Kinder fly

Redesign of aircraft baby bassinet for improved flight experience

Asha Nixon

Aug, 2021

Kinder fly

Redesign of aircraft baby bassinet for improved flight experience

Master Thesis

Faculty of Industrial Design Engineering
Delft University of Technology
August 2020

Author
Asha Nixon
M.Sc Integrated Product Design

Supervisory Team
Chair
Prof.dr.Peter Vink
Mentor
Ir. Maxim Smulders

Company mentor
Mr. Andreas Schuster

acknowledgement

Throughout my graduation thesis project journey, I have gained huge support and guidance.

Firstly, I would like to thank my chair, Prof. Peter Vink, who gave constant support throughout the project. Your great help and valuable guidance helped me to take the right direction when facing obstacles. Additionally, your constant guided me to achieve well developed higher level of work.

I would like to present my gratitude to my mentors at TUDelft. Stefan van de Geer, you have been very supportive from the beginning of this project. I highly appreciate your insightful feedback, which pushed me to explore and get inspired by everything around. I am very thankful to Maxim Smulders who agreed to mentor me during the final stages of my project. Your inquisite questioning and fruitful discussions sharpened my thinking and analysing skills.

I am fortunate to have Andreas Schuster from Belgraver aircraft interiors as my company mentor. Andreas, I want to thank you for your constant involvement in the project and my opportunities to explore the project scope. . Furthermore, I want to thank Erik van de Meer from Belgraver aircraft interiors for expert advice about aviation industry and market.

I would like to thank Mark Broekhans, Technical Fleet & Arbo Process Engineer, KLM and Flight Attendants: Danette Toet, Michele Smeele, Esther van der Meer, Jane van Hazebroek for their wonderful collaboration to represent airlines and providing insights during different stages of concept development.

I want to thank Don, Roland and other PMB faculty who provided expert help and support for building multiple iterations of the prototype. I would particularly thank Lynda Paulde for providing a crash coarse on tailoring which was a fruitful skill used for this project.

I would definitely want to thank my parents, brother and Lena for being the constant source of encouragement and shoulder of support throughout the project journey. Finally I would like to thank my friend Adi and Anand who provided stimulating discussion, good distractions and care to keep me happy throughout my graduation project.

executive summary

Better flight experience for babies and parents

Travelling by air has seen a boom in the past decades due to social, demographic and economic factors (Adepalli, 2018). An increasing trend is observed among young parents travelling with their babies facilitated by low travel costs (Yeoman, 2012). However, babies below 2 years are not considered as regular passengers and airlines make babies fly on their parents/ guardians lap with no or meagre fees (EASA, 2019).

Most airlines provide baby bassinet to help parents manage their journey. The current Belgraver bassinet provides a temporary place at an economy class bulkhead wall for babies below 6 months to sleep and relax during the flight journey (KLM, 2021).

However, this design is aged and needs to be updated to meet the user needs and desires. In addition, since this product is integrated into the aircraft, it needs to meet aviation safety regulations like 16G test, burn test and strength test (Belgraver, 2021).

An abundance of research is carried out to understand adult passengers' physical, psychological, and social comfort, reflecting the evolution of passenger seats and amenities (Anjani, 2021). However, this is sparse in the case of infants (0-2 years) and their parents who experience internal and external stress throughout the journey (Harris, 2014).

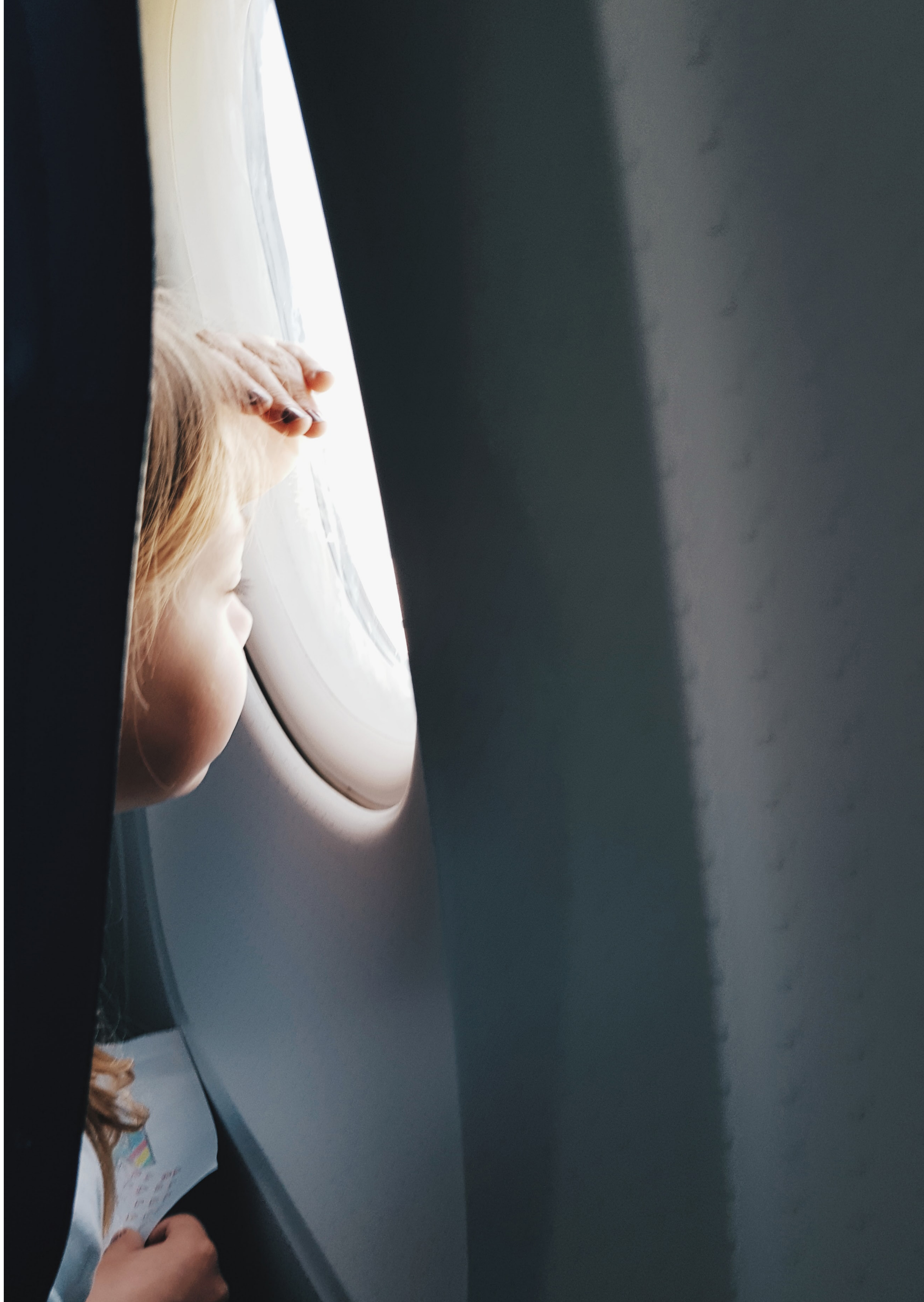
The main opportunity of this master thesis is to redesign the baby bassinet to meet the identified needs of parents, babies and flight attendants in the economy class cabin environment, which is implemented in the market in 3 years.

In this project, the current bassinet interaction insights of babies and parents were obtained by interviewing 2 parents and conducting an online focus group with 14 parents. Further, 4 flight attendants and a flight manager from KLM were interviewed to understand their needs and requirements. The key challenges were developed by grouping the drawbacks of the Belgraver bassinet. They are comfortable, ease of handling and hygiene.

The solution Kinder fly is a dual product: bassinet and baby seat, to accommodate all the babies under 2 years. Each sub-system, frame, basket and mattress, is developed through iterative cycles: synthesis – simulation – evaluation – decision (Roozenburg et al., 1995). The concept development results were evaluated with 3 parents in aircraft environment, in which the Inclusivity of bigger babies was highly appreciated.

The challenges of comfort and ease of handling were given priority, and significant improvement in these areas are obtained. However, hygiene issues need to be tackled in the future. In conclusion, the concept, Kinder Fly entertains the baby and parent to have a stress free, relaxed and comfortable flight experience.

contents



kinder fly 2021

1 introduction

1.1. Client and assignment

Belgraver Aircraft Interiors is one of the leading companies in non-structural aircraft interior parts. They are based in Naarden, The Netherlands. Their mission is to satisfy their airlines' customers by providing cost-effective alternatives to OEM products with improved quality and quick production time (Belgraver, 2021). The services include design, manufacture and repair of interior parts.

A baby bassinet is a small baby crib in the bulkhead wall of the economy class of Long haul flights (LHF) (see fig 1 (Tan, 2012)). Many airlines provide this non-mandatory bassinet that focuses on helping parents manage their sleeping babies (below two years of age). The initial assignment is based on analysing and improving the current baby bassinet of client Belgraver aircrafts interior (see fig 2). This bassinet design is primitive, with its last update in the late 1990s (Belgraver, 2021).

As a result, airlines and Belgraver are interested in upgrading the bassinet design to improve all users' present and future needs. For this project, the airlines' perspective is obtained from KLM personnel. This assignment is focused on creating a user-friendly flight experience for economy class parents with infants in long haul flights, which is to be implemented within 3 years.

Figure 1 Baby bassinet in economy class context

Figure 2 Belgraver baby basinnet

1.2. Approach

The User-Centred Design(UCD) approach utilised for this project where the focus is on needs, desires and potentials of users (baby, parent and flight attendants) of baby bassinet (van Boeijen et al., 2020)

UCD in combination with the agile design and development process leads to quick design, simulation, evaluation and reflection cycles of the intermediate outcomes with users and the client (Jongerius et al., 2013).

This integrated approach produced highly involved user inputs which help in bridging their gap with airlines to realise a desirable, feasible and viable solution. The overview of the design methodology of this project is visualised in fig 3.

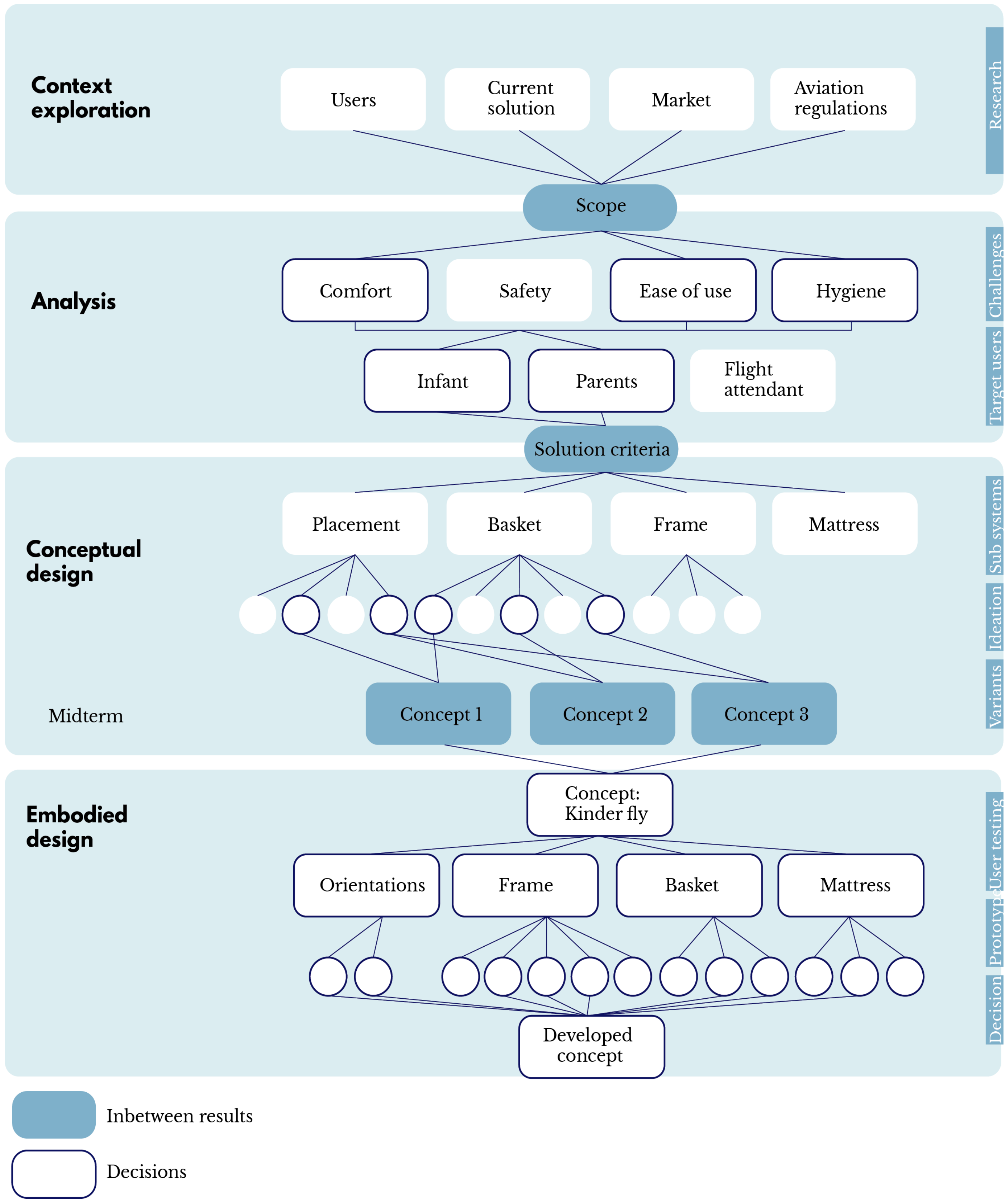


Figure 3 Overview of methodology

2 context exploration

2.1. Post-COVID 19 trends in Long Haul flights

2.1.1. Long haul flights for babies

Commercial aviation can be categorised based on flight length as short, mid and long haul flights. On average LHFs ranges flight duration of 6 hours or more (Moffitt, 2020). With the impact of globalisation, accessible air travel, and global economic growth, family tourism is growing, with more than 60% of millennial parents travelling with babies (Mandich, 2019).

LHF journeys are often preferred by parents travelling intercontinental to avoid interim transfer hassles accompanying babies (Anderson, 2021). It provides the quickest global travel solution encouraging more parents with babies to travel.

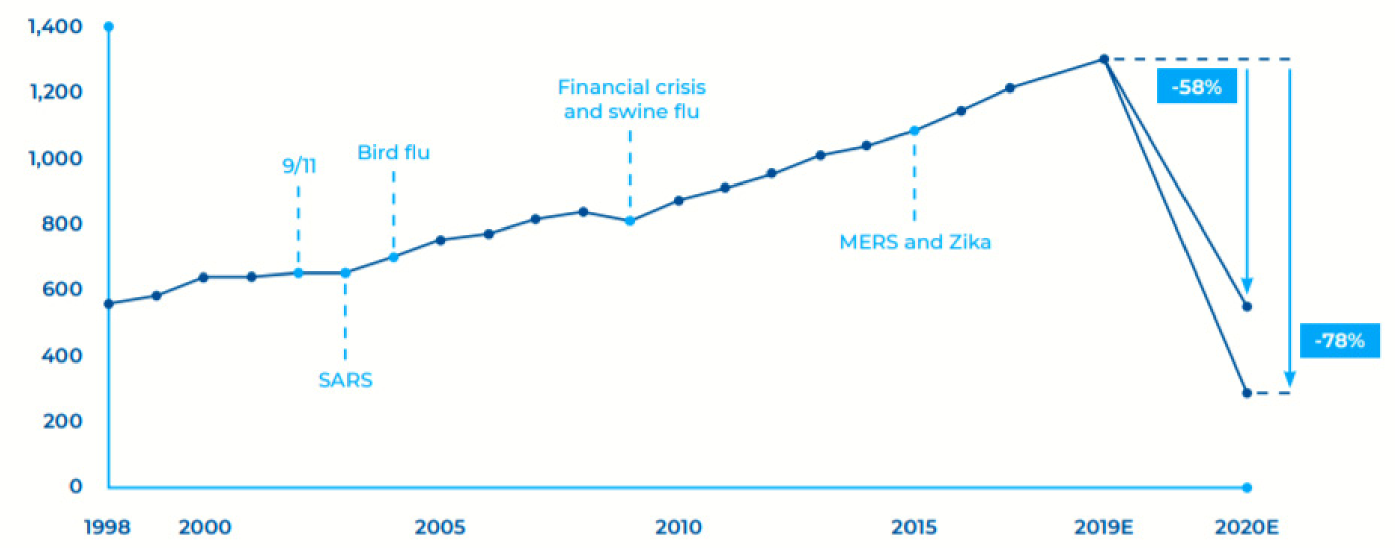
2.1.2. Covid impact and recovery

Nearly 4.7 billion people travelled by air pre-COVID in 2019. Even though this figure dropped in 2020, it is forecasted to increase again by about 2.8 billion in 2021 (Mazareanu, 2020).

Among this passenger traffic, many babies travel on domestic and international airlines. Existing reports suggest that nearly 1% of passenger traffic constitutes infant passengers, which estimates 8 million in 2021 or equivalent of 76,700 infants every day ((Kamarbhari, 2018).

In response to the COVID-19 pandemic, international family travel dropped to 78% compared with the pre-pandemic period in 2020 (fig 4). IATA forecasts slow yet steady air passenger traffic, returning to its glory revenue not earlier than 2024 (Recovery Delayed as International Travel Remains Locked Down, 2020).

The observed steady rise of demand for baby bassinets in LHF further persuades airlines to redesign to attract this niche yet significant group of passengers: parents with babies. In addition, Belgraver would benefit from having the improved design among its competitors (further explained section 2.5).



Source: World Bank, UN World Tourism Organization (UNWTO), Skift Research estimates. Data as of August 2020

Figure 4: Air passenger traffic trend

2.2. History of Aircraft baby bassinet

Baby Bassinets are safe and personal space for babies to sleep. It usually has flexible cloth walls, a mattress for comfort and a detachable cover on top to protect the infants from falling out (Newtonbaby, 2021). In addition, its distinct features like lightweight, compact form and inexpensive compared to conventional cribs had led to using bassinets in airplanes (Baker, 2015).

Historically, baby bassinets are optional services provided by airlines usually available in LHF. FAA categorise baby bassinet as an accessory of aircraft which is allowed to hold the baby on air. In order to understand the current user experience with baby bassinets in the flight ecosystem, the historical advancement in airline services for infant passengers is studied. This research is obtained from online resources, journals and documentaries. Finally, the gained insights are presented as a timeline in fig 5.

1953

British Overseas airways corporation, babies are placed in "sky cots" attached to the overhead luggage bins above the parents' seats (Leach, 2017). The structure is similar to a hammock with see-through panels on the side. Fig 5a Image credit: British Airways Speedbird Heritage Centre, 2021

1975

A major event in 1975 was Operation Baby when over 25ooo babies were translocated from Vietnam to the U.S. during the Vietnam war. The babies were placed in cardboard boxes that were strapped to the passenger seats (Wright, 2016). Fig 5b Image credit: Vintag, 2016

Figure 5 a,b,c Aircraft baby bassinet - product timeline

1985

By 1985, Bigger babies were allowed to fly with car seats when the FAA approved using the Child restrain System(CRS) on flights (Lawdepot, 2021). However, this demands to be strapped to a passenger seat, as shown in figure 5c. Image credit: (Reynbakh, 2021)

The main difference in the evolution of aircraft baby bassinets is the placement in the cabin. The first bassinets are attached to the overhead cabin luggage, where babies are placed above the parent's seat. The bassinet has moved to the bulkhead wall in the latest designs. A typical pattern seen with the placement is keeping the bassinet away from utilising the passenger seats. This decision is motivated by increased passenger traffic and revenue generation for airlines, unlike the free baby bassinets (Broekhans, 2021). Further research and analysis of aircraft baby bassinet placements is discussed in section 8.1.

2.2.1. Belgraver Bassinet product

The client Belgraver aircraft interiors is one of the leading global suppliers of baby bassinets providing their product service to various international airlines like KLM and Emirates (Belgraver, 2021). This section discusses the current bassinet design, placement in the cabin, functions, and limitations.

Service:

EASA, 2019 defines the bassinet function as holding the baby on air with exemption during turbulence and Taxiing, taking off and landing (TTOL). The Belgraver baby bassinet design is only for EC and PEC. Although aircraft baby bassinet is not considered the safest means of travel for infants, they are still advocated to be utilised to improve the comfort of infants and parents in-cabin environment (EASA, 2019).

Currently, this bassinet is integrated into the bulk headwall of the economy class of long haul flights. In order to avail aircraft bassinet, parents need to inform the airlines prior to book the bulkhead wall seats. Since the bassinet locations are limited, the bassinet is provided first come, first serve basis. The number of bassinets per flight depends on the aircraft cabin layout, airline policy, number of oxygen masks available in a row and passenger demand (EASA, 2019). However, on average, a long haul flight AIRBUS, BOEING models have a standby of 4 bassinets per flight (KLM, 2021) (see fig 6).

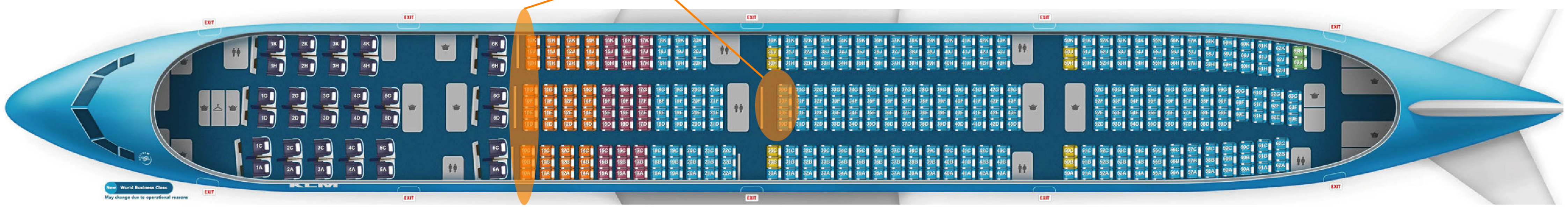


Figure 6 KLM B777-300ER flight map bassinet seats

Design

The current Belgraver baby bassinet design comprises three systems: Aluminium tubes enclosed with a fabric basket and a mattress assembly with foam and hardwood. The system tree's overview with its functions and aviation standards is shown in figures 7 and 8.

