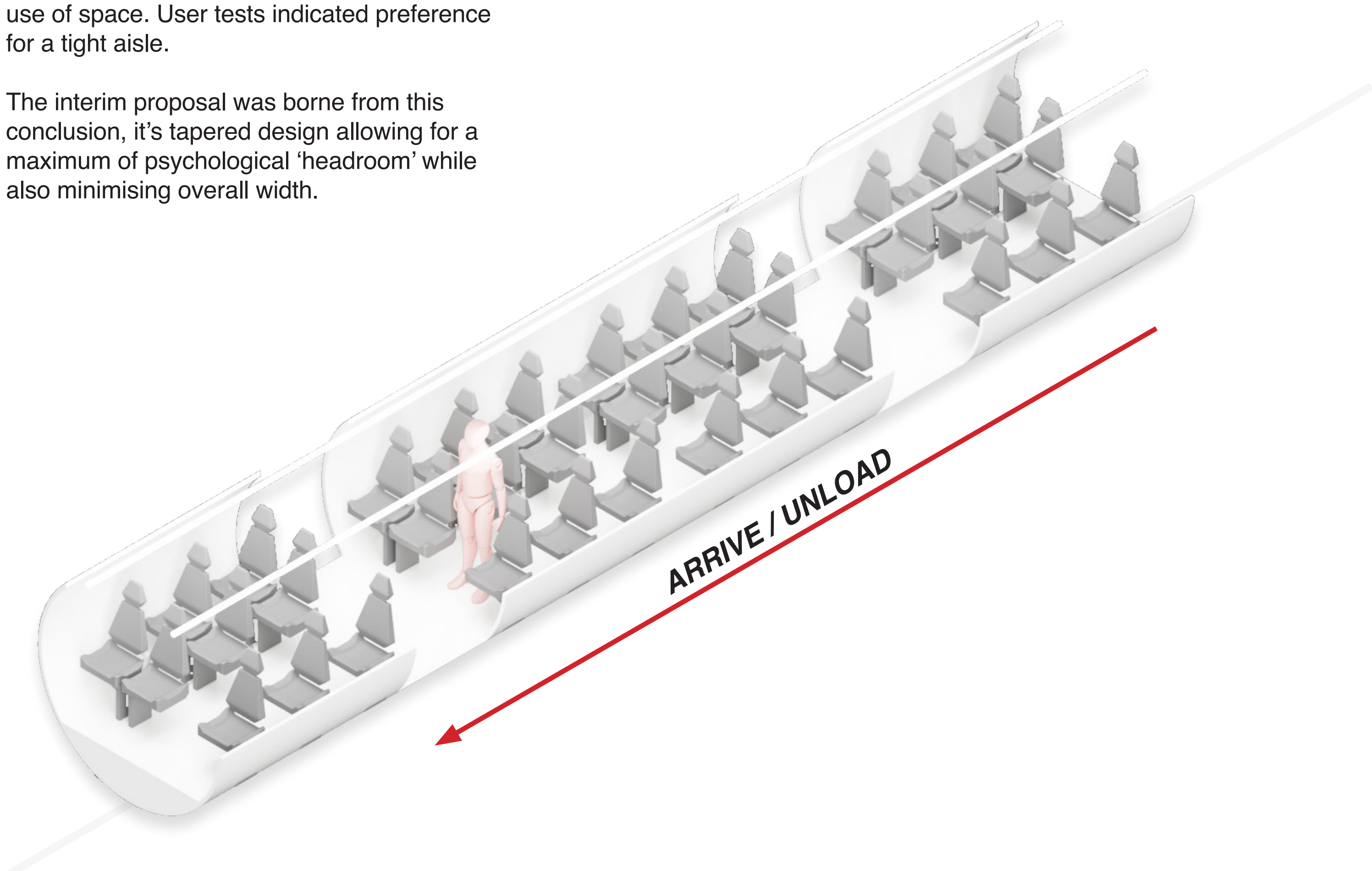
INTERIM LAYOUT CONCEPT

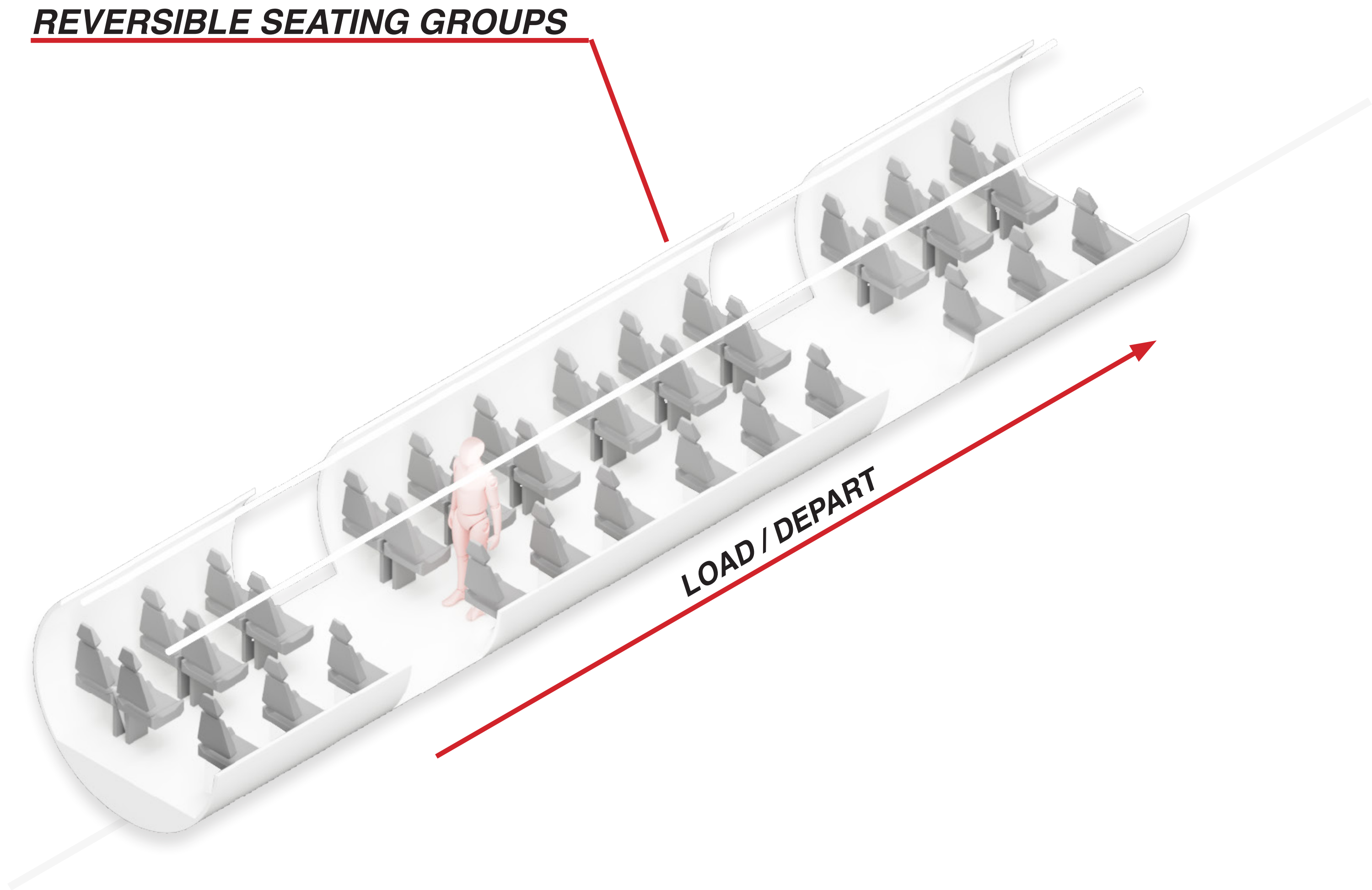
Pod Capacity 36
Pod Diameter 2.2m
Passenger Area 12m