System Tree

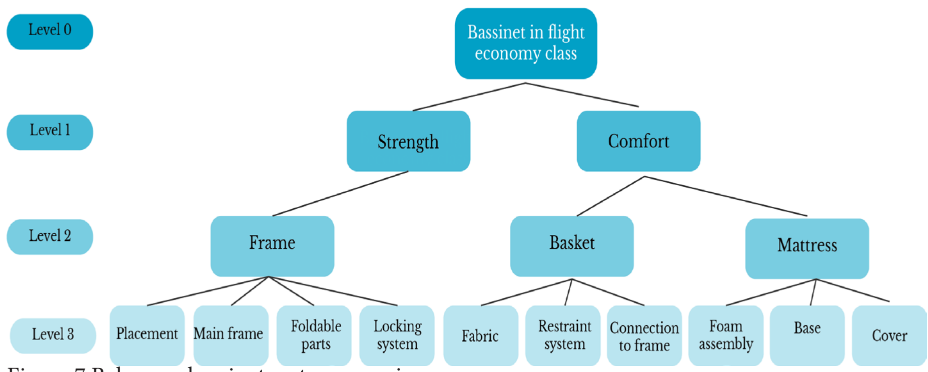


Figure 7 Belgraver bassinet system overview

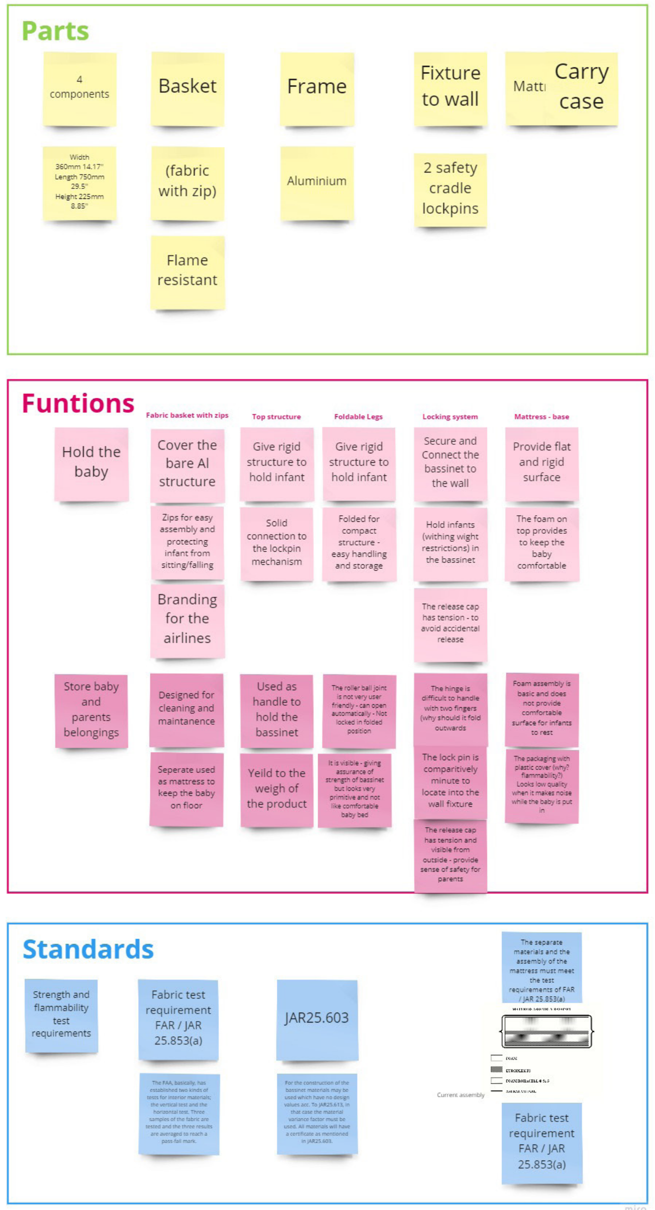


Figure 8 Belgraver bassinet: Parts, Functions and Aviation standards

The dimensions of the current bassinet design are width 340mm, length 750mm and height 225mm. These dimensions are primarily based on the width of the bulk headwall and not on the anthropological data of infants below two years (Belgraver, 2021). Therefore, this bassinet dimension poses stringent baby height and weight limitations. The baby's height should be less than or equal to 650mm, and the maximum weight limit is 40lbs (Belgraver, 2021). According to Anthropometric data (WHO Department of Nutrition for Health and Development, 2006), these limits restricts babies over six months to utilise the bassinets. Hence, bigger babies 6-24months need to travel on parent lap throughout the flight journey.

The bassinet is connected to the wall using with push ball pin mechanism, which is part of the top frame (see fig 9). The bulkhead wall has two pin slot holes. The airlines decide the height of lock pin slots, which is assumed to be influenced by significant passenger demography ergonomic requirements. For example, the bassinet lock pin holes in KLM aircraft are placed 1000mm above the floor (Appendix A). These height and lock pin hole dimensions are decided when the aircraft is purchased from airline manufacturers. Therefore, any changes to these parameters involve a collaboration of airline manufacturers. As a result, the bassinet height and lock pin system are out of design to achieve fast implementation of bassinet redesign.

Figure 9 Belgraver bassinet: Lock pin

2.3 Overview of Stakeholders

In order to improve the current Belgraver bassinet product, it is essential to identify the stakeholders that interact with the product on multiple levels.

This analysis results from initial literature research, interviewing the client (Schuster, 2021) and airline experts (Broekhans, 2021) (van der Meer, FA user research, 2021)) and observing multiple video logs of babies in.

Furthermore, the relationship between these stakeholders and their impact on this project is visualised in a Power vs Interest matrix shown in fig 10.

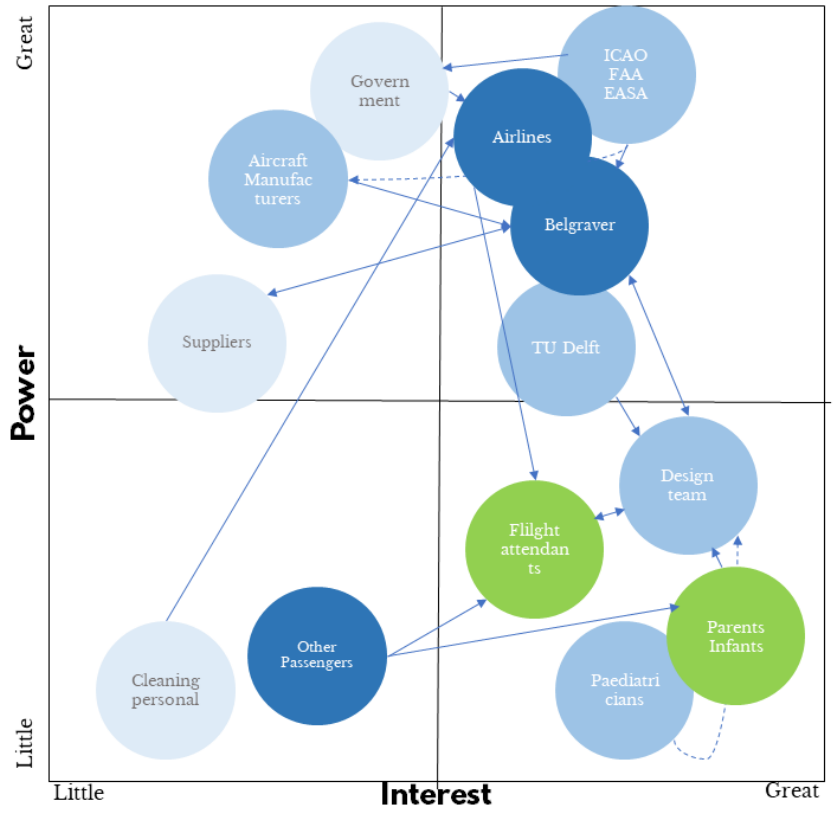


Figure 10 The various stakeholders organised along interest and power

Babies, Parents and Flight Attendants

This project's primary stakeholders are the parents and infants who are the intended users and interact the most with the bassinet system. A flight journey with a baby is found to be highly unpredictable, and parents usually prepare for the worst, most stressful experience (Hemingway, 2018).

On the other hand, a relaxed baby in flight can tremendously improve the mood of the flight environment and co-passengers. In turn, parents can relax and enjoy their journey. Thus, a comfortable and hassle-free product interaction for parents and babies will build their confidence to travel more frequently and trust the airlines and Belgraver products (Lozadac, 2020). Furthermore, parents can influence other new parents with their experiences to choose their flying carriers. Parents highly follow paediatricians inputs about babies healthand also it is necessary to research and mandatorily address to design a medically safe bassinet (Branciforte, 2019).

The next interested stakeholder is the FAs. They handle the product during installation on the wall, storage, inspection and brief cleaning of the bassinet (Broekhans, 2021). Further, interviews with FAs will help in identifying their issues with the handling of the product. Addressing FAs requirements will assist them to provide better service to babies and parents.

Belgraver

Being a lead manufacturer of non-structural aircraft interior parts with global airline customers. Aircraft baby bassinet is one of the special products in their portfolio, customised to different airline needs with periodic repair and maintenance programs (Belgraver, 2021). Hence, the redesign of the bassinet focussing on baby and parent interactions would provide the market advantage and better business and new airline clients for Belgraver. To bring this to reality shortly, the crucial requirements are fast implementation and manufacturability abiding by the existing aviation standards. Therefore, the scope of this project does not involve airlines manufacturers.

Airlines

Over the decades, airlines strive to keep up their high-cost effective business, which has strained the user experience in a cramped flight environment. On the contrary, airlines are also working towards a customer-centric future flight experience (KPMG, 2020). The focus on bassinet improvement has been minimal due to their low volume and meagre revenue turnout (explained in detail in section 2.4). However, airline companies are pushing their bracket of inclusive inflight experience for all. Their major requirements are to address this target group's needs and create a future-ready cabin experience with interior design aesthetics.

Aviation associations

International Civil Aviation Organization (ICAO), European Union Aviation Safety Agency (EASA), Federal Aviation Administration (FAA) are some main aviation associations that regulate and standardise aviation systems. They lay the foundation to determine the airworthiness of all the products, including the baby bassinet (FAR/JAR standards) (Belgraver, 2021). Further explanation of bassinet standardisation is discussed in Apendix B.

Identifying a striking balance between the needs of all stakeholders is challenging and time-consuming. However, to conclude, it would be ideal to prioritise the requirements of babies and parents while acknowledging the positive technical aspects of the current bassinet design to establish a desirable and feasible solution.

2.4. Services for babies from commercial airlines

The aviation industry is still far from providing an inclusive service, especially for special groups like babies and disabled passengers. Accessibility and Inclusivity in air travel is the main goal discussed during the IATA Global Symposium 2019 (IATA, 2021).

Particularly baby passengers are not always welcomed into air travel. Highly focused on catering to the luxury travel of business travellers, some airlines act indifferent towards these vulnerable infants and their families. For example, Malaysian airlines banned children from first-class and all premium classes of A380 (Flynn, 2012). Silent rows of 7-14 (devoid of passengers less than 12 years old) were announced as a marketing strategy by AirAsia (AirAsia, 2013). This culture is expected to change into providing inclusive and personalised services in the future.

Many airlines have started the dialogue between industry, regulatory associations and passengers to improve this situation. Most airlines provide the essential services of discounted or no ticket fare, free check-in of strollers and car seats and priority queue during boarding (KLM, 2021) (Emirates, 2021).

Bassinet service is provided by highly customer-centric airlines for their long haul flights. The top three family-friendly airlines – Ethihad Airlines, AirCanada and Qatar airlines have pushed this further to providing children in-flight entertainment, special meals and complimentary toys (The most family-friendly airlines, 2020).

In addition, with more and more social conversations between parents around the globe, there is a solid emerging voice demanding to meet unique requirements. More and more millennial parents share their experiences with flying with their babies online as video logs, community posts influencing the travel choices of other parents. It has further pressurised the aviation sector to improve our target group's flight experience.
Airline companies aim to address babies and parents' physical, social and emotional comfort by redesigning the existing baby bassinet.

2.5. Market analysis of baby bassinets

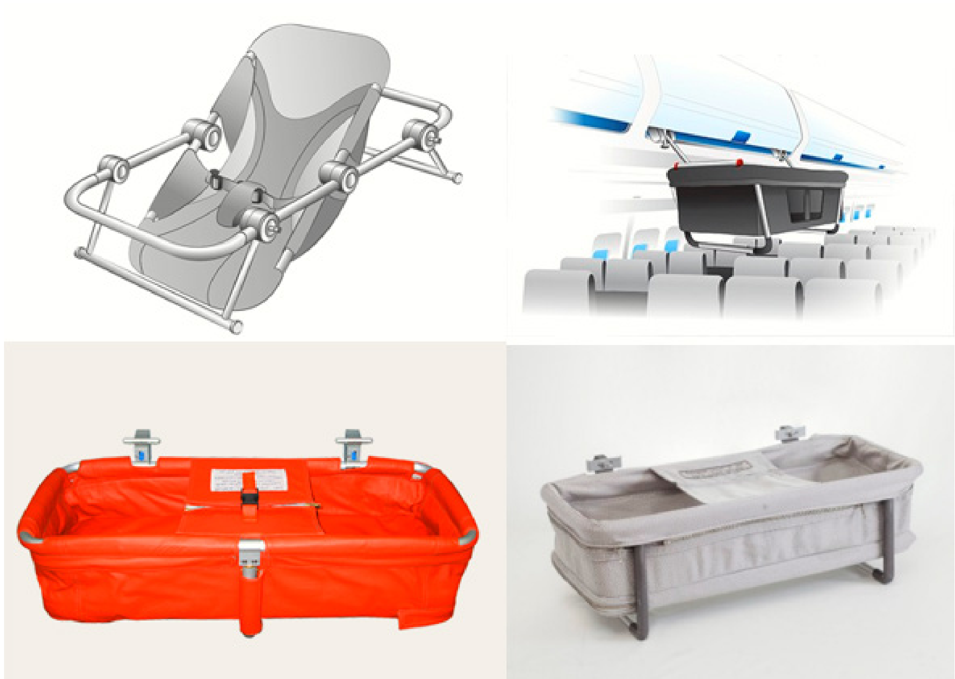


Figure 11 Market analysis a. UUDS Premium class, (b) UUDS Economy class (c)Diethelm Keller aviation (d) Anjou Aero

A few comparable baby bassinets exist on the market, such as the baby bassinet from UUDS, Anjou Aero, Diethelm Keller Aviation and MAC interiors (see fig 11).

All these products provide one position for the baby – lie down or sit. All the products fixed in the bulkhead wall abide by the restrictions of 2 pins fixture assembly. This dimension restricts the baby height criteria along with all products. In general, all bassinet designs have a metal frame structure fabric covering it. UUDS baby safe is the only product with an additional placement option below the overhead luggage bin (UUDS, 2021), shown in fig 11.

No solution in market which is for all babies below 2 years

However, this placement of bassinet is not found in practice from literature research. UUDS have a solid non-collapsible stroller seat like design for premium classes. However, only Diethelm Keller Aviation bassinet addresses user comfort, like air ventilation, into consideration by including vents (Diethelm Keller Aviation, 2021). No product addresses the needs of parents and flight attendants who also frequently interact with bassinet. From this analysis of products from the market, it is evident that no solution caters for all babies below two years, their ergonomic requirements and ease of handling and storage.

3 problem analysis

Chapter 2 describes an overview of different areas of improvisation required by different stakeholders and the limitations of existing bassinet. These insights are the basis for defining the problem for this project. A critical and analytical approach is carried through WWWWWH questions (Heijne & van der Meer, 2020) and iterative reformulation of problem definition (Roozenburg & Eekels, 1995) (see Appendix C).

‘Young Parents with babies struggle to fly in long haul flights because the flight services are limited. The solution should provide a comfortable, relaxing environment for babies, parents and flight attendants during their flight journey, within the next 3 years.’

3.1 Design directions

Exploration of design directions is guided by observing the parent and baby’s entire travel journey from home to destination (described in Appendix D). Therefore, design directions are formulated through a decision matrix, where the directions are evaluated by the implementation duration and size of the ecosystem, fig 12. This resulted in four promising desirable directions which benefit babies and parents.

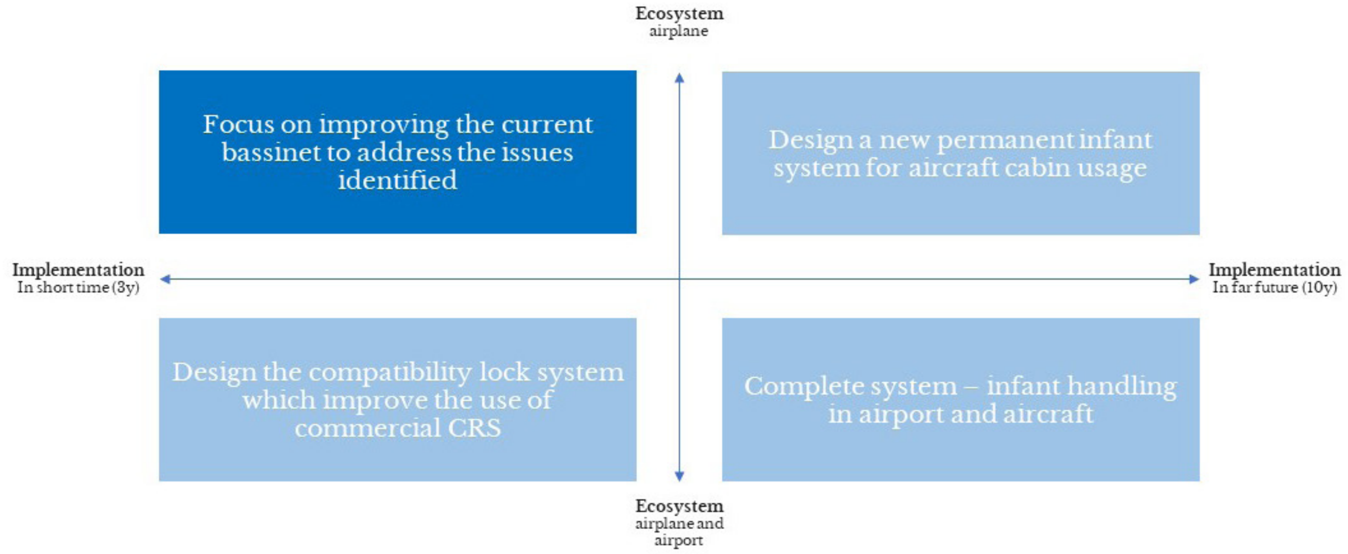


Figure 12 Design directions

Within the airplane ecosystem:

The redesign of baby bassinet will yield an efficient and feasible implementation of current flights without major alterations to the current cabin layout. On the other hand, a permanent bassinet design installation into the cabin seat layout is a possible direction to explore the safety of babies throughout the flight journey.

Airplane and airport ecosystem:

It is inevitable to extend the user journey research to the airport interactions, which precedes and succeeds the flight journey. From the analysis of parents research (see section 4.4.1), there is an opportunity to create a system around baby bassinet to improve the entire journey with babies

Currently, many parents carry their infants in CRS in airports and cars. Therefore, designing a compatibility lock system to attach the passenger-owned CRS in the cabin environment can smoothly transition into a flight environment. However, this direction can lead to adult passenger seats for infants, which is not profitable for airlines and outside the client’s product portfolio.

In contrast, a long term design direction involves an aviation baby handling system which is standalone to be used in airports with wheelbase and as bassinets in aircraft. This directly increases the opportunity to expand the client’s product portfolio and even gain a monopoly on baby handling systems for aviation.

After considering the Belgraver’s and airlines requirement of earliest implementation with minor changes to existing cabin design, improving the user experience with the current bassinet design is selected.

This design project focuses on providing a comfortable and stress-free EC flight experience for primary users (infants and parents), which yields a strong relationship with airlines and is implemented within the next three years.

3.2. Scope

Belgraver aircraft interiors will be responsible for developing and producing the baby bassinet: frame, basket, mattress, and cover (section 2.2.1). The design student from TU Delft is responsible for designing the parts within the existing aircraft layout. This defines this project's scope, where the lock system to bulkhead wall, fixtures on bulkhead wall, storage procedures are excluded (see Figure 13).

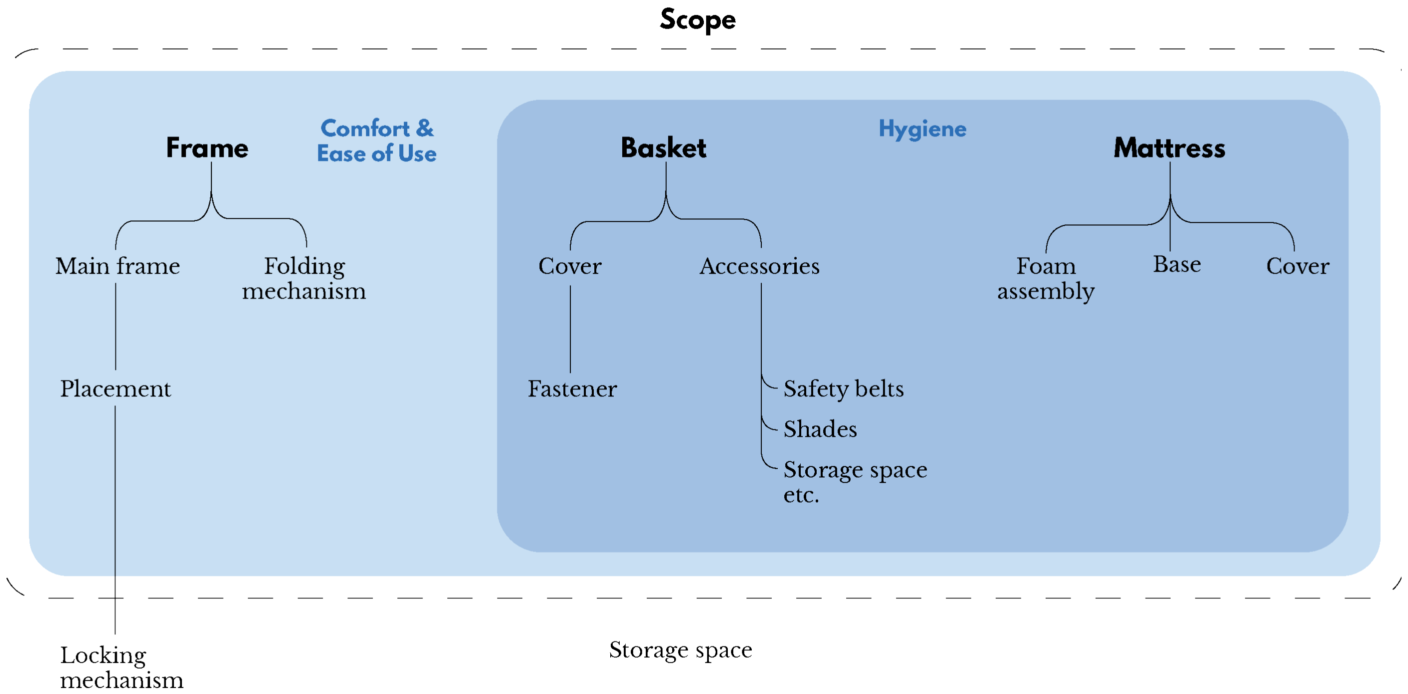


Figure 13 Project Scope

4 user research

The key users are infants, their parents/family and the flight attendants. Hence, it imposes a great need to comprehensively discover the needs of different users to improve the current product for overall positive impact.