A large part of the work up to the interim stage was in detailing the most efficient internal configuration, in accordance with the reversible pod concept.

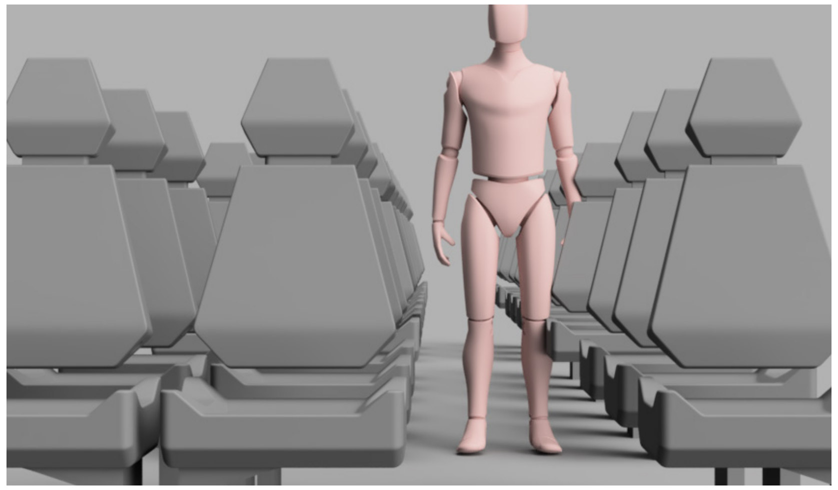
A fully-reversible consistent concept was chosen as it enables favourable treatment of each passenger, while enabling the maximum use of space. User tests indicated preference for a tight aisle.

The interim proposal was borne from this conclusion, it's tapered design allowing for a maximum of psychological 'headroom' while also minimising overall width.



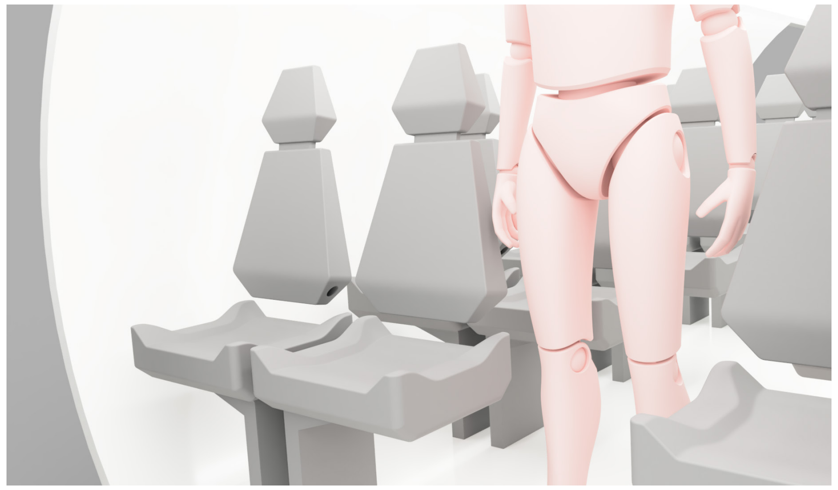


Chair Profile

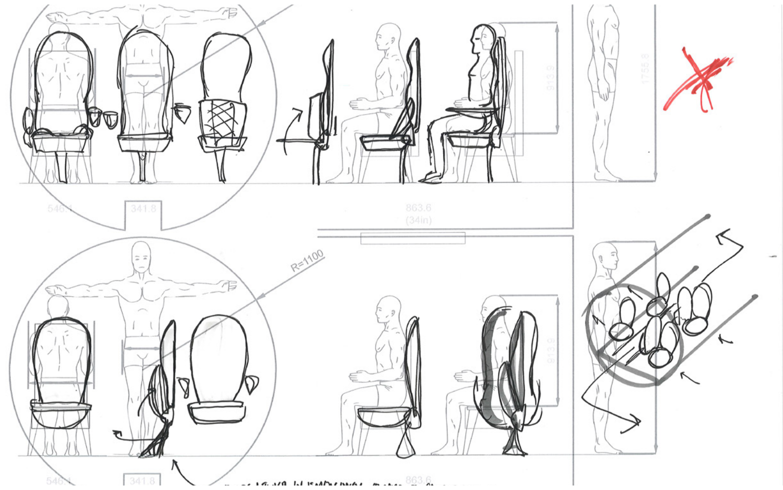


Aisle Space & Headroom

Hip room for access



DESIGN DEFINITION



JOINT LAYOUT AND CHAIR IDEATION

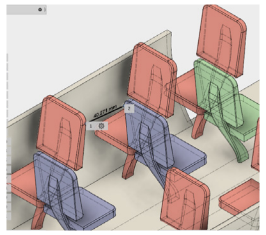
It was identified that the system, seating layout and specific seat were symbiotic, and therefore these were intially developed together in order to reveal new directions.

These investigations were carried out though sketching, brainstorming, and small scale models, taking into account from the start ergonomic factors.

CONTINUAL FULL SCALE IDEATION AND TESTING

Studio resources were used continually for rapid exploration. The volume available was a key factor and as such develpments were made more reliably and quickly though large scale sketching and modelling.

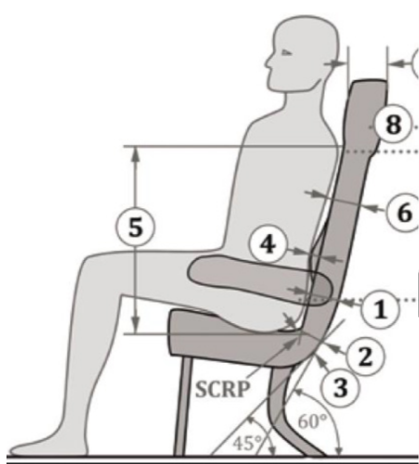
The results of these experiments led to a design which was deep rooted in requirements for adequate comfort and ease of access and egress.



3D MODELLING FOR LAYOUT AND DESIGN DEVELOPMENT

3D CAD software was used in tandem with continual ideation in order to realise joint seating and layout proposals.

These proposals were used mainly to explore and refine the space efficiency of the seating concept and to ensure that maximum use of space was achieved. It was found that seating all passengers in the same orientation was the most effective route.



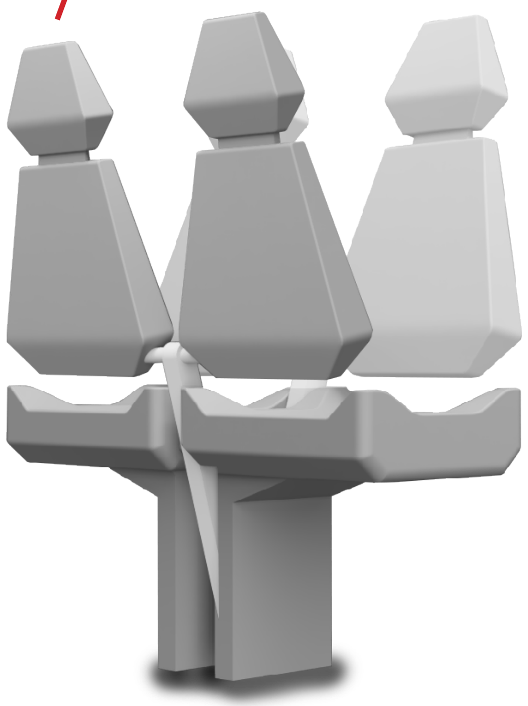
FOCUS ON STANDARDS AND DEMOGRAPHICS

An array of standards for seating design were reffered to, prominently FAR 25, Measure of man and woman, Boeng Guidelines, and Synthesis of Subsonic Airplane Design.

These sources were used continually to evolve the seating form into one which had the cabability to satisfy important safety criteria, and ensure maximal comfort for a wide variety of potential passengers.