Photo by Octav Cado on Unsplash

4.1. Scope and approach of user research

The most challenging part of this user research is that baby lacks cooperation and communication skills to observe and comment on their interaction with the bassinet. This is tackled by relying on parents' ability to understand their children's needs by constantly observing their reactions to the environment.

Further, a literature study of paediatricians' medical reports and health blogs yields the medical necessities for a comfortable and medically safe journey.

The parents are the next group of users who interact with the bassinet and infants in combination. They are highly proactive and have high power in choosing the product for their infants' usage. This research is conducted by observing youtube video logs of flying parents, conducting online focus groups among parents in social media and interviewing parents to determine their needs, wants and wishes.

Similarly, flight attendants requirements are identified by observing their video documenting their interaction with Belgraver bassinet and interviewing KLM flight attendants.

All these researched insights led to a generation of a set of personas for the infants and parents to base the design decisions. Based on this, further interpretation of different user's emotions throughout the flight journey from boarding to exiting the plane is visualised to deduce the key pain points to handle within the scope of baby bassinet service.

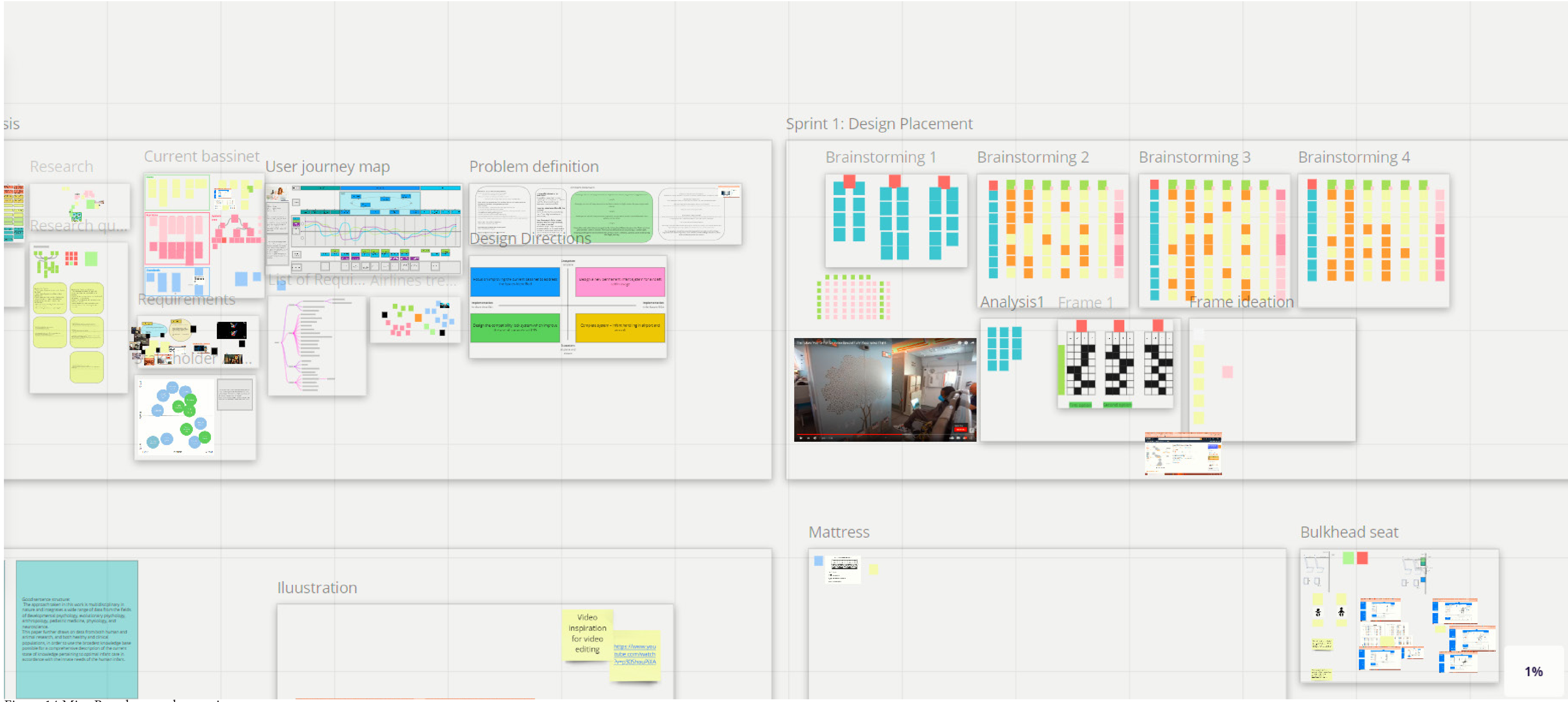


Figure 14 Miro Board research overview

4.2. Sleep Physiology

Parents often feed their babies before boarding or during takeoff to induce the baby to sleep as soon as possible in the flight journey (Participant#2, 2021). When travelling with babies over 6 months, parents often prefer night flights to match their babies sleep cycle (Participant#10, 2021).

Even Dr Jennifer Shu, a paediatrician, recommends that parents fly during their child's sleep cycle instead of drugging babies before a flight, which has multiple health issues (Shu, 2021).

Therefore, sleeping is the most encouraging activity for the babies, which eases the parent's responsibility to taking care of awake and restless, irritable babies. Hence it is essential to understand the physical, psychological factors that help infants to sleep.

Figure 15 Favourable conditions for baby sleeping: Photo by Marie Despeyroux on Unsplash

Sleep development/pattern:

It is observed by (Mindell & Owens, 2003) that the sleep requirement of infants within 1 year of age requires 14-15 hours of sleep every day. Sleep duration is spread throughout day and night. With increase in brain development over 4-6 months babies sleep longer at night. However, the duration of a nap depends on many factors (Chamberlin, 2004) –

1. Feeding cycle
2. Wet diaper
3. Too cold or too hot temperature
4. Noise disturbance
5. Light exposure

Sleep disturbing factors that can be controlled through the bassinet design are exposure levels of light and noise. This is most essential for small babies as they sleep more during the day time when its bright and noisy.

Sleeping surface:

The American Academy of Pediatrics (AAP) disapproves babies below 6 months of age to sleep in sitting position (fig 16) as they may assume positions that pose a risk of airway obstruction or suffocation which can be fetal causing Sudden Infant Death Syndrome (SIDS) (Moon, 2016). Paediatricians strictly advise the infants to sleep position flat on their back over a firm surface with no additional cushion supports to avoid the risk of SIDS (see fig 17).

Figure 16 Baby sleeping in sitting position, Credits: Shutterstock

Figure 17 Baby sleepingon flat and firm surface, Photo by Emily Banda on Unsplash

4.3. Hygiene in aircraft

A long-haul flight can accommodate about 250 – 350 passengers, and usually these flights are on tight schedules. This indicates that some intricate parts of the planes are dirtier than others. Some of these areas can be avoided when travelling in the business(BC)/ first class(FC). Since baby basinets are not accessible from BC/FC, babies are at a higher risk of infection from these areas.

The general perception of lavatories being the dirtiest place in an aircraft was debunked by a 2015 study, which culminated that overhead air vents, seatback trays, seat belt buckles, aisle seat headrests, and airplane blankets are some of the dirtiest places on a commercial plane (Whitmore, 2019).

Airlines do not generally specify the number of cabin interior deep cleanings for an aircraft, but it can be assumed to be once in three months. Experts suggests that one can avoid these risks by keeping alcohol-based sanitizers and wipes handy (Brennan, 2019). Additionally, choosing an airplane that provides blankets in sealed plastic bags and avoiding physical contacts with the above mentioned places will help the passengers to mitigate the risks of getting infected.

4.4. Insights from parents

From a user-centric design perspective, it is the responsibility to understand the users' superficial and innate needs and wishes to create an impactful and successful product. Therefore, two branches of research are done to grasp the personal insights of parents on flight travel with babies and specific experience with current bassinet design

4.4.1. General feedback on flying with babies

From a broader perspective, the entire journey of parents and babies from their destination A to B was observed. In addition, in the light of social media, video logging of six parents with the babies through airports and airplanes are analysed (refer to Appendix D). Three parents travelled with babies below 6 months and three above 6 months. The general pattern observed is that parents are mentally prepared to tackle babies' mood swings, cater to their needs, and manage baby luggage and products (strollers, car seats, pack n play) (Canning, 2019).

Main motivations for parents planning the trip, packing, feeding and sleeping routine is to keep baby as comfortable as possible in the new enclosed environment. This inturn helps the parents to stay calm and not cause any disturbance to others (Lozadac, 2020). These insights motivated the initial design directions exploration (section 3.1) and understanding the basic moods and expectations of flight travel for parents.

The initial online focus groups were conducted in Facebook and Reddit platforms (Appendix E). 14 parents participated in this discussion that contributed to the discovery of other external factors which impact the overall flight experience for parent and infants. Other bassinet specific insights are discussed in section 4.4.2.

-Flight crew negligence and frustration towards infant's special needs
-Cannot use a stroller to move infants inside the plane
-Judgemental remarks from co-passengers
-Most airlines do not provide baby food service
-Limited or no diaper changing facility in toilets

In conclusion, it is clear that airlines need to work on improving their inflight and airport services towards baby passengers and provide specialised training for flight attendants to achieve a comprehensive baby-friendly flight experience.

4.4.2. Feedback on current bassinet service

Figure 18 Pros and cons of current baby bassinet

With the goal to understand the parents' and babies' viewpoints about the current bassinet service, two in-depth online interviews were held (refer Appendix E). The answers from the participants can be distinguished into positive and negative impacts (see Fig 18. This validates a great deal of happiness and relief for parents to use the bassinet service. It has provided a sense of relief from the parental role and help in relaxation for both parents and infants.

Contrarily the identified issues with the present solution serve as ignored requirements that need to be addressed in this project. Further, these insights contribute to a detailed program of criteria in section 6.

4.5. Flight attendants

To gain deeper knowledge on FAs interaction and experiences with bassinet services, four female FAs from KLM were interviewed online. The interviews were structured, its metholodogy is described in Appendix F.

The most striking yet common finding is that almost meagre to no training is given to prepare the attendants for servicing the highly demanding family with baby groups.

Further, on-lap babies are not counted into the passenger list. Hence FAs are not obligated to provide blankets, pillows for infants. This explains the frequent, unpleasant encounters with parents mentioned in section 4.4.1.The analysed results from interviews gave way to discovering multiple pain points under ergonomics and hygiene factors.

Ergonomic factors

It highlights the complexity involved in the process of installing and removing the bassinet for every usage. Pain points in this installation process are caused by the following activities, see figure 19.

1.Hold the bassinet from the sides
2.Locate and insert pins into small holes
3.Hold the safety pins with three fingers
4.Open the lever and push pin simultaneously with 2 fingers while holding
5.Hold the bassinets immediately after disengaging the pins
6.Parents need to see the baby without compromising their comfortability

Figure 19 Observation of FA installing bassinet and current lock assembly

Hygiene factors

FAs are the face of the airlines where parents inevitably expect special care to provide clean and hygiene products for their infants. Even though it is not a part of FA's job profile, mostly bassinets end up dirty and with no concrete cleaning procedure, FAs are forced to clean the product onboard superficially.

1.Cleaning roughly on-air – before installing
2.Unclear and Cumbersome cleaning procedure
3.No blankets are mandatorily allocated

4.6. User Emotional map: Flight journey

To combine the gathered insights user interviews and focus groups from section 4.2 – 4.5, a map of the emotional journey of babies, parents and FAs during flight journey is visualised in fig 20.

This experience map outline depicts and outlines all positive and negative feelings of the three users for all stages of the flight travel. Each stage in this scenario indicates various activities and conceivable contemplations the users can have amid their journey. It moreover briefly clarifies the situation and the user's objectives and desires.

The current user experience map helped to find the opportunities for development during various stages for all the three users.

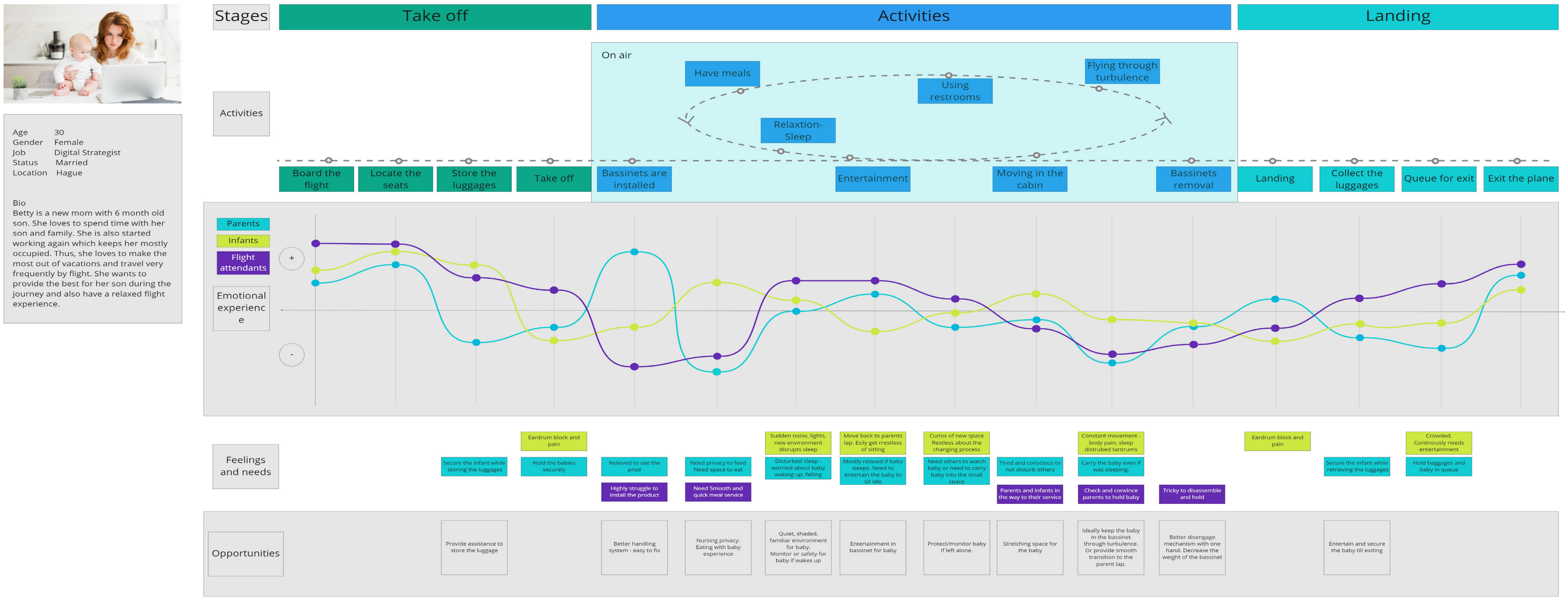


Figure 20 User Emotional map: Baby, Parent and FA
kinderfly2021

4.7. User experience vision

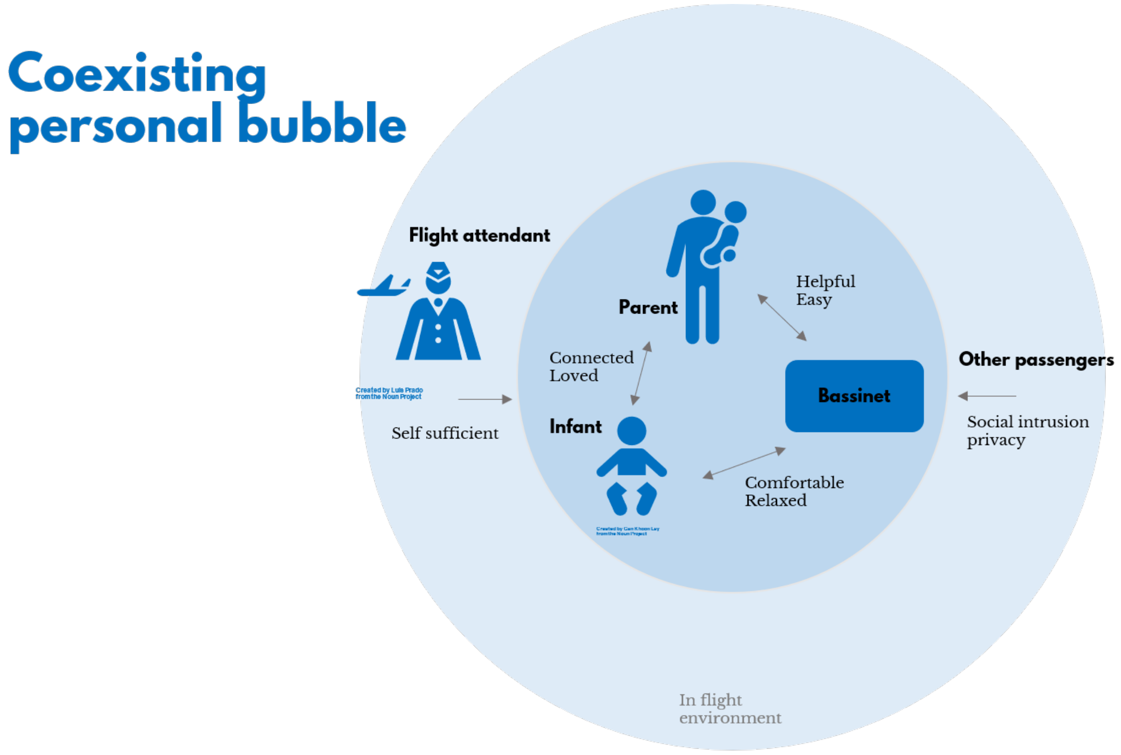


Figure 21 User experience vision

A product/product-service kindles certain feelings and emotions. The combination of emotions paints the whole picture of user perception and emotional experience towards the product (Desmet & Hekkert, 2007). Therefore, the redesign of the baby bassinet also needs to elicit specific emotions that make the parents trust the product and put the target users at ease.

The vision for this bassinet redesign is Coexisting personal bubble. This vision handles two different social relationships between infants, parents, Flight attendants and other passengers (see fig 21). On the one hand, it allows infants to travel comfortably with constant attention and care from their parents. However, on the other hand, the whole family is exposed to other passengers judgement who might consider cranky infants a significant inconvenience (Budd, 2011). Thus, the challenge is to provide adequate personal space for parents and infants without intruding on the aircraft ecosystem.

5 key challenges

The analysis of insights from context exploration (sec 2) and user research (sec 4) has resulted in broadly three key challenges for this project. They are: Comfort, Ease of use and Hygiene. These key challenges categorised under target user groups are described in Figure 6. To efficiently handle the project's complexity, key challenges of comfort and ease of use of bassinet are given priority over hygiene challenges. These two challenges create fundamental improvement in user interaction with the bassinet.

	Infant	Parent	Flight Attendant
Comfort	1. Infant must be able to fly comfortably in long haul flights of 12 hours a. The mattress must be comfortable for sleeping b. Infant must be comfortable to be awake and play in bassinet c. Infant should be comfortable while taken out of bassinet d. The environment must be calm and relaxing	1. The user must be able to sit without infant on lap for long duration 2. The user must be able to feel safe to leave their infant be in the bassinet 3. The user's comfort must not be hindered by the bassinet	
Ease of use	1. Infant must be accomodated into the bassinet with ease and safety a. The size of the bassinet should be flexible to hold different infants b. The safety belts should protect infants from falling	1. The user must be able to place and secure infant in the bassinet correctly 2. The user needs to understand the usage of bassinet a. About the periods bassinets cannot be used b. About the mechanism of total system 3. The user must be able remove infant swiftly when required	1. The user must able to hold the bassinet from the side aisle 2. The user must be able to place the bassinet correctly a. Locate and insert pins into small holes b. Hold the safety pins with three fingers c. Open the lever and push pin simultaneously with 2 fingers while holding d. Hold the bassinets immediately after disengaging pins
Hygiene	1. Infant must have a hygiene environment a. The bassinet must be clean for every use b. The fabric should be hypoallergic	1. The user should be able to clean the bassinet easily 2. The user must be able to feel the cleanliness of the bassinet	1. The user must be able to clean the bassinet before installing and after removal 2. The cleaning procedure must be defined and simple

Figure 22 Key Challenges

6 list of requirements

This chapter lists the key requirements of the challenges listed in section 5. The requirements are segregated into each subsystem of the bassinet (section 2.2.1). This helps in validating the decisions for each system efficiently in the concept development. The extensive list of requirements with their sources is described in Appendix G.

General

- MUST be implemented in market in 3 years
- MUST weigh 3.7kg or less

Bassinet Frame

- MUST accommodate all infants till 2 years –Height - 95cm
- MUST accommodate all infants till 2 years – Weight - 16kg
- MUST accommodate active (non-sleeping) infants during cruise
- MUST be installed from the aisle
- MUST be locked and unlocked with one hand

Bassinet basket

- MUST secure infant in sleeping position
- MUST secure infant in active position
- MUST make parents and infants feel safe
- MUST be hypoallergenic
- MUST be breathable material
- MUST be clean for every use
- SHOULD block the light when infant is sleeping
- SHOULD provide quiet environment
- CAN monitor baby when left unattended
- NICE to include entertainment for infants
- NICE to be able to remove infant without waking during turbulence

Mattress

- Must be flat surface
- Must be firm
- Must have soft tactile feature
- MUST be water/dust resistant
- NICE to provide a familiar environment

Bassinet Placement

- Must prevent infant from falling
- Must not reduce parents' leg room
- Must not hinder parents to stand
- Infant Must be visible to parents
- Should provide storage space

7 ideation

The idea generation is done in quick sprints for each subsystem of the bassinet to achieve an exhaustive list of ideas. This process started with brainstorming session to generate different placement possibilities to find inspiration for a bassinet.