INTERIM CONCEPT

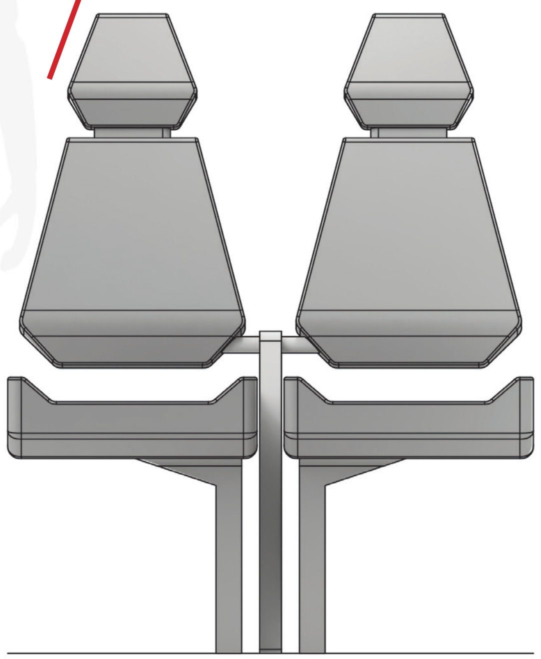
REVERSIBLE



LUMBAR SUPPORT

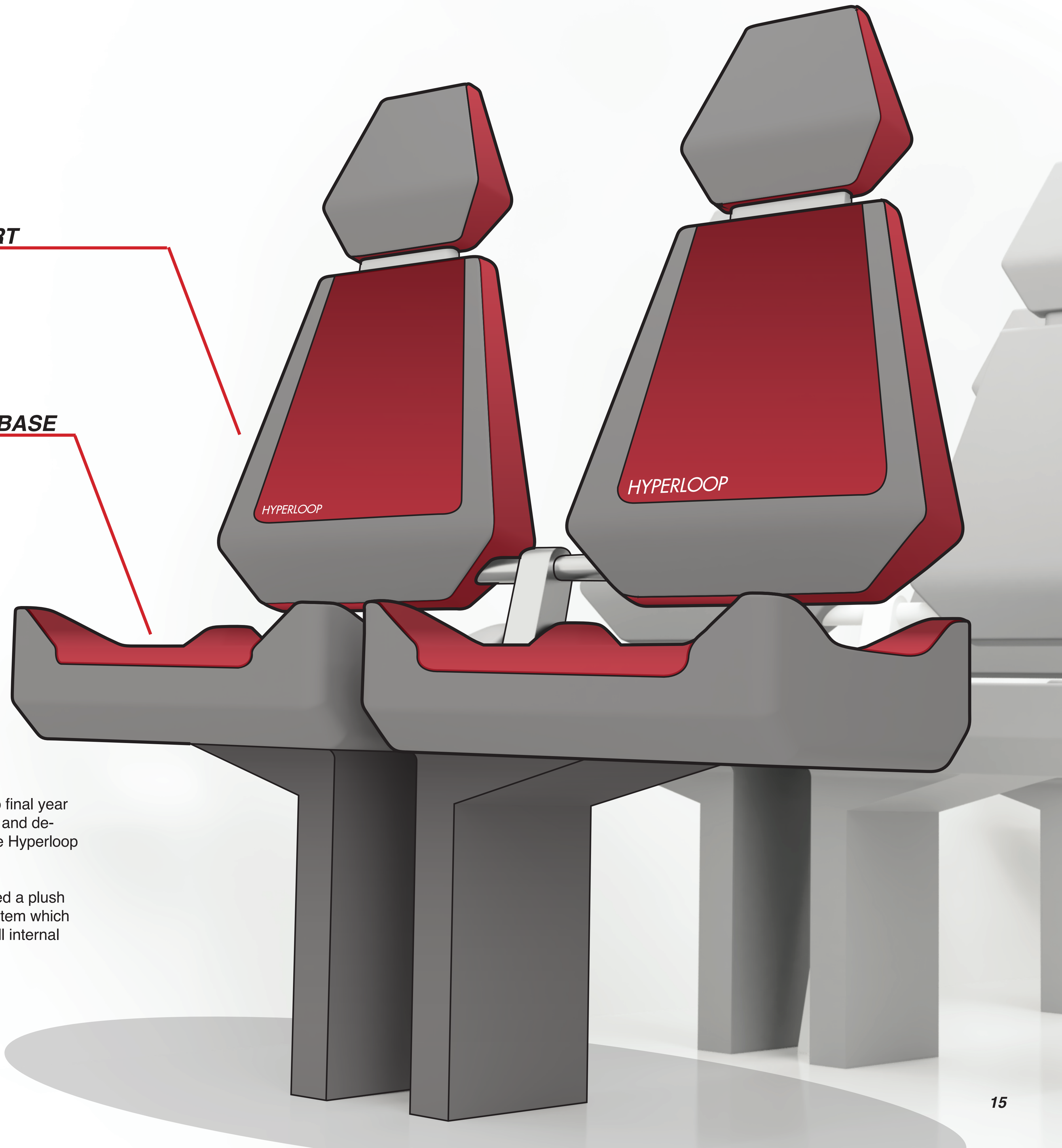
BI-DIRECTIONAL BASE

TAPERED PROFILE

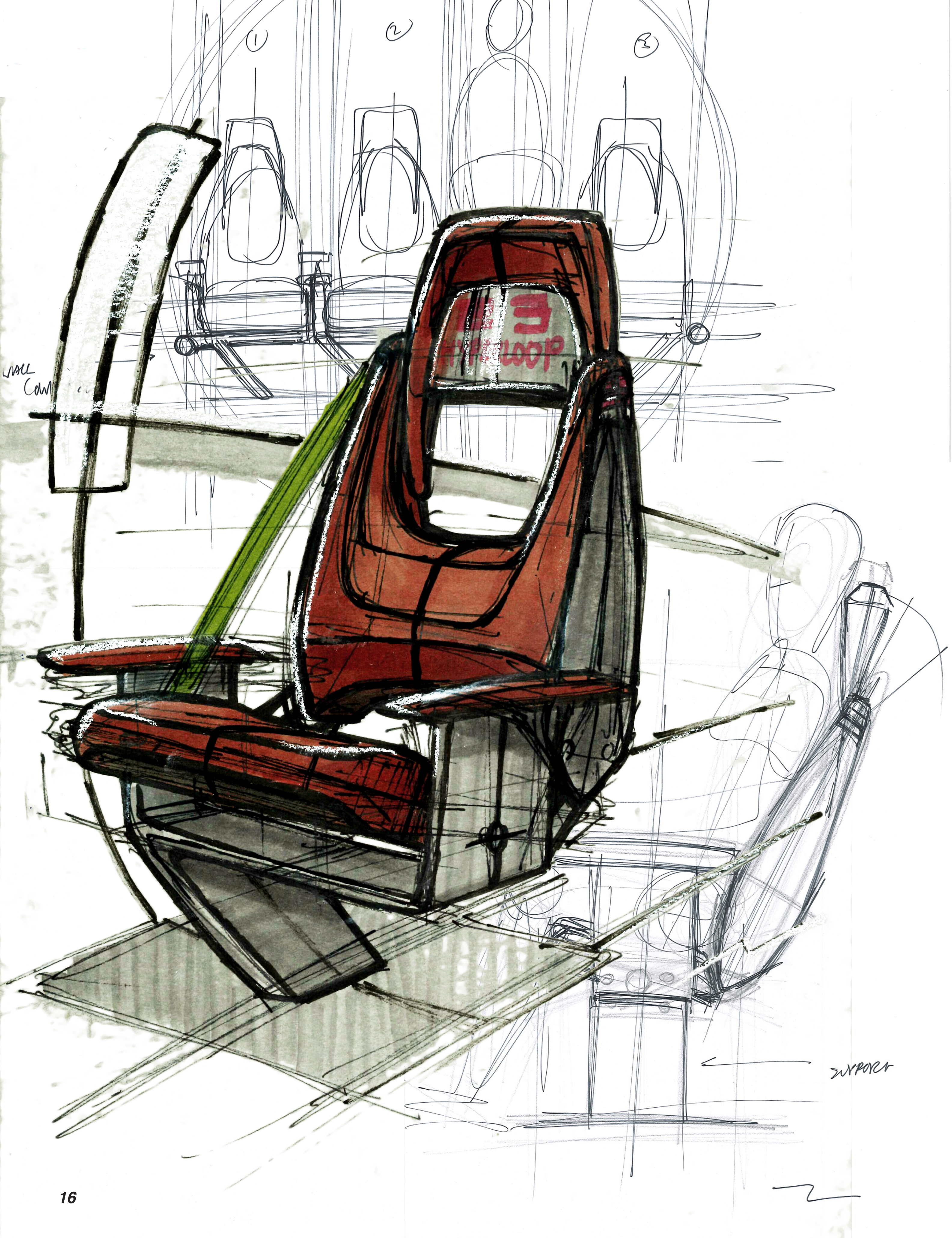


The focus of the overall Hyperloop final year project is to deliver a fully detailed and defined seating solution for a feasible Hyperloop system.

In it's interim stage, 'tetra' described a plush but durable reversible seat ing system which makes best advantage of the small internal space available.



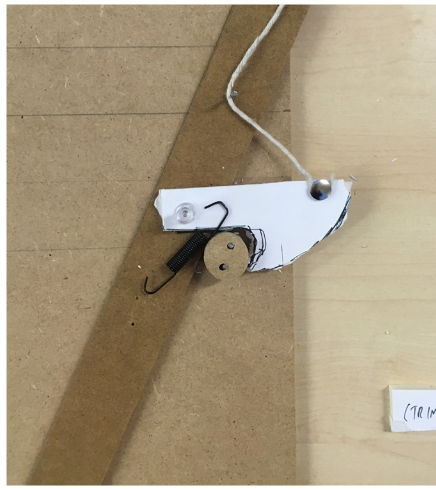
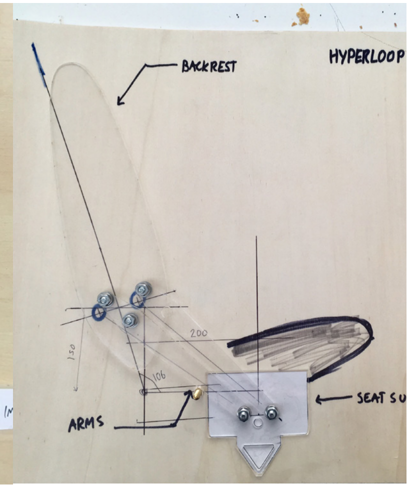
CHAIR DEVELOPMENT METHODS




FULL SCALE 3D MODEL AND REFINEMENT

A full scale 3D model was produced, which was key in developing many thoughts on the final design. The smooth action of the light-weight backrest was illustrative of the qualities of the design, but it was found that a more sophisticated mechanism may be required for final design.

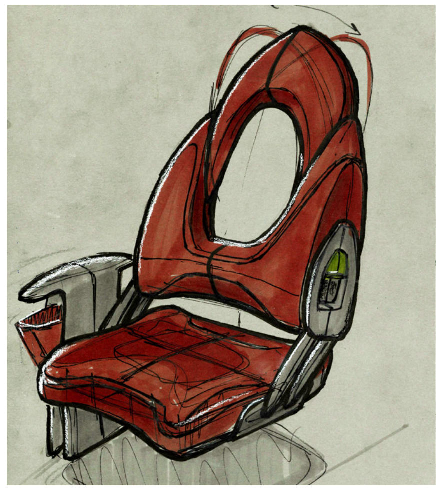
The prototype continued to be useful, as it was built to be strong and adaptable, it was later used for final design refinement.

2.5D MECHANISM DEVELOPMENT

In the development of more sophisticated mechanisms, 2.5D prototypes were used which enabled rapid prototyping of complex geometric problems.

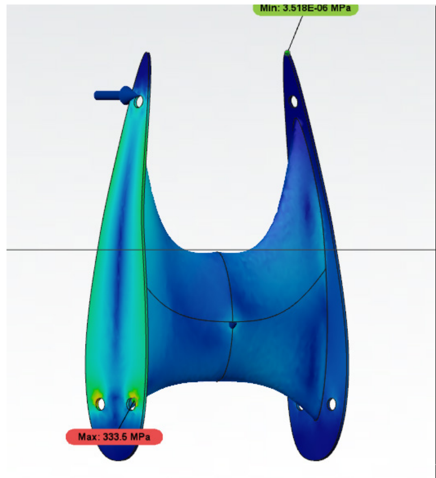
Refinements in these concepts led to the discovery of the importance of tightly toleranced connections, and helped ideate multiple locking mechanism.

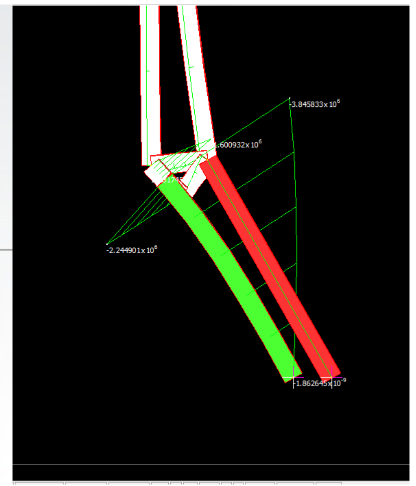



IDEATION AND FORM VISUALISATION WITH SKETCHING

The project stretched the boundaries of Product Design Engineering by developing designs with thorough attention to aesthetics and form.

Several iterations of sketching, at all scales, allowed my design to evolve into a more compelling finished product, and creatively uncovered the intention to open up the interior through minimal structure and padding.





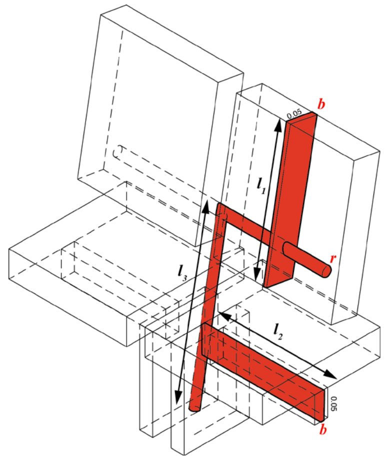
STRUCTURAL ANALYSIS VIA CAE SIMULATION

The final point of the technical analysis conducted was to ensure a design which was strong.