Further, these ideas were grouped into three placement clusters: On bulkhead wall, around the economy passenger seat and other places in flight (fig 23).

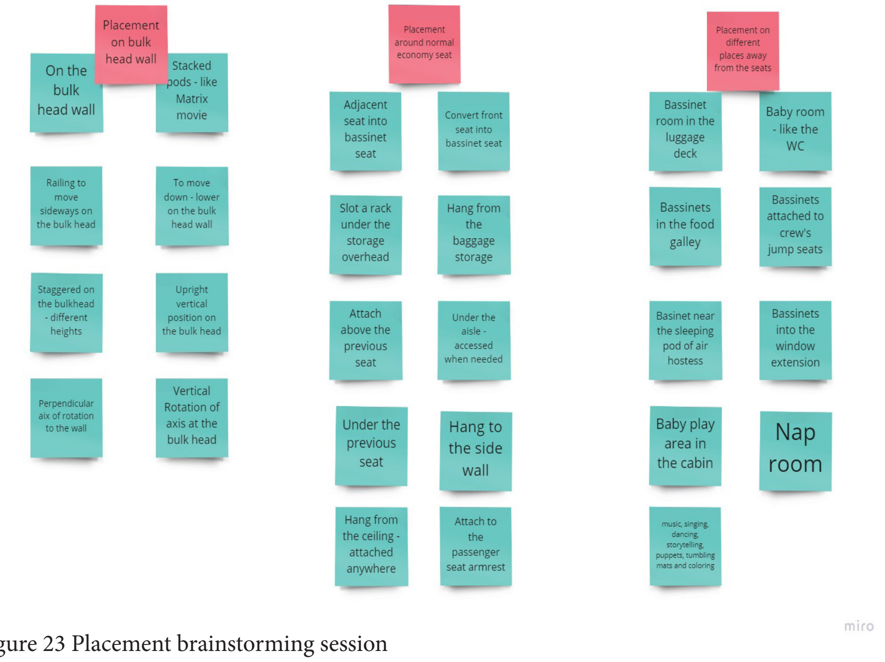


Figure 23 Placement brainstorming session

Initial idea generation of bassinet form and functions focussed on bringing the desired product experience vision. These ideas were still close to the current design.

The next iteration of ideation utilised Biomimicry to look into nature to find different nurturing solutions (Benyus, 1997) and inspiration from personal childhood experiences (see fig 24).

These ideas were then converged into concepts (section7.1,7.2 and 7.3), aiming to perceive the design problem from varied perspectives.

Figure 24 Inspiration board for concepts

7.1. Concept 1 - Cocoon

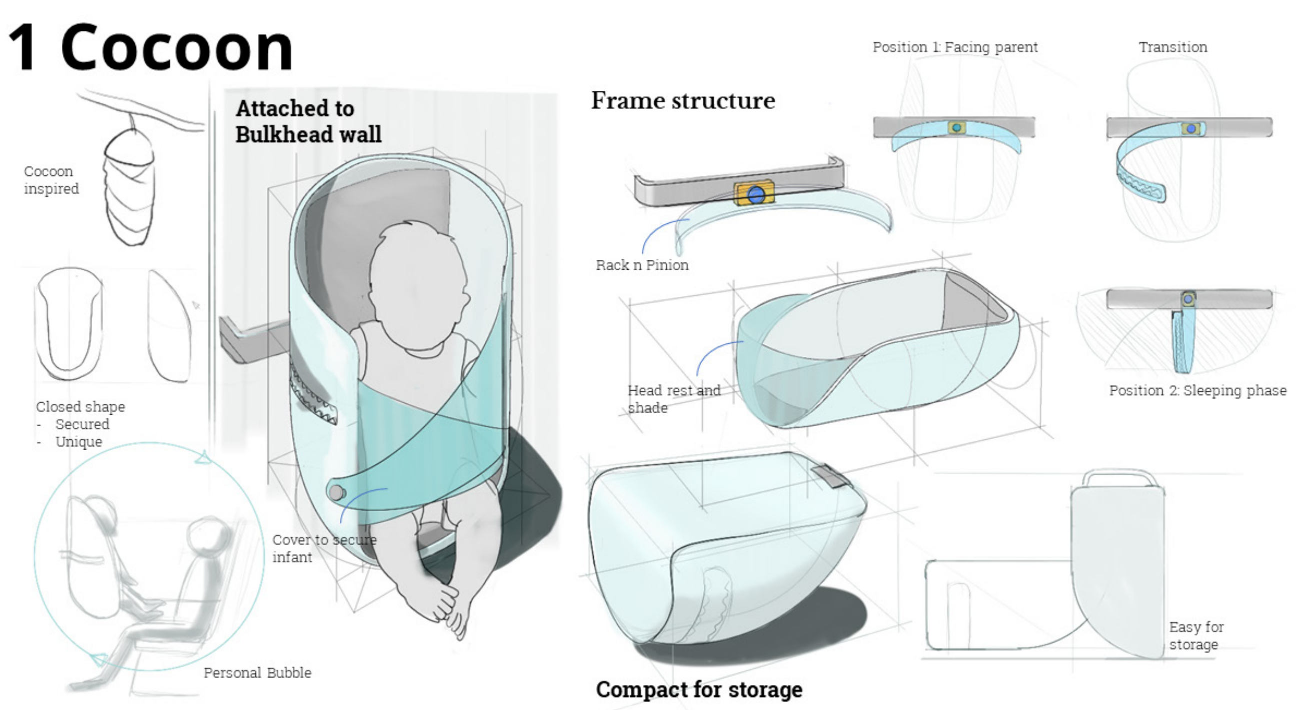


Figure25 C1 Cocoon

Concept Cocoon is a compact baby shell that has dual orientations. It can be transformed to a horizontal or vertical orientation to facilitate all babies to sleep and be active comfortably and safely. The curved rack frame enables this smooth transition of the orientations. The hard shell with soft lining and closed-form with overlapping covers translates to safe, caring emotions and privacy for babies are derived from cocoon structures. Further, the partial folding of the bassinet for storage in the overhead bin or under passenger seats.

7.2. Concept 2 - Flexi Bed

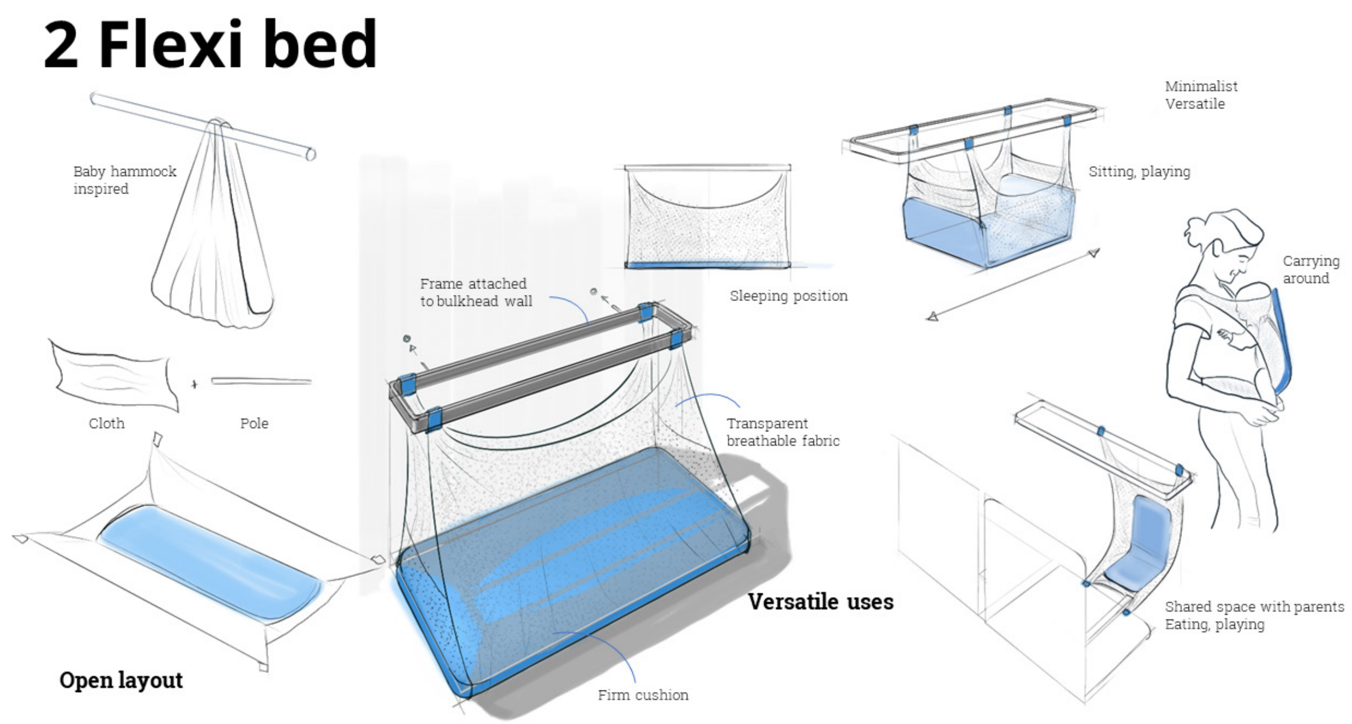


Figure 26 C2 Flexi-bed

Flexi-bed is a minimalist approach of the bassinet with only 2 major components – a rigid hanging frame and fabric bassinet. The inspiration is a simple hammock and how it can be utilised creatively for various activities of the baby. It exhibits versatile function to act as a bed, baby seat, baby carrier and shared space with parents by playing with attachments to the frame. This concept features lightweight, multifunctionality, compact characteristics.

7.3. Concept 3 - Buddy

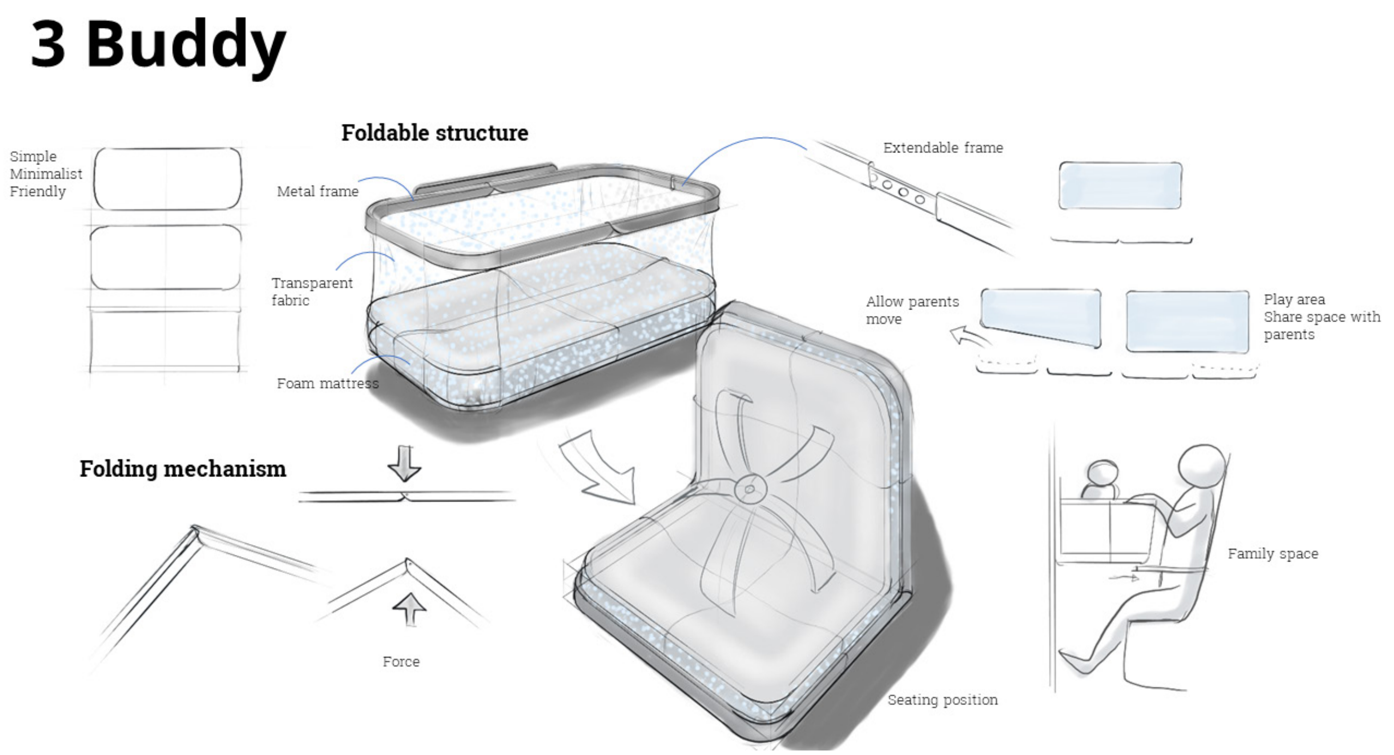


Figure 27 C3 Buddy

Concept Buddy is a friendly design evolved from the Belgraver bassinet form and functions. The metal frame holds the bassinet, which modifies into a seat for bigger babies by folding the frame. In addition, the width of the frame is extended to create more room for babies to be active and play. This restrained exoskeleton and industrial aesthetics of the bassinet convey rigidity and safety and provide a familiar and friendly experience for the baby and parent.

7.4. Concept selection

All the three concepts are evaluated with Harris profile (see Appendix H). Overall, concept 1 (C1) and concept 3(C3) had better scoring compared to concept 2(C2). The key remarks of the analysis is discussed in this section.

C2 had the most versatile design, which had good handling and comfort for the babies. However, the C2 frame provides no structural strength and safety for the babies for aviation usage. Hence, C2 is not selected for this context.

C1 has the most complex frame structure with movable parts to facilitate the highest flexibility in the orientations between vertical and horizontal positions when desired by the babies and parents. However, this frame negatively impacts the handling, repairability, and foldability of the bassinet. On the other hand, C3 these factors are satisfied through the restrictive frame design that allowed only one orientation at a time. Furthermore, a reduced degree of freedom increases mechanical strength and thus the safety factor of the bassinet. An in-depth analysis of the advantages and disadvantages of dual orientation can be seen in Appendix I.

In conclusion, C1 provides the most modern aesthetics, safety, and comfort for babies and parents. At the same time, C3 has a sound argument into the manufacturability, ease of handling and repairability aspects. Therefore, the final concept incorporates the desirable characteristics of C1 and C3 discussed further in chapter 8.

8 final concept

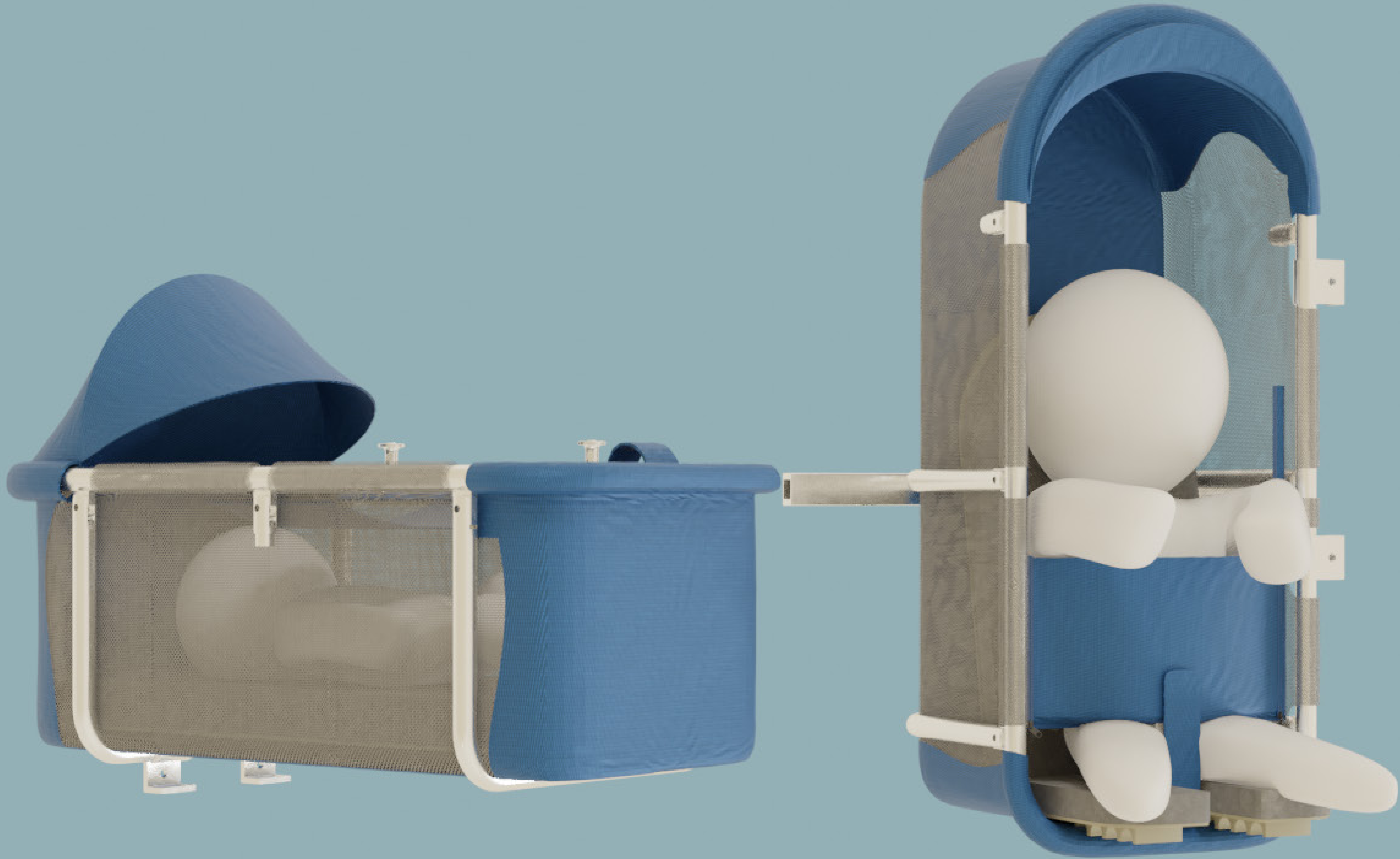


Figure 28 Final concept

Kinder fly

This is the selected final concept combining the desirable aspects of C1 Cocoon and C3 Buddy as discussed in the previous section. Kinder fly is the first bassinet-baby seat designed for the aviation industry. This concept caters to all babies below 2 years. The baby bassinet can be used in both horizontal and vertical orientations bassinet and baby seat.

The bassinet comprises three systems: frame, basket and mattress (see figure 29). This final concept brings together the comfort and enriched parent and baby interaction of the C1 from features like two orientations, locking system of bassinet, shades, reclining system and restraint system. In addition, the familiar metal frame base improves manufacturability, airworthiness and simple handling of C2 and the current Belgraver bassinet.

The concept has an asymmetrical frame design abstracted from the cocoon structures to associate the safe use of the only right way. This frame supports the fabric basket and the mattress assembly within. This chapter describes this concept, and its systems in detail - shape, size, material selection, function, technical and user evaluations.

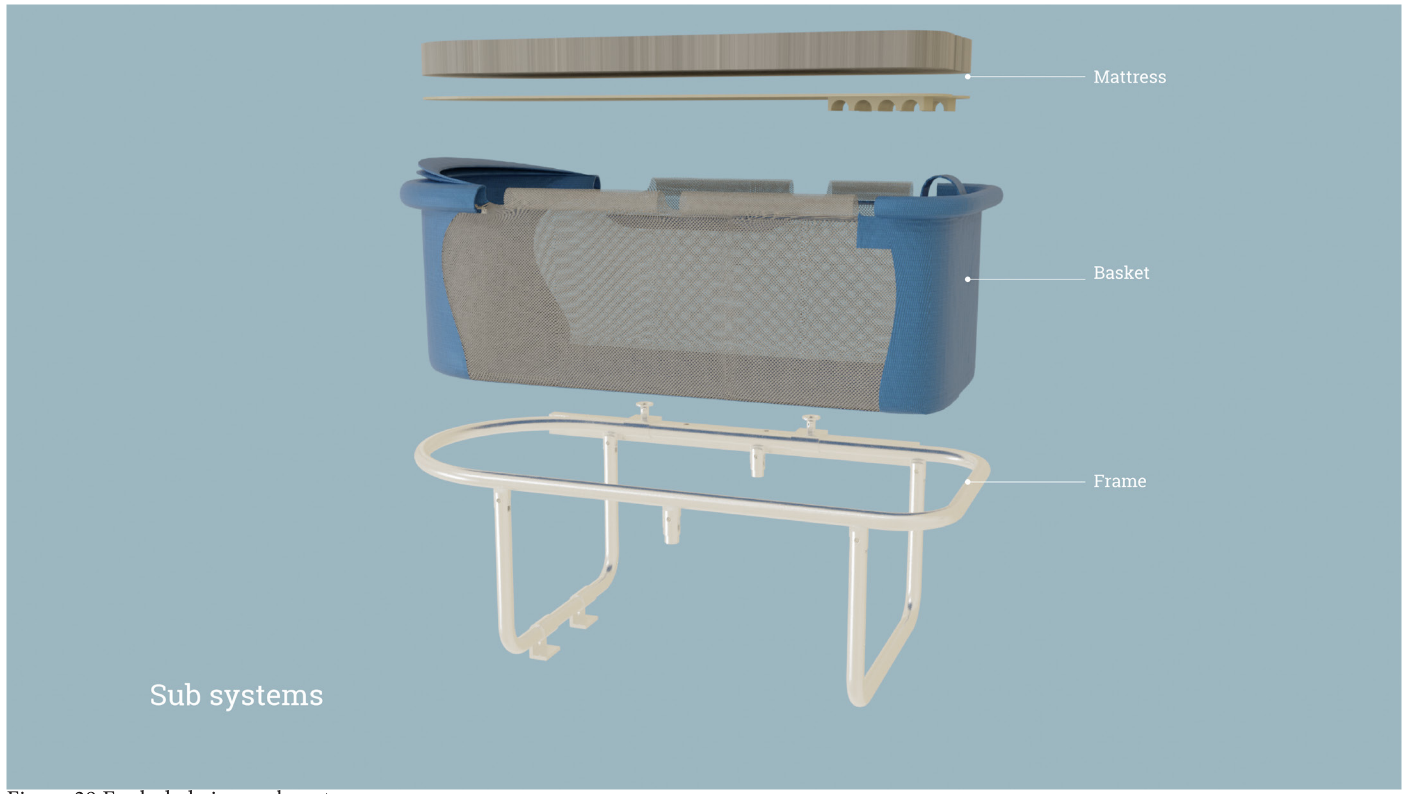


Figure 29 Exploded view: sub systems

8.1. Placement

In order to conceptualise a better flight experience for babies and adults, it is essential to find an optimised space within the fully packed cabin. The placement of the baby bassinet determines the geometry, dimension, and user interaction.

In order to zoom out of the project scope and find inspiration for the bassinet, initial idea generation of the bassinet placement was done. By comparing existing bassinet placements, brainstorming new placement opportunities within aircraft layout, discussing with a Flight cabin engineer on this topic (Broekhans, 2021) and conducting physical observation at Boeing 737 cabin, it is concluded that the baby bassinet will be placed in the current bulkhead wall position.

The bulkhead wall placement of the baby bassinet is shown in fig 30. The bulkhead wall provides the closest seats for the users, with the baby in front at the eye level of its parent(s). In addition, it has the lowest hindrance to other passengers as it is isolated to the beginning of each cabin segment with no passenger in front. Furthermore, bulkhead walls are primarily free with no or few devices like information monitors providing the opportunity to use that.


Figure 30 Bulkhead wall placement

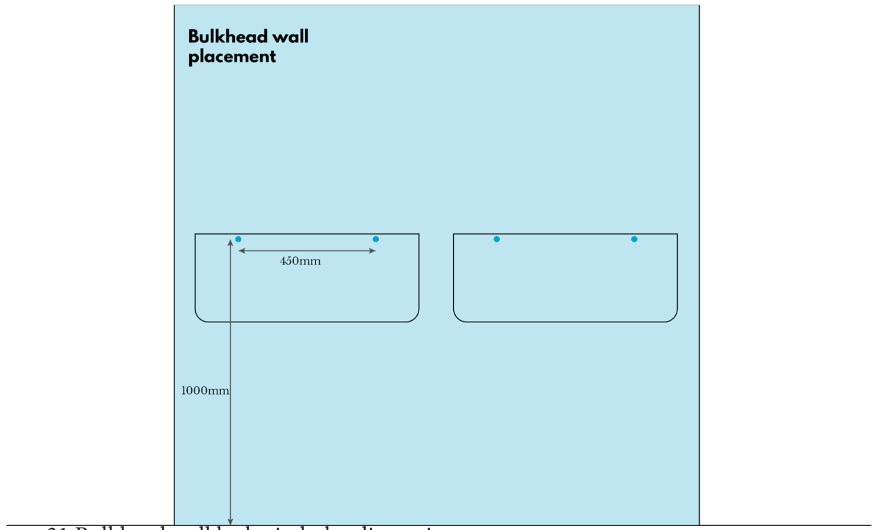


Figure 31 Bulkhead wall lock pin holes dimensions

Moreover, the airlines decide bulkhead wall placement position and dimensions of the bassinet locking mechanism while purchasing new airplanes from airplane manufacturers (Broekhans, 2021). Therefore, the placement of the bassinet is inherently predetermined.

The bassinet fixture standard is maintained by keeping the dimensions between the lock pin holes as 450 mm (see fig 31) (Belgraver, 2021). The height of the lock pin holes is different for each airline, and it is designed for the ergonomic comfort of key demographic passengers. For KLM, the height of the fixture from the floor is one meter (Broekhans, 2021). This dimension is used as a reference for user testing iterations of the concept prototype.

8.2. Orientation

Furthermore, this multiple orientation design allows all babies under two years to use the bassinet without any height restrictions and during different activities: sleep, eat, play. Hence, it improves parents' comfort by allowing them to relax and be unrestrained from active babies (see 4.3 User research: Parents). This feature is highly desired from market analysis (2.5) but not available, creating a market advantage for the client Belgraver.

From the discussion of concept selection 7.4, it is evident that orientation flexibility should not increase the complexity of the frame and locking assembly to ease the FAR certifications and implementation into the aviation market.

Therefore, to manage the complexity of two orientations in the user experience and provide safe product usage, the orientation of the bassinet is fixed for each flight journey. In addition, babies around 6 months and above develop stable head, neck and shoulder joints which allow them to sit unassisted (Jansheski, 2021). Therefore orientation of the bassinet for each use depends upon the age and height of the baby passenger. It is further explained as use cases.

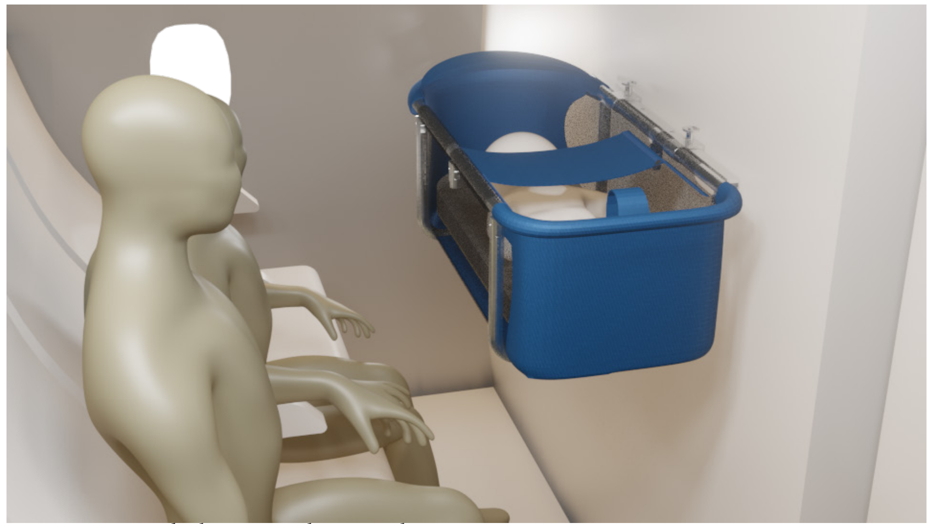


Figure 32 Using the bassinet in horizontal orientation

Scenario 1:

When the baby passenger is less or equal to 650mm long and cannot sit up on their own (approx. till 4-6 months old), the bassinet is installed in the horizontal orientation to provide a safe horizontal sleeping position (section 4.2.1) and assisted seating position when the baby is awake.

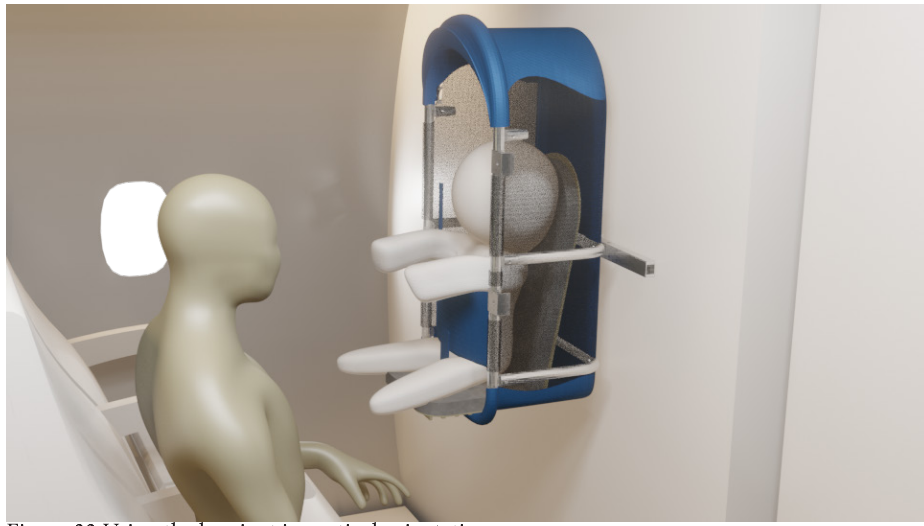


Figure 33 Using the bassinet in vertical orientation

Scenario 2:

If the baby passenger exceeds 650mm height and can sit up independently (more than six months old), the bassinet is installed in the vertical orientation to sleep, eat and play alongside the parents.

8.3. Overall Dimensions

The concept's overall dimensional analysis is adapted from the anthropometric data of babies of 0-2 years. The maximum dimensions in categories: small babies (till 6 months) and big babies (6 months – 2 years) are shown in fig 34.

Small baby	Big baby	Concept
Height = 720mm = 28.35" (P99)	Height = 950mm = 37.41" (P99) Seating Height = 608mm (P99)	Length = 750mm
	Hip breadth = 225mm (P99) Breadth over the elbows = 315mm (P99)	Width = 340mm
	Buttock popliteal height = 241mm (P50)	Depth = 240mm

Reference: WHO Department of Nutrition for Health and Development, 2006
Reference: Dined, 2021
Figure 34 Analysis of anthropometric data

Length

750mm (length) - This comfortably fits the small baby in the HO and the big baby in VO.

Width

340mm (width) - This fits all babies to fit into the width of the bassinet and also have extra room for limb movements for baby comfort (Participant#1, User test, 2021)

Depth

240mm (depth) - This P50 depth allows babies to comfortably rest their entire leg or upper legs without kicking the parent. (sec 8.4.6.)

8.4. Frame

The frame forms the primary structural part of the bassinet, which provides overall form and support. The bassinet is attached to the bulkhead wall by connecting the frame to the wall attachment. The installation of the frame is in both orientations, as discussed in section 8.2. This chapter discusses the various aspects of the bassinet frame.

8.4.1. Design assembly

The frame assembly consists of the mainframe, attachment housing, push-lock pins and bracket. The exploded view of this assembly is shown in fig 35. The bracket is attached to the bulkhead wall through the push ball lock pins in the predefined positions mentioned in section 8.2.

The mainframe has a rigid top frame with two foldable legs. In addition, the mainframe has attachment housing – two in the top frame and two in one leg. It also has rubber bushes on the legs. This mainframe is installed to the bracket on the wall by locking the attachments with push-button lock pins.

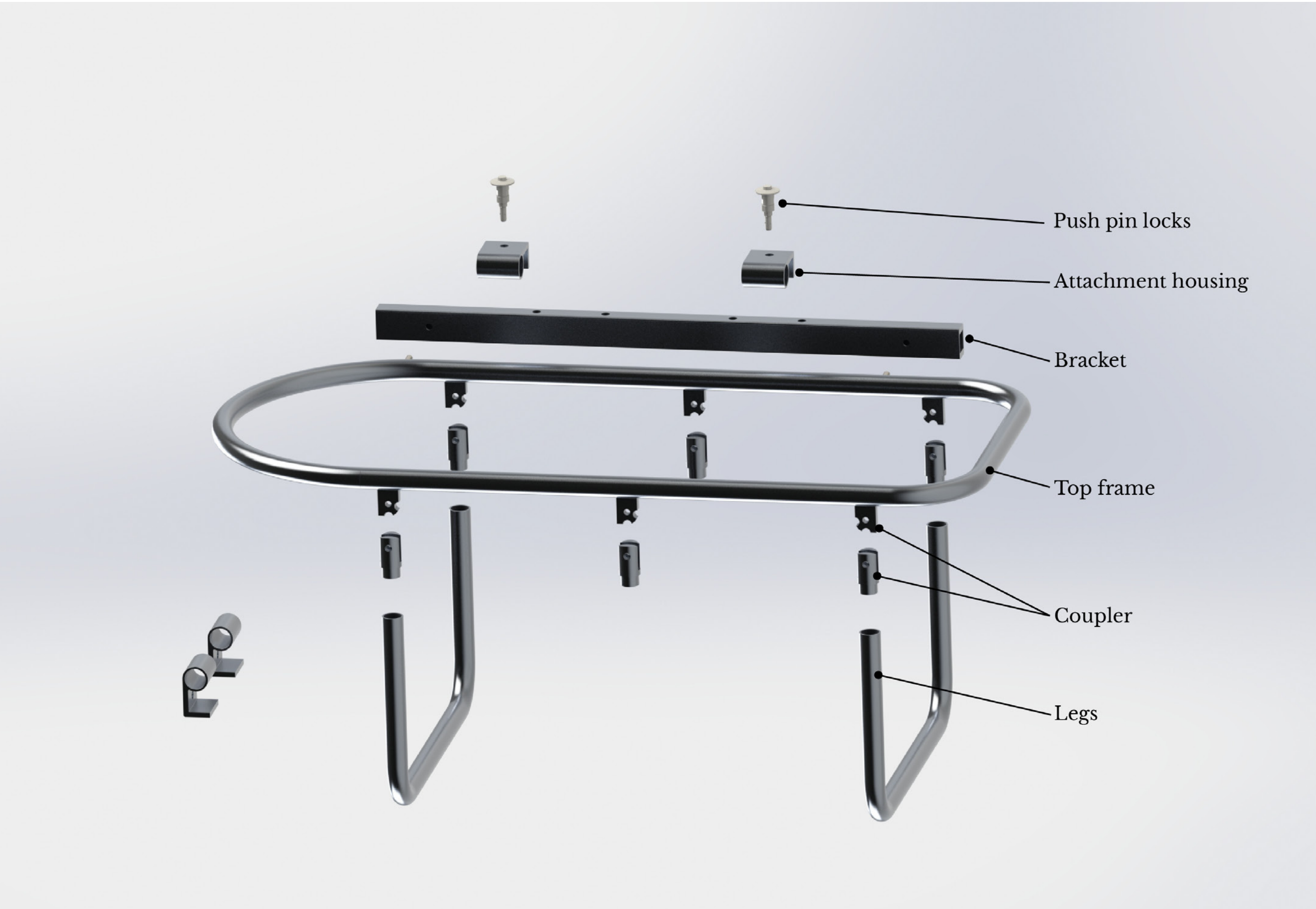


Figure 35 Frame exploded view

8.4.2. Mainframe

The mainframe is the skeleton of the bassinet. To find the suitable material for the frame, a metal frame and hard plastic shell alternatives were analysed through SolidWorks Simulation (see Figure 36). The aluminium frame is selected over the hard plastic and polymer shell frame due to its robust mechanical strength, net reduction weight of 5 kg per bassinet, and foldable frame design.

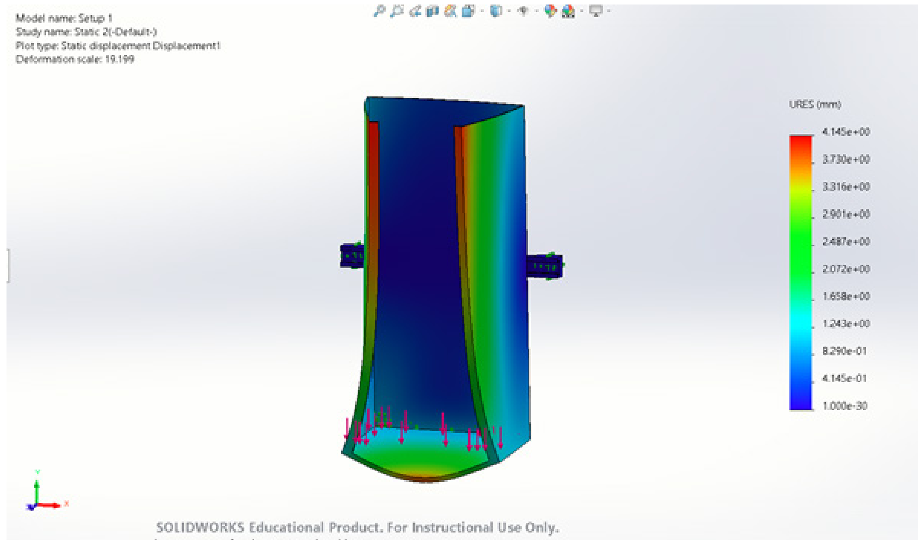


Figure 36 Simulation of plastic shell

Al 6061 T6 is the material used in the current Belgraver bassinet (Belgraver, 2021). This material is adopted to this concept, on its excellent strength to weight ratio, fracture toughness reliability, ease and versatility of fabrication processes, low manufacturing costs and 100% recyclability of the material (Mouritz, Adrian P, 2012).

Aluminium-Magnesium-Silicon alloy 6000 series is the best Aluminium alloy for good strength and high machinability compared to the newer 7000 and 8000 Al alloy series (Yashpal, 2015). Furthermore, this material selection can utilise the existing production facility of Belgraver, which enables the quick implementation of production.

Moreover, from the material research, Carbon composites can be a good alternative for bassinet frames (Mouritz, Adrian P, 2012). In-depth material exploration of Carbon composites is explained in section 8.4.7.


Figure 37 Al alloy tube main frame

Tube cross section

Circular tube is selected over rectangular, square and oval cross-sections because (Kim, 2017),
1) A circular cross-section has the maximum inside surface area to perimeter ratio, reducing the material weight and minimum installation costs.
2) Compared to the alternatives, the minimum deflection in shear and bending loads.

The Al alloy circular tube main frame comprises an asymmetrical top frame; the curved end denotes the head side, and the flat end denotes the foot side of the bassinet (see fig 37). This design provide parents a clear baby placement indicator and an easy locator for FAs to check the babies. The curved surface at the head end provides a larger surface area for increasing the air passage and visibility of the baby's head. Further, this semicircle frame supports the bassinet shade structure (see section 8.5.4). Moreover, the foot end frame provides a flat base for the baby seat in the vertical orientation.

Figure 38 Foldable frame in both orientations for storage

The legs of the frame are Aluminium tubes bent 90 deg to form U shaped members. Two legs are connected to the frame, which has 90-degree freedom of motion to fold for storage. The leg motion is guided and locked in extreme angles using the ball-spring mechanism.

This leg assembly is selected for its optimised load distribution, simple folding mechanism and least weight compared to alternative assembly ideas. In addition, the frame is collapsed to allow efficient storage. Fig 38.

Legs are connected to the top frame via the coupler. It is locked using quick-release telescopic push pins or snap locks to allow swift changing of the leg position for different orientations without compromising the legroom of parents. This is further discussed in section 8.4.6.

8.4.3. Bracket

The bracket is a straight rod directly connected to the bulkhead wall, which provides multiple locking positions to allow the mainframe to be installed in two orientations (see figure 39, 40). This bracket remains installed to the bulkhead wall at all times, even which the bassinet is not used. This reduces the weight of bassinet and complexity of installation process to enhance the handling ability of FAs (refer section 9).

Since the bracket is the critical member that supports the weight of the entire bassinet and baby, the rectangular tube is preferred over circular tube for its desired mechanical properties even though mass is increased by 40 g (Aluminum Tube Weight Calculator, 2021). The bracket is a rectangular Aluminium alloy tube with 30% higher shear, torsional resistance in bending load case and require simple attachment geometry to connect the mainframe compared to the round tube alternative (PTAirco, 2007). The dimensions of the rectangular tube are 20mm (width) x 30mm (height), with a thickness of 6mm and length of 550mm.

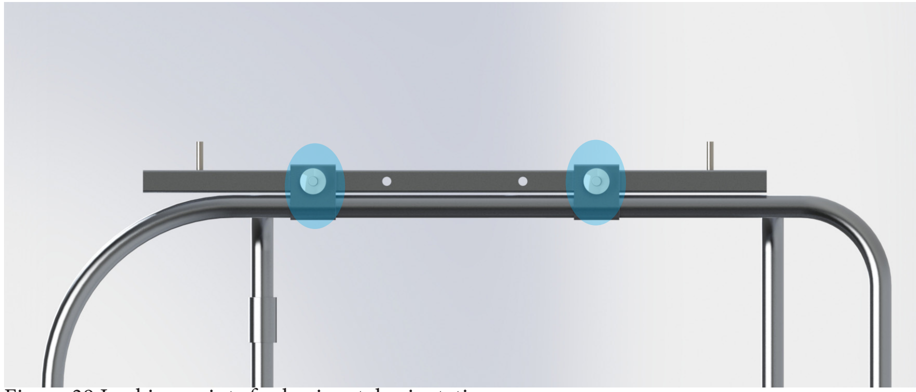


Figure 39 Locking points for horizontal orientation

Figure 40 Locking points for vertical orientation

The bracket is connected to the bulkhead wall with current used standardised fixture assembly, which is two 6.4mm diameter Stainless steel ball pushpins placed at a distance of 450mm apart (see fig 41).

8.4.4. Attachment mechanism

Attachment Housing

Mainframe is attached to the bracket on the wall by the attachment mechanism. This mechanism comprises housing and ball push pins (see fig 42). Two housing is bonded to the top frame and two on the upper leg to provide attachment points for both horizontal and vertical orientation. Another option of using only two attachment housing connected to the bracket instead of the mainframe requires additional holes in the mainframe and upper leg, which significantly reduce the axial tensile strength and accelerates the failure of the frame (Afiaki, 2018). The attachment housing is a casted Aluminium 6061 alloy part which has high shear modulus, homogeneity and factor of safety of 1.5 (explained further in Sec 8.4.5) .

Each housing has a hook to attach to the top of the bracket, which allows the FA to lock the attachment without holding the entire bassinet, which is a good improvement from the current locking procedure (van der Meer, FA user test, 2021). The new installation steps are detailed in section 2.

Figure 42 Attachment system

Push pin lock

The housing is locked to the bracket by market-ready stainless steel push pin locks with 8 mm diameter and 6 mm clamping grip (Anemo, 2021), see fig 43. This push pin lock confirms aviation standards (NASM/MS 17984) (Halder, 2021) and provides double shear strength of 63800N with a factor of safety of 1.5 (Federal airworthiness regulation part 25.303) (C. T. Modlin, 2014). The maximum calculated shear load on each pin lock under 16G conditions is 45440N, which gives a FOS of 1.4. Detailed force calculation is shown in Appendix J.

The ball push pin locks are self-locking, and with its downward installation, Unlocking involves two actions in opposite directions: pushing the button and lifting the lock. This prevents the baby or parents from accidentally unlocking the bassinet. Further, locking requires single directional actions of pushing the button and pin-lock into the housing. This feature further simplifies the installation and removal process compared to the current locking mechanism.

Figure 43 Push pin lock

8.4.5. Vertical orientation – Height adjustment

The bassinet's vertical orientation is observed in the context of baby, parent and co-passenger comfort in the B737 fuselage (see fig 44). However, the initial design of attaching the head end leg to the bracket resulted in the bassinet frame hindering the passenger seats' legroom.