Acceleration cases and standards were studied to inform an investigation into the strenght of the design in 9G decelleration.

This refined the design into one which was a valid suggestion of a conceptual design.

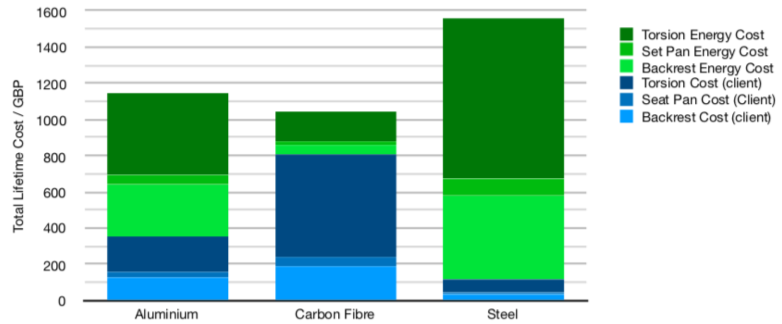
MATERIAL AND PROCESS SELECTION



STRUCTURAL INVESTIGATION AND SIMPLIFICATION

A seat from a domestic car was torn-down, under the assumption that the material choice would be steel. Furthter structural analysis efforts looked at the forces in the chair and the structures required to combat them.

This formed a simplified engineering model that was digitised and used prominently in the material selection process.



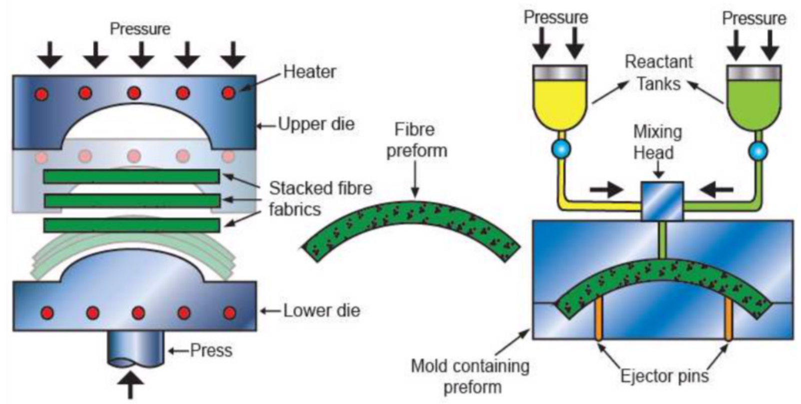
MATERIAL SELECTION THROUGH LIFETIME COST TO CLIENT

The cost of energy in transit was considered, in addition to cost of manufacture, to arive upon a material selection that would minimise overall cost to the client.

The material selected was carbon fibre, the lightweight properties of which gave suprising reductions in overall cost when compared to steel, aluminum, and a range of other materi-als, despite high initial costs.

EXPLORATION OF CARBON FIBRE MANUFACTURING PROCESSES

Carbon fibre was explored as a potential material, and manufacturing methods consid-ered. These were developed in tandem with ever more resolved design concepts in order to find a process that was manufacturable and feasible

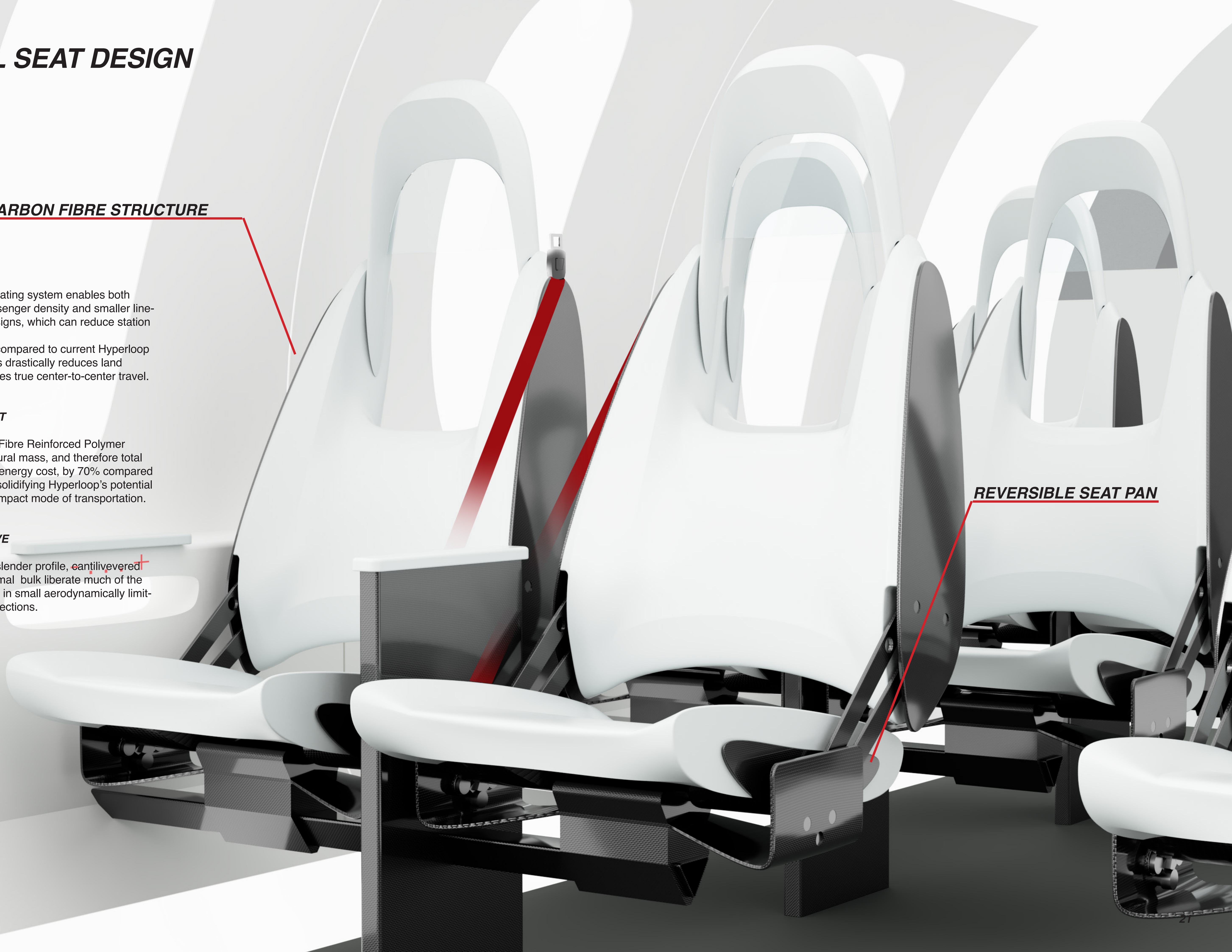


SELECTION OF APPROPRIATE PROCESSES THROUGH VOLUME

A production process selection focused on delivering a design concept which could be produced in appropriate volume. The se-lection was HP-RTM which is known for it's excellent volume production levels as it cures quicker than other methods.

The implications of this process selection were thoroughly considered in the final de-sign, with parts designed to have thin, mould-able profiles, and making use of titanium inserts to make accurate connections.

FINAL SEAT DESIGN



REVERSIBLE

A reversible seating system enables both maximum passenger density and smaller line-ar terminal designs, which can reduce station footprints
by up to 72% compared to current Hyperloop proposals. This drastically reduces land cost and enables true center-to-center travel.

LIGHTWEIGHT

Using Carbon Fibre Reinforced Polymer reduces structural mass, and therefore total lifetime transit energy cost, by 70% compared to aluminium, solidifying Hyperloop's potential as a reduced-impact mode of transportation.

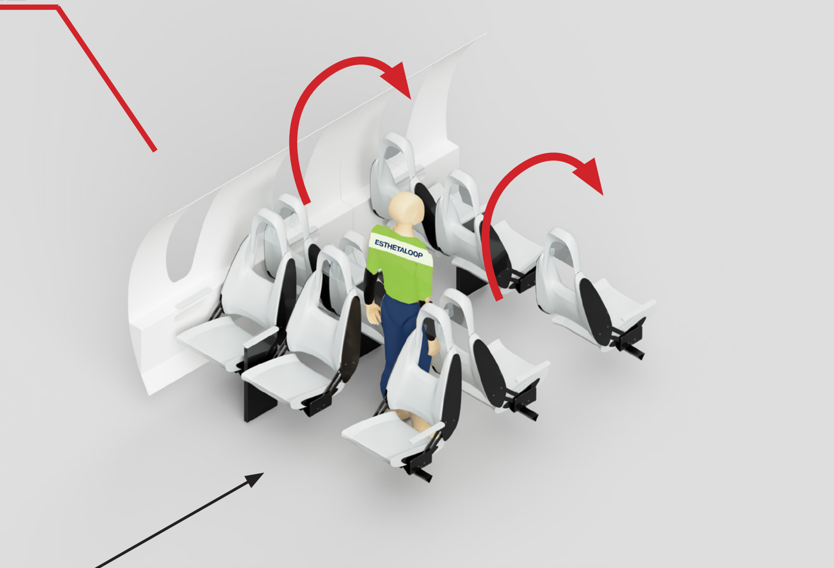
UNOBTRUSIVE

The system's slender profile, cantilivevered base and minimal bulk liberate much of the interior volume in small aerodynamically limit-ed pod cross sections.

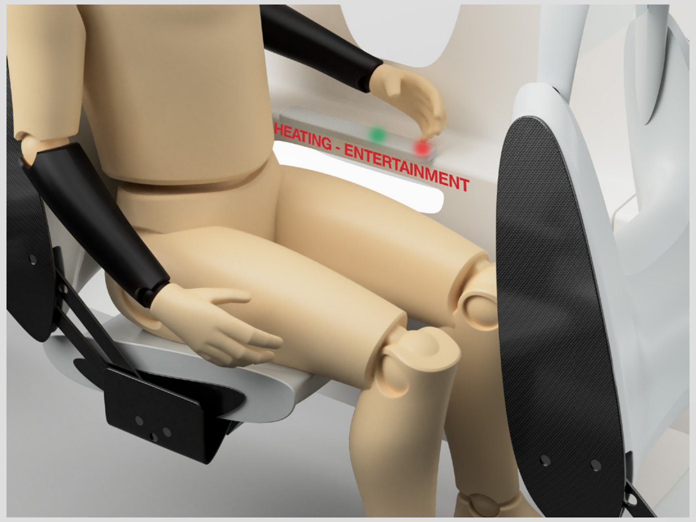
USER JOURNEYS

The chair interacts with many users over a single cycle, here these interactions are outlined in the context of the final design

OPERATOR REVERSAL

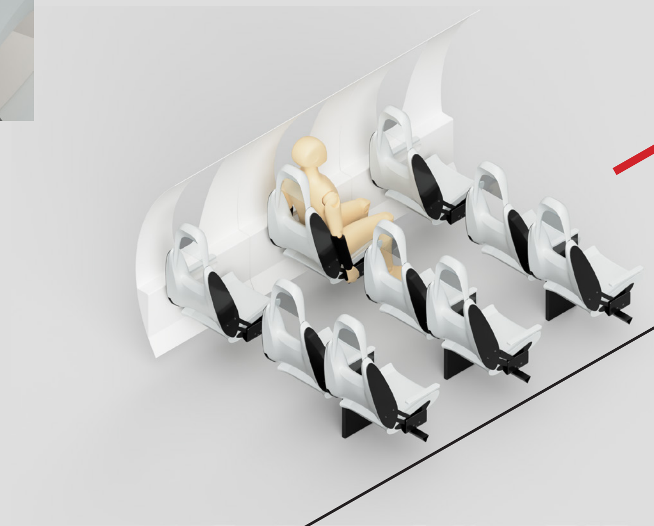


Passengers take their seats then use the attached three point harnesses to secure themselves.