This challenge is resolved by changing the leg fixture from top to the middle of the mainframe which lifts the bassinet by 200mm, as shown in fig 45. Ideation for height adjustment mechanisms of the frame and its evaluation is shown in Appendix L.

This selected design alternative to adding another fixture to the middle of the mainframe had the least mass contribution, negligible effect on the structural strength of the mainframe, support seatback, and compact foldability for storage.

The height increase of vertical orientation received positive feedback from concept testing with parents for not restricting the parents' legroom and additionally enable parents to perform other tasks like entertainment, reading and working (Participant#2, User test parent, 2021)

Figure 44 Analysing interaction of vertical orientation

Figure 45 Leg placement to increase the height and evaluation in B737

8.4.6. Material exploration CC

Carbon fibre composites(CFC) are increasingly replacing metal components in the aviation industry for their key characteristic of high strength to weight ratio. Within two decades, the use of composites (including CFC) in the aircraft body has increased from 10% to 53% (Wong K., 2017). This section is focused on exploring the feasibility and impact of incorporating carbon composite into the concept.

Mechanical Properties

It is vital to overlook mechanical properties to understand the characteristics of CFC for the baby bassinet application. Mouritz(2012) explains that CFC is recognised for its high stiffness and principle strength combined with lightweight property compared to metal alloy alternatives (fig 46). Further, it also has high fatigue strength and excellent corrosion resistance, yielding a durable bassinet product. Flame retardancy of CFC is enhanced by using PolyUrethane epoxy resin and flame retardant prepreg materials (Dragon Plate, 2021). However, the fracture toughness is low, requiring altering the bassinet frame design to avoid any load in the transverse direction (Mouritz, Adrian P., 2012).

Property	Aluminium	Titanium	Magnesium	High-strength steel	Nickel superalloy	Carbon fibre composite
Cost	Cheap	Expensive	Medium	Medium	Expensive	Expensive
Weight (density)	Light	Medium	Very light	Heavy	Heavy	Very light
Stiffness (elastic modulus)	Low/medium	Medium	Low	Very high	Medium	High
Strength (yield stress)	Medium	Medium/high	Low	Very high	Medium	High
Fracture toughness	Medium	High	Low/medium	Low/medium	Medium	Low
Fatigue	Low/medium	High	Low	Medium/high	Medium	High
Corrosion resistance	Medium	High	Low	Low/medium	High	Very high
High-temperature creep strength	Low	Medium	Low	High	Very high	Low
Ease of recycling	High	Medium	Medium	High	Medium	Very low

Figure 46 Mechanical properties comparison CFC and metal alternatives

Production cost analysis

A significant drawback of CFC, which affects its penetration into the largescale commercial aviation and automobile industry, is the high production cost (Mouritz, Adrian P, 2012).

The production cost (fixed and variable) estimation difference between Al alloy and CFC alternatives are analysed for a simple curved sheet part of thickness 5mm (Pinto, 2017). This analysis is sensible to be extrapolated to baby bassinet frame as most of the manufacturing process of the concept is similar to the sample used by Pinto(2017).

The variable costs (material, consumables, labour and energy cost) of the CFC frame is 130% higher than Al alloy frame. However, the fixed cost (machine, tooling, fixed overhead, building, maintenance) of the CFC frame is 20% lower than Al alloy frame (fig 47).

Thus, it is clear that material cost and labour intensive manufacturing processes of CFC are major reasons for the high production cost of CFC. Automated tape laying (ATL) and Automated fibre placement (AFP) are manufacturing processes used to improve the product accuracy suitable for the baby bassinet (Raspall et al., 2019).

The future forecast of CFC market demand exhibits a stable decrease in material cost, leading to significant competition between Al alloy and CFC in the aviation industry (Sharma Rao et al., 2018). This forecast substantiates a decrease in the production cost difference between the two material alternatives and thus strengthen the viability to incorporate CFC material in future baby bassinet models.

Table 15 – Aluminium model variable costs and respective percentages

	Cost values	% of the variable costs
Material Cost	5 629,96 €	71%
Consumables cost	1 213,77 €	15%
Labour Cost	332,81 €	4%
Energy Cost	807,06 €	10%

Table 16 – Aluminium model fixed costs and respective percentages

	Cost values	% of the fixed costs
Main Machine Cost	5 631,30 €	54%
Tooling Cost	689,22 €	7%
Fixed Overhead Cost	3 051,30 €	29%
Building Cost	477,10 €	4%
Maintenance Cost	582,12 €	6%

Table 18 – ATL variable costs and respective percentages

	Cost values	% of the variable costs
Material Cost	17 109,65 €	93%
Scrap cost	82,54 €	1%
Labour Cost	427,12 €	2%
Energy Cost	821,34 €	4%

Table 19 – ATL fixed costs and respective percentages

	Cost values	% of the fixed costs
Main Machine Cost	4 947,45 €	61%
Tooling Cost	44,51 €	1%
Fixed Overhead Cost	2 378,01 €	29%
Building Cost	232,34 €	3%
Maintenance Cost	512,69 €	6%

Figure 47 Product cost differences between Al and CFC alternatives

Mass of frame

To observe the magnitude of the mass difference between Al alloy to CFC bassinet frame, the 3d model was designed and studied in Solidworks (see fig 48). The CFC design significantly reduces 0.468g mass per bassinet. The minimum number of bassinets stored in each flight is 4 (Broekhans, 2021). Hence, the CFC bassinet yields a minimum 2kg mass reduction per flight. The impact of this mass reduction on aircraft fuel saving is discussed in next section.

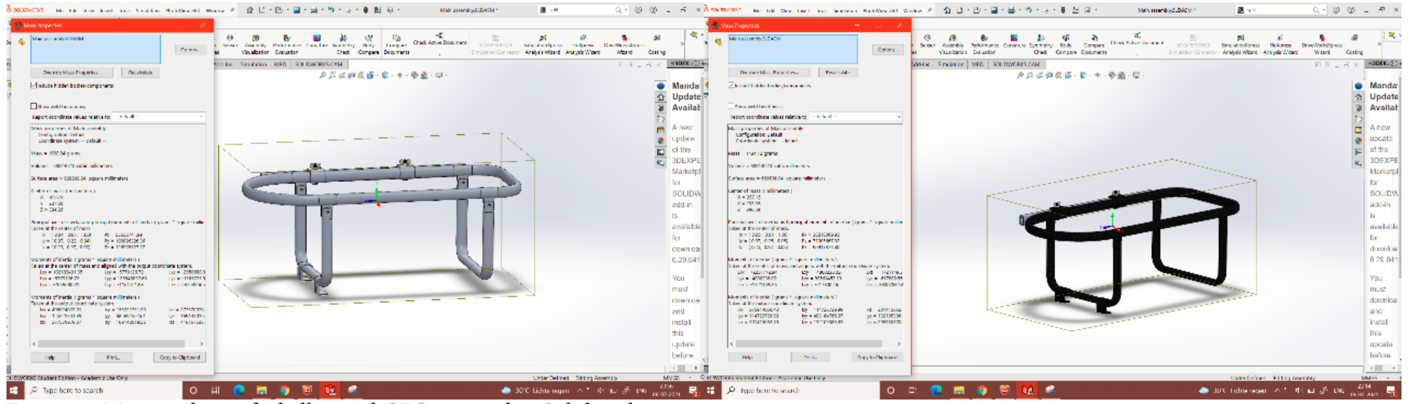


Figure 48 Mass analysis of Al alloy and CFC material in Solidworks

Flight fuel cost analysis and break-even point

It is intriguing to understand the net effect of using an expensive yet lightweight CFC material. Hence, a fuel cost saving analysis of KLM LHF fleet is done. The calculations assume that a LHF operates four round trips in a week, with an average flying time of 11.4 hours (Lee et al., 2019) per trip.

The entire calculations are based on peak trends of the 2019 aviation market to simulate the post-COVID-19 economy in 2024 (Recovery Delayed as International Travel Remains Locked Down, 2020), and its data references are shown in Appendix M. The analysis resulted in total cost saving from jet fuel and carbon cost for the KLM's long-haul flight fleet = € 17260.35.

Further, the break-even point between the increased production cost of the bassinet and its fuel cost saving is reached after 34 months (2 years and 10 months) of launching the CFC bassinet design (ULD Fuel Saver Calculator,2021). Therefore the net profit approximation by the end of 10 years of bassinet lifespan is €123,696.725, worth 107 current passenger flight fares (US passport service guide, 2021).

Sustainability impact

Sustainable development is a main goal of the aviation industry addressed in the Rio +20 summit (ICAO, 2012). In order to understand the sustainability impact of CFC in comparison to the proposed Al alloy design, Life cycle analyses of both the materials are made in the CES Eco audit tool (see fig 49).

As a result, Al alloy frame exhibits 32% higher sustainability impact than CFC frame. The main contribution of 99% is from the use phase of the bassinet in flight. On the other hand, the higher impact of CFC in material extraction and combustion in the end of life phase is negligible compared to the use phase in aircraft. CFC material alternative minimises the energy impact by 38000 MJ and CO2 foot print by 2700kg. The detailed sustainability report is shown in Appendix N.

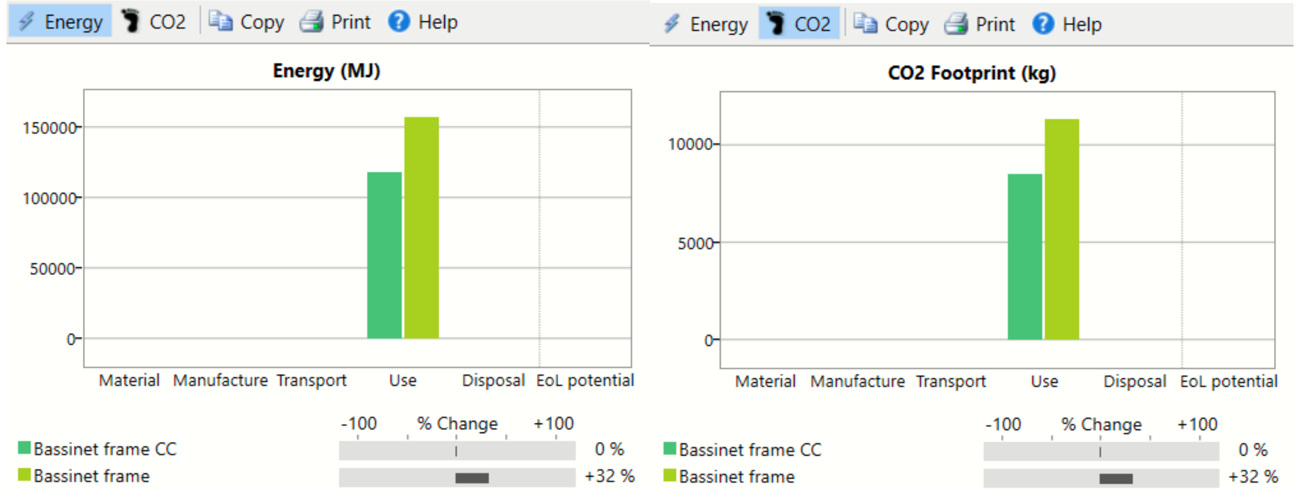


Figure 49 Energy consumption and CO2 impact of Al alloy and CFC materials

Conclusion

This explorative analysis of utilising Carbon fibre composites in the Kinder fly concept has overall a positive outcome. The feasibility of using CFC material requires multiple iterations of frame design to exploit the directional properties of its strength and stiffness.

Further, the carbon fibre market has shown a trend of competitive pricing with Al alloy in future. In addition, current manufacturing methods like ATL and ATF needs to develop to achieve medium to large scale production volume. Finally, the reduction in the weight of the bassinet has a critical role in achieving a viable solution that is profitable in the long run of flights.

In addition, it is desirable for its lower sustainability impact. Overall, in the hope of improving material affordability and higher volume manufacturability, CFC is the preferred material for future baby bassinet models.

8.5. Basket

The body of the bassinet design is the basket that is connected to the frame. The basket forms the walls of the bassinet, and the mattress is placed within it. The basket carries the baby in horizontal and vertical orientations. It also has light and noise dampening shades. This chapter explains the different aspects of basket design.

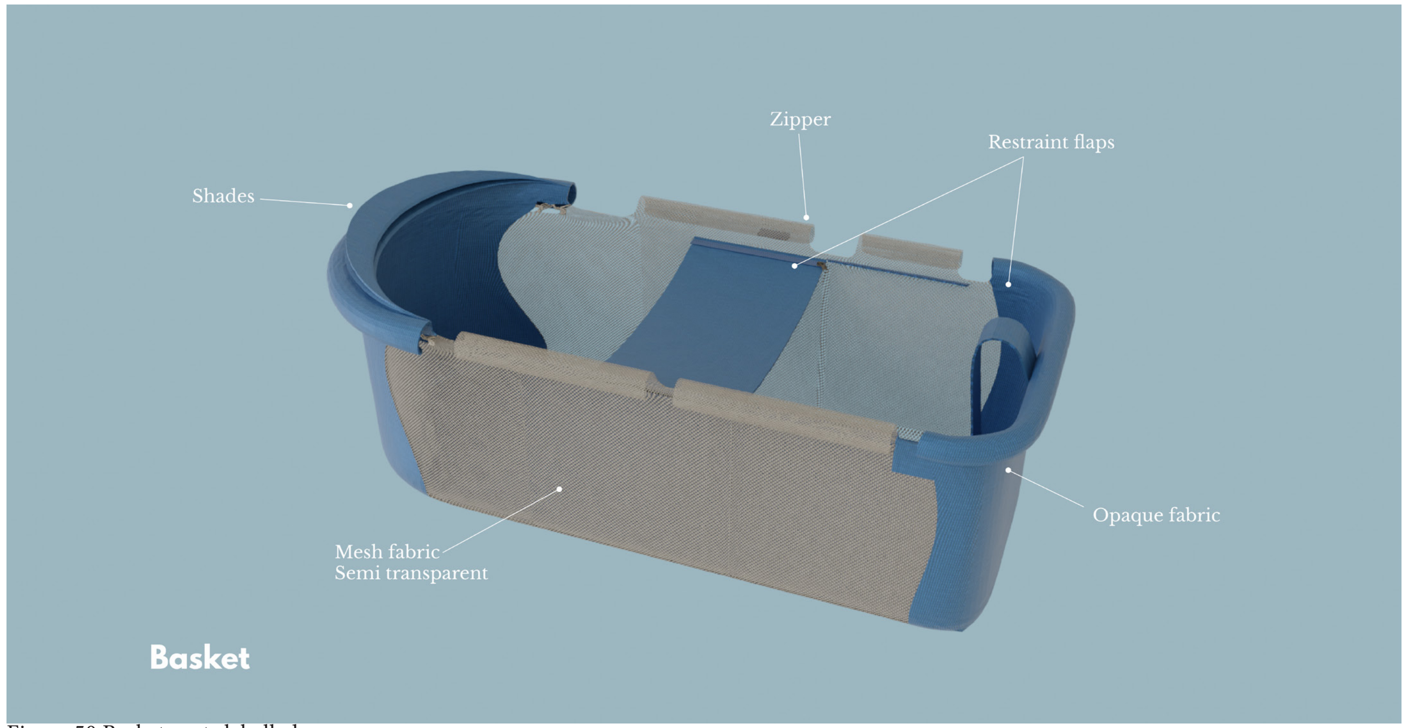


Figure 50 Basket parts labelled

8.5.1. Design

Different parts of the basket design are shown in fig 50. The basket is a fabric encasement connected to the frame. It surrounds the entire wall of the bassinet and the base. Basket fabric design has two parts: mesh – transparent fabric and opaque fabric.

This basket is connected with a zipper system to the top frame, and the fabric translates to the top frame's contour. The frame legs contain the basket walls and provide the base of placement of the mattress. The basket is connected to the legs of the frame through a fabric latch with metal snaps.

The bassinet fabric design ideation (Appendix O) was aimed to attain the visual balance between baby-parent connection and privacy from the flight cabin environment. After multiple iterations of the design, prototyping, observation in context and testing with parents, the final design is achieved.

8.5.2. Fabric material

The basket wall on the sides, facing the parent(s) and the wall, is a mesh fabric to increase the visibility for baby and parents ((Participant#7, user research, 2021))(see fig 51).

In turn, it allows parents to constantly monitor the baby with ease while performing other activities and do not require frequent standing of parents in an uncomfortable position as required by the current design (Participant#1,&Participant#2, user test, 2021). The mesh walls also increase airflow through the bassinet to avoid difficulty breathing when the top of the bassinet is covered and regulate the baby's temperature.

On the other hand, the bulkhead wall location is exposed to frequent light and sound disturbances from passengers using washroom and FAs aisle services.

Therefore, both head and foot end walls are covered with opaque, light and sound dampening material (see fig 51). Several material alternatives are considered: Foam sheets, blankets and a white noise machine.

Blanket fabric alternative is selected for its comfortability factors: breathability, non-hazardous material and hypoallergenic; hygiene factors: washability, high wash cycles; availability. Additionally, client Belgraver manufactures sound and light blocking curtains that can be used for this concept, reducing the installation cost and time (Belgraver, 2021).

Overall, this design enhances a quiet, reduced distraction environment to allow the baby to relax and sleep during the flight (Participant#2, user test, 2021).

Figure 51 Semi transparent and opaque fabric

Fabric selection

Selecting the material of the fabric is a critical decision of the basket component because of the complexity of requirements from aviation standards FAR 25.853(a), medical requirements baby health, baby comfort and mechanical strength. The most extensively used fabric materials: Cotton, Wool, Linen, Polyester and Nylon, are evaluated in Appendix P.

Polyester fabric has inherent Fire retardant properties, high fabric strength and cost-effectiveness (Kaity, 2019). In addition, polyester is hydrophobic, which provides its stain-resistant quality and eases the basket's cleaning process. However, cotton is a natural material and highly breathable, hypoallergic and has a soft tactile experience, an essential signifier of baby products (Participant#16, user test, 2021).

Hence, by selecting a polyester-cotton blend, the positive characters of both materials are utilised for the basket function. Further, client Belgraver manufactures polyester-cotton fabric for seat upholstery and curtains (Belgraver, 2021).

This fabric withstands the baby weight in both vertical and horizontal orientation and is validated by theoretical calculations shown in Appendix Q. Furthermore, the mesh and opaque fabrics are aviation grade polyester-cotton materials.

The mesh material is supplied by many aviation textile manufacturers like Spectra interior products (Spectrainteriors, 2021). The opaque fabric is the sound and light dampening curtain fabric from Belgraver (Belgraver, 2021).

8.5.3. Connection

The basket fabric is connected to the Al alloy mainframe using a divisible metal zipper, as shown in fig [FIXME]. The metal zipper has high strength, durability, quick handling time and close tolerance fitting of fabric basket (Sew Curvy, 2017). It also has high tolerance towards many wash cycles and sterilisation compared to buttons or Velcro systems (Participant#4, 2021).

On the other hand, buttons are prone to breakage and an easy target for the baby to bite, chew or even open the connection. Further, the microstructure of Velcro is known for its unpleasant noise, less strength and being allergic to some babies (Participant#8, 2021). The metal zipper system is around the entire perimeter of the mainframe for maximum connection and load distribution on the basket.


Figure 52 Zipper connection

8.5.4. Shades

The shades are attached to the head end of the bassinet top frame. It creates a temporary shield from the light and sound noises from the flight cabin to enable a less disturbing environment of baby sleeping (sleep physiology). The selected form is semicircle transcribed from the top frame head-end with convex faces of fabric draped over the plastic boning see fig 53. This layout creates a contrast between sleek fabric surfaces and defined tubing. In addition, the form is modern and futuristic in contrast to bulky, heavy rounding of shades for baby products.
The fabric is the opaque, light and sound dampening polyester cotton used in the basket. The boning is two polypropylene tubes that are easy to shape, lightweight 5g and washable (Sew Curvy, 2017). The two plastic bonings with 4mm diameter and 500mm length protect the baby's face from both sides (90deg cover to the left side and 60deg cover to the right side) while balancing enough openness to the basket to avoid suffocation. It is connected to the basket through metal snaps for quick, lightweight, and detachable connections, as shown in fig 54.

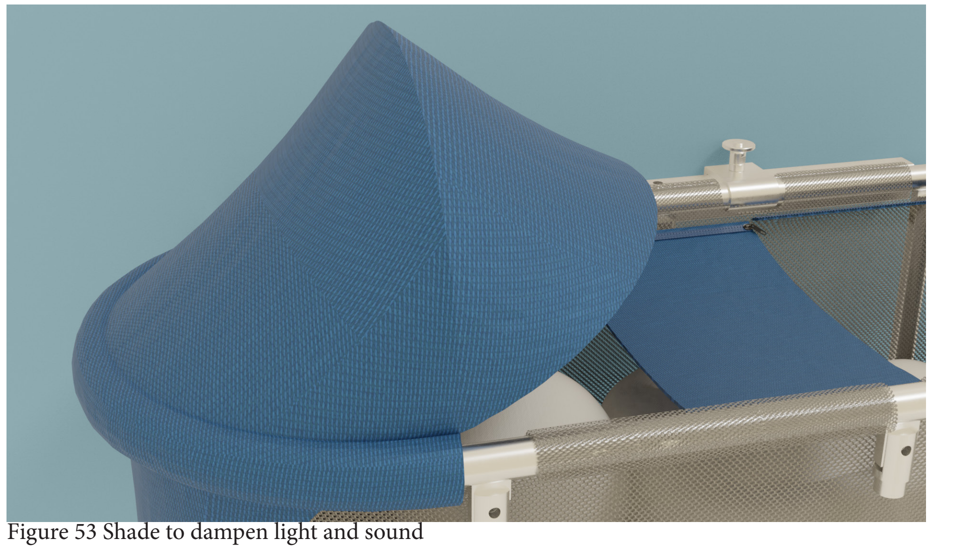


Figure 53 Shade to dampen light and sound


Figure 54 Metal snap connectors

1.5.5. Restraint system

Babies are curious and are prone to unpredictable movements, which require a restraint system to protect them from falling. The restraint system is a detachable design that is used in both horizontal and vertical orientations.

In horizontal orientation, the restraint system is a fabric belt connected to the middle of top frame. This restricts the baby from sitting up or climbing out of the bassinet but allow limb movements (see fig 55).

The restraint system in the vertical orientation has additional attachment to form 3 point harness system (see fig 56). It holds the baby in the seating position with easy access to lift and place the baby. User test (Participant#1, 2021) revealed that 5 point restraint alternative gave parents a high perceived safety of the baby.