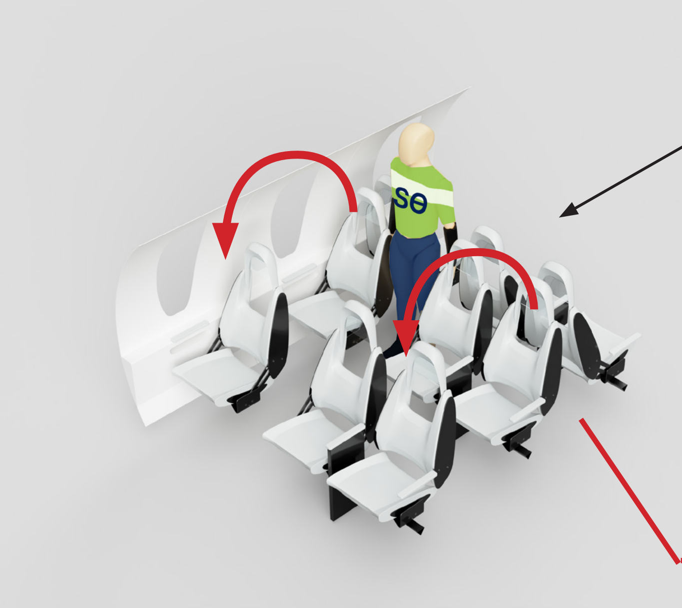
Temperature and entertainment controls are available on the armrest. Virtual windows ambiently light the passenger compartment.

TO DESTINATION



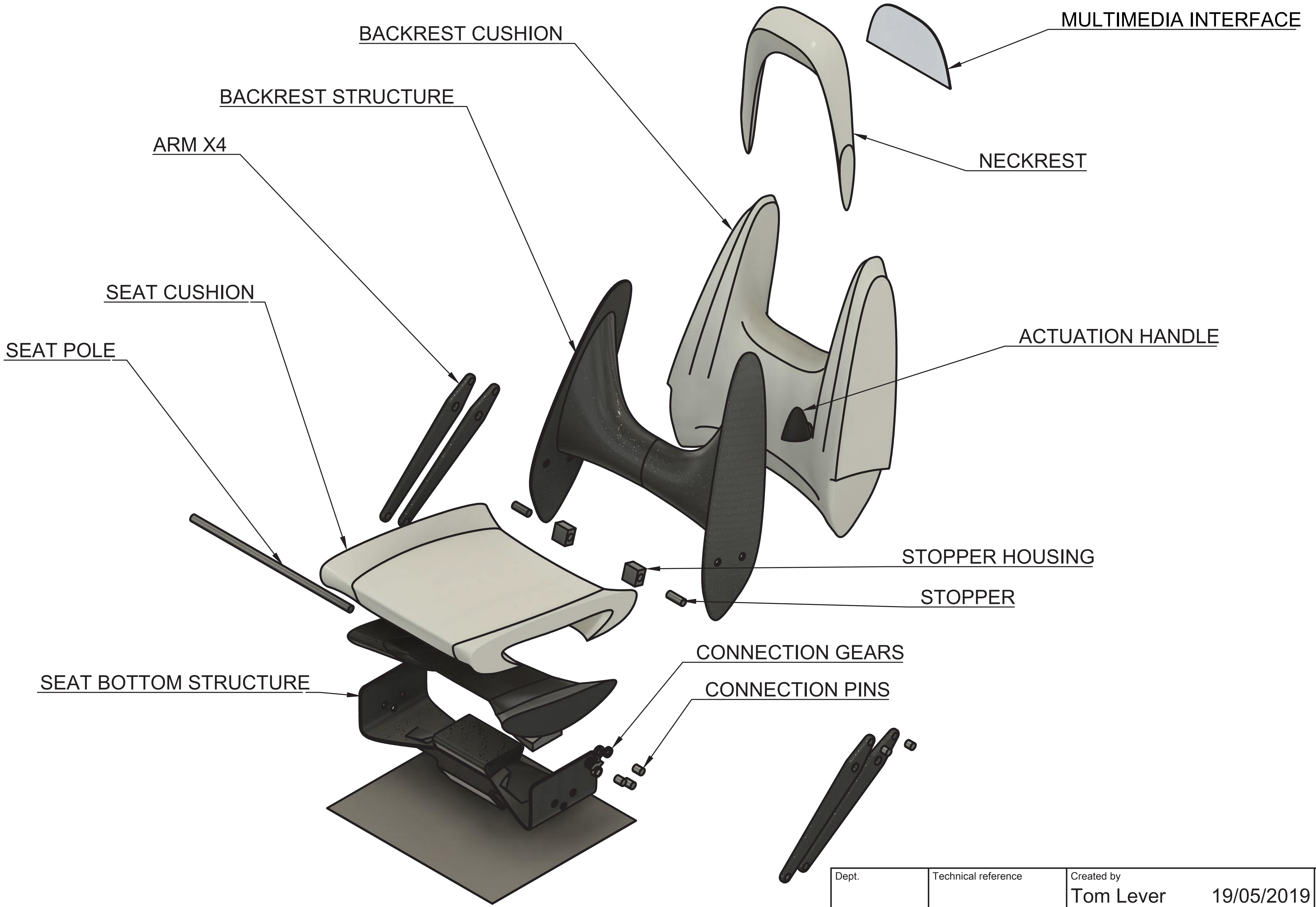
Passengers can occupy themselves on their personal VR / augmented devices, or use the translucent display screen to receive journey updates and light entertainment.

RETURN JOURNEY



OPERATOR REVERSAL

The adjustable neckrest can be adjusted to suit the passengers specific height, and provides support for light accelerative loads.



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VIA VERITAS VITA

GLASGOW HYPERLOOP

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