Therefore, they are confident to leave their baby in the bassinet unassisted while using the washroom. In order to avoid miscommunication about the safety of the baby in bassinet, 3 point restraint system is installed.

The restraint are connected to the bassinet with metal zipper connections (see fig 57). This secures the baby while distributing the losd evan throughout the basket connection,

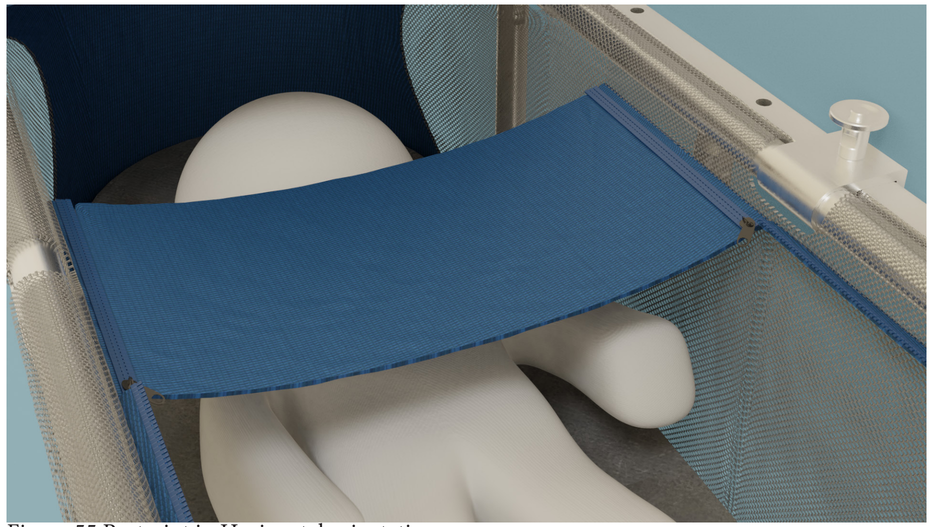


Figure 55 Restraint in Horizontal orientation

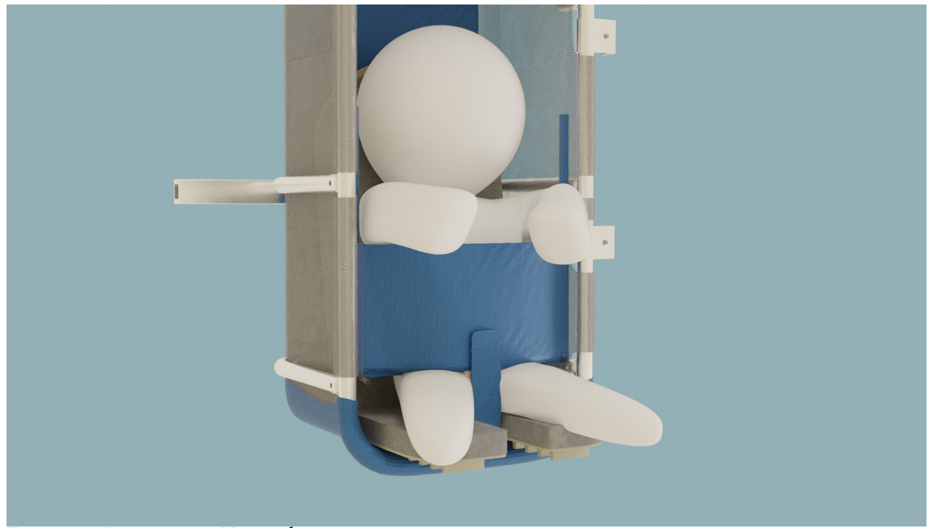


Figure 56 Restraint in Vertical orientation

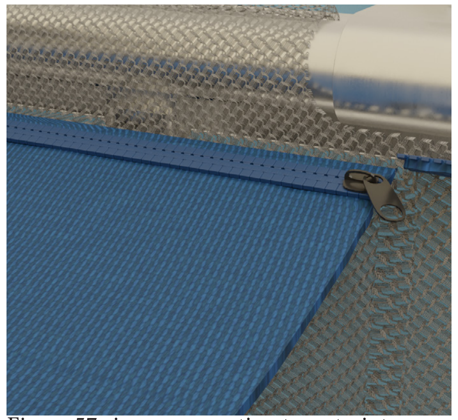


Figure 57 zipper connection to restraint

8.6. Mattress

The mattress has dual functions: it is the base of the bassinet in horizontal orientation and the seat in vertical position.

The mattress assembly consists of layers of foam and board encased in mattress fitting. The mattress assembly of the current Belgraver bassinet is shown in fig [58] (Belgraver, 2021). The requirements of the mattress are derived from the section 4.2.

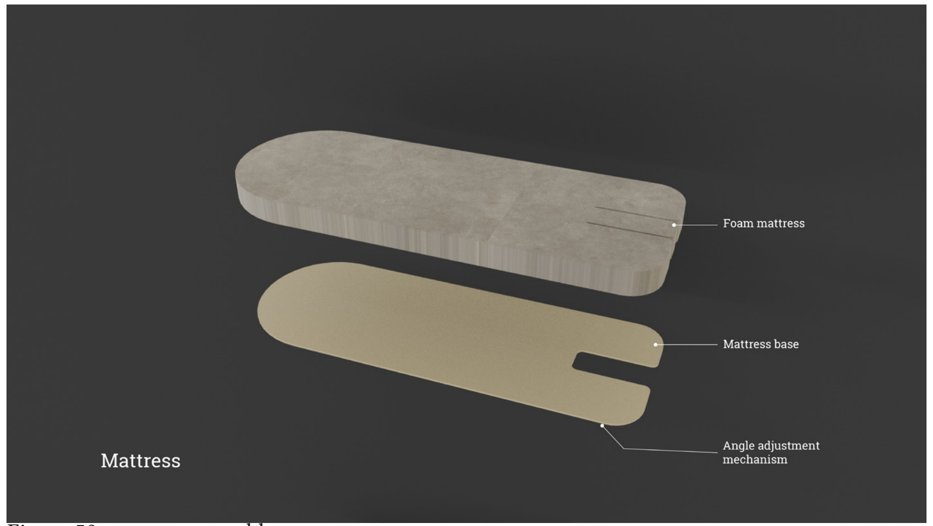


Figure 58 mattress assembly

Foam Material

The polyurethane foam material is selected for its lightweight, durability and cost-effectiveness compared to steel coil and double-sided mattresses (Baby List, 2021). In addition, polyurethane foam has no evidence of exposure to harmful volatile compounds; thus, it is safe for use for babies.

The mattress assembly materials hold good for the baby bassinet use case. However, the foil mattress cover should be replaced with food-grade polyethylene to improve the breathability of the mattress and reduce toxicity. Additionally, this water-resistant case allows easy wiping off dirt and resisting mold formation (Baby List, 2021).

Dimensions

Mattress assembly thickness is 2 inch for firmness and to avoid suffocation from excessive padding (ASTM F2194-07a ε1, Standard Consumer Safety Specification for Bassinets and Cradles) (Consumer Product Safety Commission, 2013).

The mattress's overall dimensions are 310mm and length 710 mm for a snug fit to prevent baby injuries.

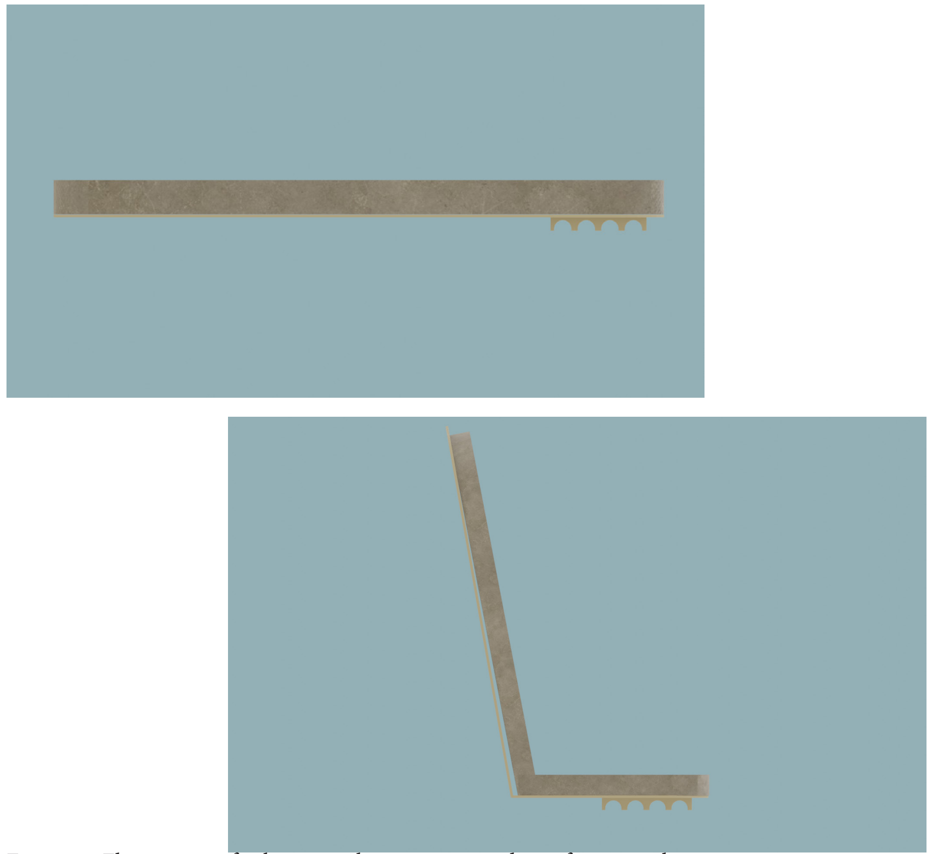


Figure 59 Flat mattress for horizontal orientation and seat for vertical orientation

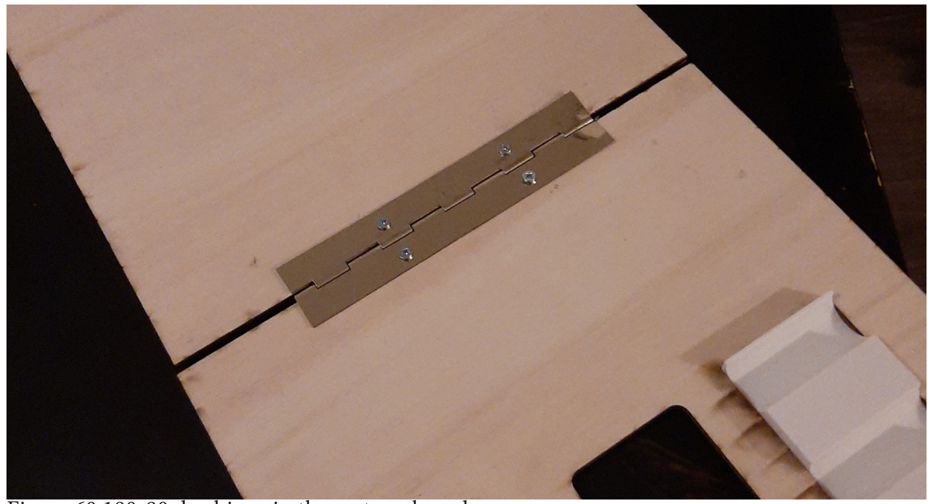


Figure 60 180-90 deg hinge in the matress board

Design

In the horizontal orientation, the mattress is a flat surface creating a bed for the baby to lie on. While in the vertical orientation, the mattress is bent to form the seat on which bigger babies sit during the flight journey (see fig 59). The mattress board has a 90 180 locking hinge to provide the restricted degree of freedom for the mattress (see fig 60).

Reclining system

The seat angle of range 110-120 degrees has a sleep efficiency index of 77% (Nicholson A.N, 2007). This is the conclusion of studying adult males' sleep patterns, which is still sound for big babies as they currently experience a maximum of 102 deg recline while travelling on parents' lap in KLM EC (Verghese, 2021).

Following the bassinet frame dimensions, the maximum recline angle of the mattress is 108 degrees which are 6 degrees more. Further increase in the recline angle is achieved by using a pillow, as shown in fig 61.

This angle adjustment mechanism has a semi-cylindrical indentation platform in the bottom of the seat, which aligns on the foot end of the mainframe (see fig 62).

The mechanism is secured by gravity and the sitting force exerted by the baby. Therefore, it is easily adjustable by parents to the desired angle with a slight lift. This reclining feature will enable the baby to sit, relax and sleep comfortably than on the parent's lap (Participant#1, 2021) (Participant#2, 2021).

The 3rd restraint belt will come in the way of the recline assembly. A slot in the board and mattress is made to allow the mattress to be reclined without any obstruction (see fig 63).

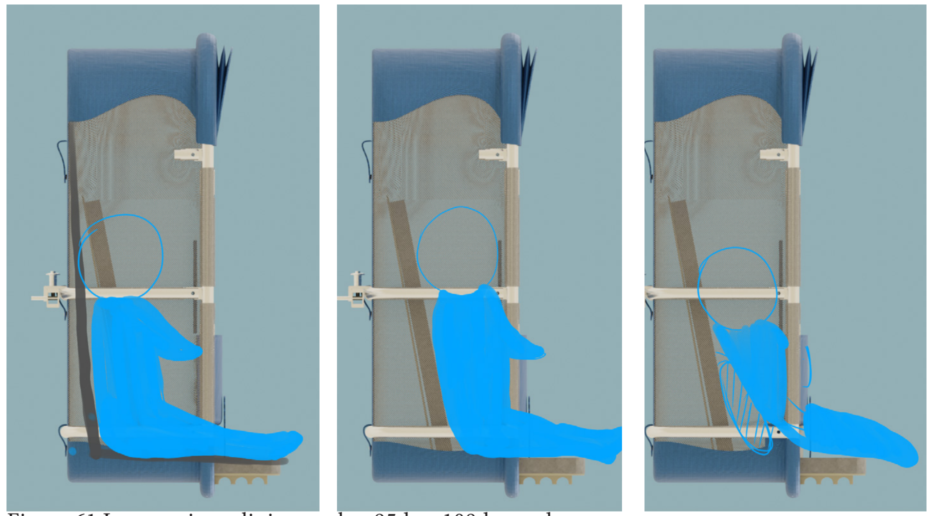


Figure 61 Increase in reclining angles: 95deg, 108deg and more

Figure 62 Reclining angle mechanism

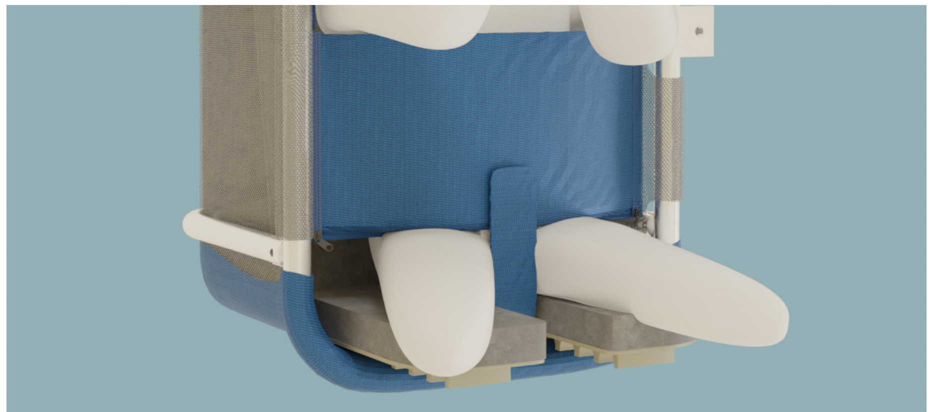
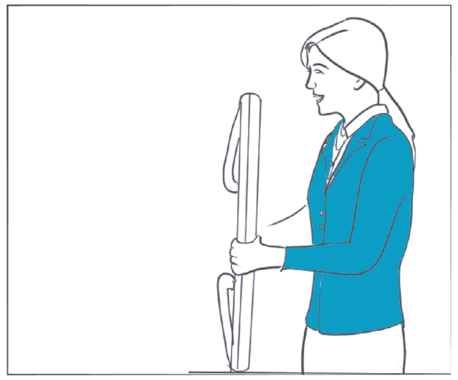


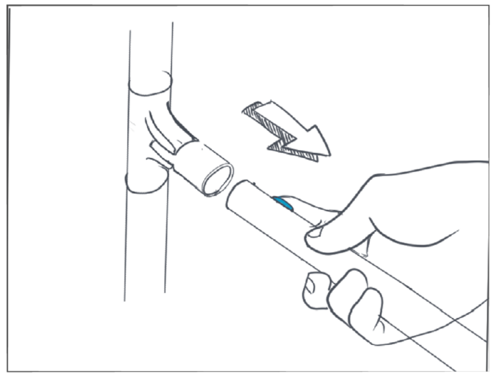
Figure 63 Slot in board and mattress

9 installation journey

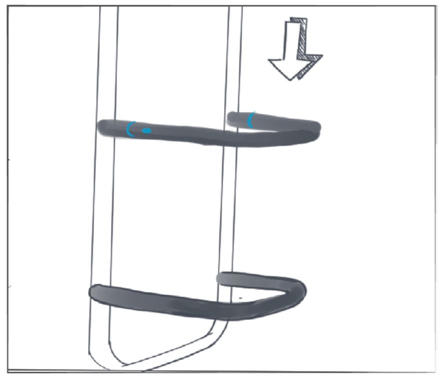
It is concluded from the interviews of FAs that seprating the locks from the bassinet frame assembly and performing two separate actions of attaching the bassinet to the bracket and locking it with push pin locks enhance the comfort and confidence of performing this action infront of parents from the aisle (fig 64).



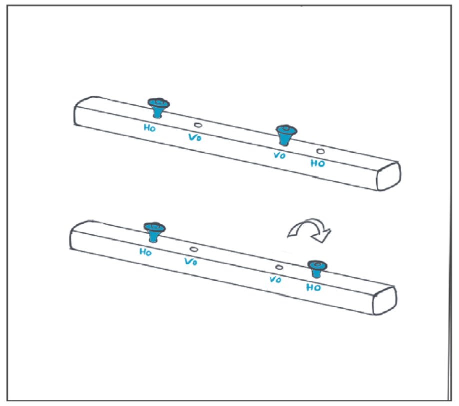
Flight attendant retreive the bassinet from the storage after a requent from the parent



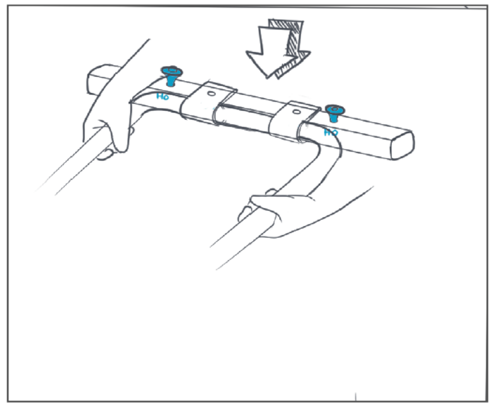
FA check if the legs are attached in right position for required orientation. If not they push the lock pin to release the leg



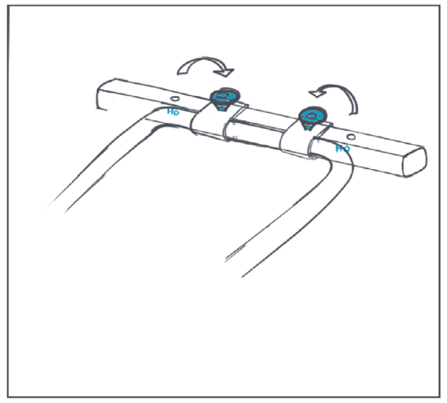
Then the leg is locked into the desired position before bringing it to the bulkhead wall



At the bulkhead wall, the FA chcks if the locks are NOT in the desired position. If so move them to other position.



The basiinet is lifted and fit on the bracket at the right holes.



Lastly, the locks are moved to lock the housing with bracket. The reverse proce-dure is followed to unlock and remove the bassinet

Figure 64 FA installation procedure of Kinder fly

10 conclusion

This project aimed to analyse and redesign Belgraver interior aircrafts' baby bassinet to improve the flying experience of babies, their parents, and flight attendants.

The design direction focused on developing the bassinet frame, basket and mattress for the key challenges: comfort, ease of use and hygiene. Based on literature research and qualitative user research, it can be concluded that bassinet accessibility for all babies within two years of age is the main factor to consider for improving parents and their babies flying experience.

The design of the bassinet focused on developing and validating a feasible and desirable dual-orientation concept. All the parts are demonstrated in a simulated environment, but most of the key challenges are fulfilled.

The Kinder fly requires further development for implementation in the market. This report holds the concept proposal with three parts of the system in two orientation use cases, substantiated with well-considered decisions on material choice, shape, dimensions, connections, user-product interactions and airworthiness.

In summary, the project resulted in a product proposal that is a unique product category for the aviation bassinet market. It can carry all target group babies, accommodate babies in both sleep and awake states, and provide freedom for parents to relax and simple structured handling of bassinet by flight attendants.

11 recommendations

After reflecting on the work done in this project further developments of the concept in different aspects is recommended in this section.

Firstly, for the next product in the category for baby passengers the scope should be zoomed out to focus and provide solution to all issues of parents and babies in the airport and air plane ecosystem.

The placement of bassinets need to be expanded to increase the number of bassinets for use in flights with high demand. From evaluation of placement ideation, the next preferred placement to the bulkhead wall is near the economy seats: converting seats around the parent into baby seats.

More indepth user study using fully working prototype with actual babies in the aircraft environment is required to understand baby interaction with horizontal and vertical orientations of the concept.

Further to improve the usability of the concept, frame design needs to be developed to attain the flexibility to use both the orientations during single-use.

The FA installation procedure has two steps: hanging the bassinet on the bracket and locking it using push pin lock. Incorporating magnetic lock or smart electronic lock technologies can further reduce the task of FAs. However, such a lock system needs to hold the bassinet and baby's load and be cleared for airworthiness.

Further, a parent suggested that the highly active baby might feel restrained to move their hands within the basket wall in the vertical orientation. This further needs to be evaluated with more participants, including babies, to iterate on the design of the basket wall to provide zipper openings on either side to allow babies to be active. This might pose a further challenge in zippers accessibility which needs to be restricted to be used only in vertical orientation and not in a horizontal orientation for safety reasons.

The basket prototype of the exact fabric material needs to be tested under vertical and horizontal loading conditions. Then, additional polyester/nylon belts can be added to improve the carrying capacity of the basket.

Some parents prefer covering of the entire bassinet while the baby is sleeping in the horizontal position: this might lead to reduced air circulation in the bassinet. The current shades design, which covers only the baby's face, needs to be tested in a trial run. If still required, the design needs to be modified to cover the entire bassinet.

Improving the hygiene of the product was not prioritised as the other two challenges were the key to the successful solution and due to the time constraint of the project. The cleaning procedure of the bassinet needs to be defined by the airlines: Cleaning it in-house with blankets will increase the procedure's feasibility and implementation. Further, a checking system needs to be developed to record the number of times the bassinet is used in one wash cycle. Extra blankets should be provided when the bassinet cannot be cleaned immediately. It would also be better if wet tissues and wipes are provided to the parents to manage any mess created by their babies. These changes require proper training of the FAs, who need to be informed of the additional steps that need to be done for their baby passengers.

Lastly, from the CFC material exploration, it is recommended to plan for CFC bassinet variant design in few years when the scaled-up manufacturing methods are ready in the market.

12 references

Adepalli, G. P. (2018). Socio-economic and demographic factors that contribute to the civil aviation industry. Procedia Manufacturing, 2-9. Retrieved from https://pdf.sciencedirectassets.com/306234/1-s2.0-S2351978918X0002X/1-s2.0-S2351978918300027/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX-2VjEEcaCXVzLWVhc3QtMSJGMEQCIFjt7D4Iv8hc24tTQPMGu81ce%2B7JYgJrB3xcNPpVr1BJAiBVR-LiFA1tlRYqq68ge8600vJkZ0rcyx13IzrU0XwggDi

AirAsia. (2013). AirAsia X quiet zone. Retrieved from AirAsia: http://www.airasia.com/au/en/inflight-comforts/quiet-zone.page

Amber. (2011, June). Parenting Advice – Courtesy of the Year 1935. Retrieved from http://www.amberanddom.com/: http://www.amberanddom.com/index.php/2011/06/17/parenting-advice-courtesy-of-the-year-1935/

Anderson, H. (2021). User research: focus group. (A. Nixon, Interviewer)

Afiaki. (2018). To what degree does a hole in a tube make it weaker? Retrieved from Phisicsforums.com: https://www.physicsforums.com/threads/to-what-degree-does-a-hole-in-a-tube-make-it-weaker.952298/

Aluminum Tube Weight Calculator. (2021, August 03). Aluminum Tube Weight Calculation. Retrieved from easycalculations.com: https://www.easycalculation.com/engineering/mechanical/aluminum-tube-weight.html

Anemo. (2021). Quick release pin BAB™ 620C8B6. Retrieved from anemo.eu: https://anemo.eu/quick-release-pins/620C8B6

Baby List. (2021). Best Crib Mattresses of 2021. Retrieved from Babylist.com: https://www.babylist.com/hello-baby/how-to-choose-a-crib-mattress

Baker, L. (2015). Bassinet vs. Crib: How to Decide. Retrieved from Healthline.com: https://www.healthline.com/health/parenting/bassinet-vs-crib

Bedgood, L. (2020). Marketing to the Generations – 90% of Parents Say Their Kids Influence Purchase Decisions. Retrieved from Business2Community.com: https://www.business2community.com/consumer-marketing/marketing-to-the-generations-90-of-parents-say-their-kids-influence-purchase-decisions-02327816

Belgraver. (2021). Special products. Retrieved from Belgraver aircraft interiors: https://www.belgraver.nl/special-products/

Benyus, J. (1997). Biomimicry: innovation inspired by nature. New York: William Morrow & co.

Branciforte, K. (2019). FIRST TIME FLYING WITH A BABY | Travel Tips for Baby. Retrieved from Youtube.com: https://www.youtube.com/watch?v=pjcvptu2n7Y

Brennan, D. (2019). How to Avoid Germs When You Travel. Retrieved from webmd.com: https://www.webmd.com/parenting/germs-and-travel#4

British Airways Speedbird Heritage Centre. (2021). Photographs from 1950 to 1959. Retrieved from British Airways.com: https://www.britishairways.com/en-us/information/about-ba/history-and-heritage/photographs

Broekhans, M. (2021, April 9). User research. (A. Nixon, Interviewer)

Budd, L. (2011, September). On being aeromobile: Airline passengers and the affective experiences of flight. Journal of Transport Geography. doi:10.1016/j.jtrangeo.2010.06.017

Canning, L. (2019). Flying with a Baby Alone: Secrets from an Experienced Mom. Retrieved from Youtube.com: https://www.youtube.com/watch?v=_F-H6YBJSmc&t=7s

Chamberlin, J. (2004, February). Sleep, baby, sleep. Retrieved from American Psychological Association: https://www.apa.org/monitor/feb04/sleep

C. T. Modlin, J. J. (2014). The 1.5 & 1.4 Ultimate Factors of Safety. NASA.gov. Retrieved from https://ntrs.nasa.gov/api/citations/20140011147/downloads/20140011147.pdf

Consumer Product Safety Commission. (2013). Safety Standard for Bassinets and Cradles. Federal register. Retrieved from https://www.federalregister.gov/documents/2013/10/23/2013-24203/safety-standard-for-bassinets-and-cradles

Desmet, P., & Hekkert, P. (2007). Framework of Product Experience. International Journal of Design, 13-23. Retrieved from https://diopd.org/wp-content/uploads/2012/02/frameworkproductex.pdf

Diethelm Keller Aviation. (2021). Baby Bassinet. Retrieved from diethelmkelleraviation.com: http://www.diethelmkelleraviation.com/products/baby-bassinets/

Dragon Plate. (2021). FLAME RETARDANT CARBON FIBER. Retrieved from dragonplate.com: https://dragonplate.com/flame-retardant-carbon-fiber

EASA. (2019). FAQ n.71607. Retrieved from EASA: https://www.easa.europa.eu/faq/71607

Emirates. (2021). Travelling with infants. Retrieved from Emirates.com: https://www.emirates.com/nl/english/family/on-board/travelling-with-infants/

Flynn, D. (2012). Malaysia Airlines defends baby ban, kid-free zone on Airbus A380. Retrieved from executivetraveller: https://www.executivetraveller.com/malaysia-airlines-defends-baby-ban-and-children-free-zone-on-airbus-a380

Halder. (2021). Ball Lock Pins - according to aviation standards (NASM / MS). Retrieved from https://www.halder.com/: https://www.halder.com/PM/Aviation-Products/Ball-Lock-Pins-according-to-aviation-standards-NASM-MS?ix_search%5Bfacet_norm_en%5D%5B%5D=NASM%2017984&group_id=node_group_g1437_en&page_location=1&view=teaser&limit=24

Harris, J. S. (2014). Crying babies on planes: Aeromobility and parenting. Annals of Tourism Research, Volume 48, Pages 27-41. doi:https://doi.org/10.1016/j.annals.2014.04.009

Heijne, K., & van der Meer, J. (2020). WWWWWH. In A. van Boeijen, J. Daalhuizen, & J. Zijlstra, Delft Design Guide: Perspectives-Models-Approaches-Methods (pp. 118-119). Amsterdam: BIS Publisher.

Hemingway, E. (2018, Mar). WHAT TO TAKE ON A PLANE FOR BABIES || LONG HAUL FLIGHT. Retrieved from Youtube.com: https://www.youtube.com/watch?v=4EdaL0cyUdc

ICAO. (2012). Global Aviation and Our Sustainable Future. Retrieved from https://www.icao.int/environmental-protection/Documents/Rio+20_booklet.pdf

Jansheski, D. G. (2021). When Can Your Baby Sit in a High Chair? Retrieved from momlovesbest.com/: https://momlovesbest.com/feeding/high-chairs/when-start-high-chair

Jongerius, P., Offermans, A., Vanhoucke, A., Sanwikarja, P., & van Geel, J. (2013). Get Agile: Scrum for UX, Design and Development. BIS Publishers.

Kamarbhari, S. B. (2018). Development of Egronomic CRS concept for infants in conventional aircraft seats. Universiti Putra Malaysia. Retrieved from http://psasir.upm.edu.my/id/eprint/76405/1/FK%202018%20 76%20IR.pdf

Kidd, S. T. (2016). Extraordinary intelligence and the care of infants. Proceedings of National Academy of Sciences of USA. doi:https://doi.org/10.1073/pnas.1506752113

KLM. (2021). Children travelling. Retrieved from klm.com: https://www.klm.com/travel/us_en/prepare_for_travel/travel_planning/children/index.htm

KLM. (2021). Children travelling. Retrieved from klm.com.

KPMG. (2020). Customer experience in the new reality. KPMG International.

Kaity. (2019). What Is Polyester? The 8 Most Vital Questions Answered. Retrieved from contrado.com: https://www.contrado.com/blog/what-is-polyester/

Kim, S. (2017). Why Is Pipe Always Circular Not A Square & Rectangular Shape? Retrieved from cheresources.com: https://www.cheresources.com/invision/topic/25889-why-is-pipe-always-circular-not-a-square-rectangular-shape/

L A Adams, V. I. (1989). Reducing bedtime tantrums: comparison between positive routines and graduated extinction. pubmed.gov, 756–761.

Lawdepot. (2021). What You Need to Fly with a Child. Retrieved from Lawdepot.com: https://www.lawdepot.com/law-library/family-articles/what-you-need-to-fly-with-a-child/?loc=US#.YRZMEYgzZPY

Leach, N. (2017). Precarious cargo: Fascinating images reveal that babies on plane journeys in the 1950s were simply placed in overhead cradles. Retrieved from Dailymail.co.uk: https://www.dailymail.co.uk/travel/travel_news/article-4160364/Babies-1950s-overhead-cradles-planes.html

Lozadac, B. (2020, December). How to fly ALONE with baby | Flying ALONE with Twins. Retrieved from Youtube.com: https://www.youtube.com/watch?v=sk54GWy9MsU

Lee, M., Li, L., & Song, W. (2019). Analysis of direct operating cost of wide-body passenger aircraft: A parametric study based on Hong Kong. Chinese Journal of Aeronautics, 32(5), 1222-1243. doi:https://doi.org/10.1016/j.cja.2019.03.011

Mandich, M. (2019, April 1). Millennials: Have kids, will travel. Retrieved May 18, 2021, from Phocus Wire: https://www.phocuswire.com/Millennials-have-kids-will-travel

Mindell, J., & Owens, J. (2003). A clinical guide to pediatric sleep: Diagnosis and management of sleep problems. Philadelphia: Lippincott Williams & Wilkins.

Moffitt, M. (2020). What is considered a short-haul, medium-haul and long-haul flight? Retrieved from pointhacks.com.au: https://www.pointhacks.com.au/differences-short-medium-long-haul-flights/

Mouritz, Adrian P. (2012). Introduction to aerospace materials. In Introduction to Aerospace Materials (pp. 1-14). Woodhead Publishing. doi:https://doi.org/10.1533/9780857095152.1

Moon, R. Y. (2016). SIDS and Other Sleep-Related Infant Deaths: Updated 2016 Recommendations for a Safe Infant Sleeping Environment. Americal Academy of Pediatrics. doi:https://doi.org/10.1542/peds.2016-2938

Nicholson A.N, B. M. (2007). Influence of back angle on the quality of sleep in. Ergonomics, 30(7), 1033-1041,. doi:https://doi.org/10.1080/00140138708965993

Newtonbaby. (2021). Bassinet Vs. Crib: What's The Difference And Which One Is Best For Your Baby? Retrieved from Newtonbaby.com: https://www.newtonbaby.com/blogs/nursery/bassinet-vs-crib

Participant#10. (2021). User research. (A. Nixon, Interviewer)

Participant#2. (2021). User research: focus group. (A. Nixon, Interviewer)

Participant#1. (2021). User testing at B737. (A. Nixon, Interviewer)

Participant#2. (2021). User test. (A. Nixon, Interviewer)

Participant#4. (2021). User research parent. (A. Nixon, Interviewer)

Participant#7. (2021). User research. (A. Nixon, Interviewer)

Participant#8. (2021). user research parent. (A. Nixon, Interviewer)

Pinto, J. P. (2017). Economic comparison between materials in the aerospace industry. Tecnico Lisboa .
PTAirco. (2007). Round vs. Square Tube Strength. Retrieved from homebuiltairplanes.com: https://www.homebuiltairplanes.com/forums/threads/round-vs-square-tube-strength.3372/

Recovery Delayed as International Travel Remains Locked Down. (2020, July 28). Retrieved from IATA.org: https://www.iata.org/en/pressroom/pr/2020-07-28-02/

Reynbakh, A. (2021). Flying with children: two year old baby sleeping in her own car seat setting on an ordinary seat on a commercial airliner. Concept photo of air travel with baby. Natural in-plane lightning conditions. Retrieved from ShutterStock.com: https://www.shutterstock.com/image-photo/flying-children-two-year-old-baby-367931372

Roozenburg, N., & Eekels, J. (1995). Product Design: Fundamentals and Methods. Utrecht: Lemma.

Raspall, F., Vaheed, N., & Velu, R. (2019). Fabrication of complex 3D composites by fusing automated fiber placement (AFP) and additive manufacturing (AM) technologies. Advanced Manufacturing: Polymer & Composites Science, 5(1). Retrieved from https://doi.org/10.1080/20550340.2018.1557397

Recovery Delayed as International Travel Remains Locked Down. (2020, July 28). Retrieved from IATA.org: https://www.iata.org/en/pressroom/pr/2020-07-28-02/

Sharma Rao, N., Simha, T., Rao, K., & Ravi Kumar, G. (2018). Carbon composites are becoming competitive and cost effective. Retrieved from https://www.infosys.com/engineering-services/white-papers/documents/carbon-composites-cost-effective.pdf

Schuster, A. (2021). Client Interview. (A. Nixon, Interviewer)

Shu, J. (2021). Is it safe to sedate my baby for travel? Retrieved from babycenter.com: https://www.babycenter.com/family/travel/is-it-safe-to-sedate-my-baby-for-travel_7263

Tan, J. (2012). SINGAPORE - FEBRUARY 12: Front row economy class seats with baby bassinet in Singapore Airlines' (SIA) last Boeing 747-400 aircraft at Singapore Airshow February 12, 2012 in Singapore. Retrieved from Shutterstock.com: https://www.shutterstock.com/image-photo/singapore-february-12-front-row-economy-95697718

The most family-friendly airlines. (2020). Retrieved from lastminute.com: https://www.lastminute.com/en/discover/family-friendly-airlines/

UUDS. (2021). Aircraft Baby Bassinet. Retrieved from www.aero.uuds.com: https://www.aero.uuds.com/en/baby-safe

US passport service guide. (2021). International Airfare - Finding the Best Deal on International Flights. Retrieved from www.us-passport-service-guide.com: https://www.us-passport-service-guide.com/international-airfare.html van Boeijen, A., Daalhuizen , J., & Zijlstra, J. (2020). Delft Design Guide: Perspectives-Models--Approaches-Methods. Amsterdam: BIS Publishers.

van der Meer, E. (2021). FA interview. (A. Nixon, Interviewer)

Vintag. (2016). Babies are strapped into airplane seats enroute to LAX during "Operation Babylift" with airlifted orphans from Vietnam to the US. April 12, 1975. Retrieved from Vintag.es: https://www.vintag.es/2016/07/operation-babylift-historical-photos.html

Verghese, V. (2021). Economy class seat survey. Retrieved from smarttravelasia.com: http://www.smarttravelasia.com/economy.htm

Whitmore, G. (2019). How Dirty Are Airplanes? Retrieved from forbes.com: https://www.forbes.com/sites/geoffwhitmore/2019/03/20/how-dirty-are-airplanes/?sh=6f922fd62ebb

WHO Department of Nutrition for Health and Development. (2006). WHO Child Growth Standards. Geneva: WHO Publications. Retrieved from https://www.who.int/childgrowth/standards/Technical_report.pdf
Wong, K. (2012). Why Humans Give Birth to Helpless Babies. Retrieved from Scientific American: https://blogs.scientificamerican.com/observations/why-humans-give-birth-to-helpless-babies/

Wright, A. (2016). After the Vietnam War, America Flew Planes Full of Babies Back to the U.S. Retrieved from Atlas Obscura.com: https://www.atlasobscura.com/articles/after-the-vietnam-war-america-flew-planes-full-of-babies-back-to-the-us

Wong K., C. D. (2017, June). Composites recycling solutions for the aviation industry. Science China Technological Sciences, 1-10. doi:10.1007/s11431-016-9028-7

Yeoman, U. M.-H. (2012). Demography and societal change. Family tourism: Multidisciplinary perspectives, Channel View, Bristol, 30-49. doi:https://doi.org/10.21832/9781845413286-007

Yashpal. (2015). A Review on use of Aluminium alloys in Aircraft components. i-manager's Journal on Material Science, 3(3), 33-38. Retrieved from https://www.researchgate.net/publication/319456144_A_Review_on_use_of_Aluminium_Alloys_in_Aircraft_Components

13 glossary

baby/babies
are the target group of flight passengers below two years of age

parents
spefically the parents who fly with their babies in economy class

flight attendants
they guide and serve the passengers on air. They also take care of baby

bassinet
a compact place for babies. It has mattress and cloth walls

bulkhead wall
it is a demarkation wall between different compartment of the flight

legroom
it is the space around passengers legs.

ICAO
Internationalcivil aviation organisation that creates regulations for the welfare and proper conditions of flight glabally

EASA
European Union Aviation safety agency perform similar functions in EU

SIDS
Sudden infant death syndrome is usually caused by blocking of windpipe which is even fatal

child restraint system
the only devices approved for the safety of child in transportation

14 appendices

Appendix A: KLM Bulkhead wall dimensions

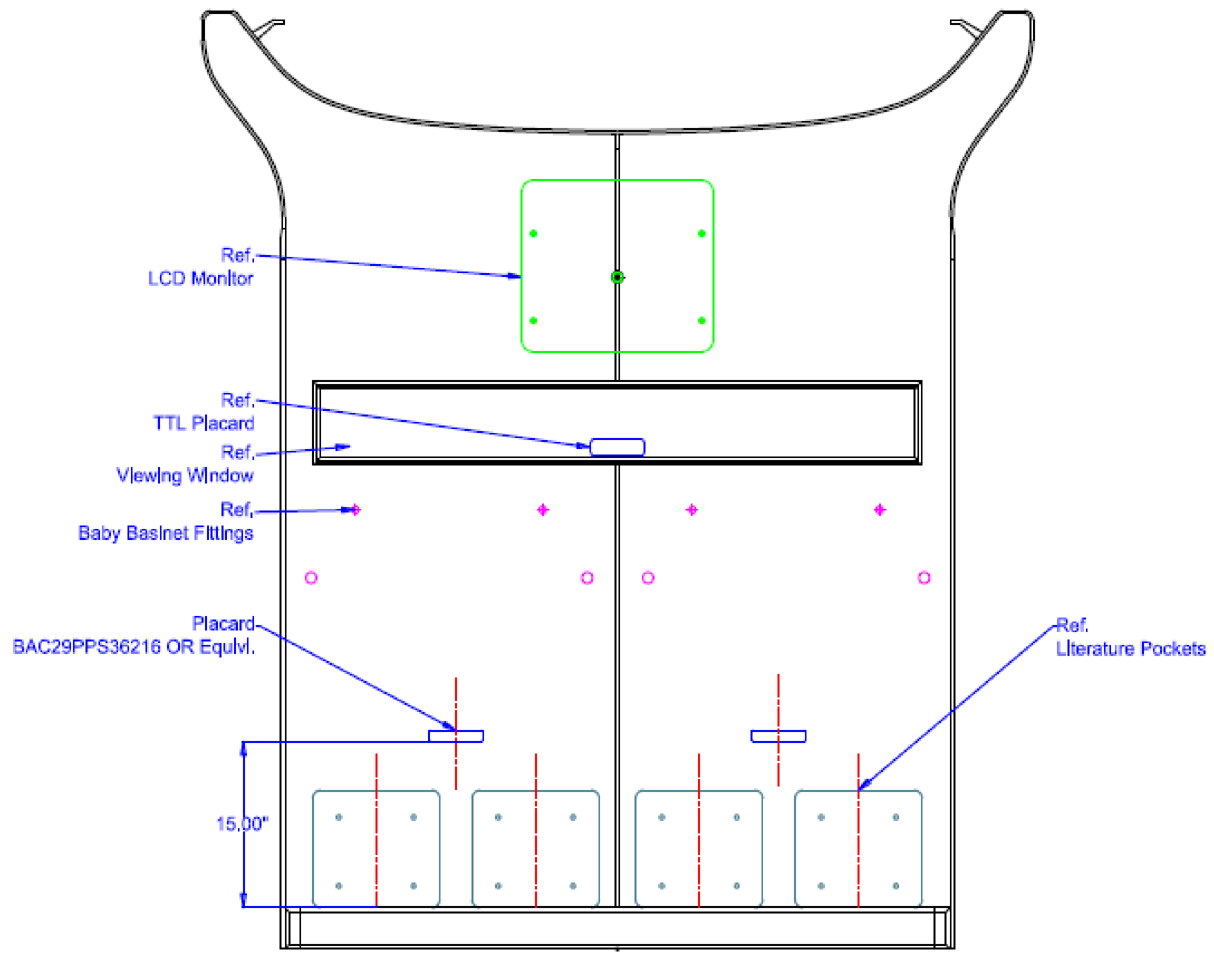


Figure 9 – CTR Cabin Class Divider – Placards
Forward Looking

Appendix B: Aviation standards for bassinet

EASA has categorised the baby bassinet as a cabin service provided by airlines to relieve parents from holding the babies. The bassinet is in the primary aircraft certification process: Certifications Specifications and Acceptable Means of Compliance for Large Aeroplanes CS-25 (ED Decision 2012/008/R) (EASA, 2019). Hence, it is not certified as a separate device. Airlines can choose to certify their aircraft with bassinet when they purchase.

It is evident that the baby bassinet is clearly not a Child Restraint System (CRS) and hence does not certify to be used during TTOL and turbulence. Therefore, during these specific phases, babies need to be help on the parent's lap. In addition, it does not provide safety for babies, which adult passengers receive. Enhancing the safety requirements for baby bassinets will require revision and the establishment of new standards by aviation associations, taking 5 – 10 years (Belgraver).

Appendix C: Problem definition process

Who causes or can influence the problem?
Cause: Parents More infants travelling in flights
Primitive solution offered by airlines
Influence: Airlines desire to provide better services
Pro-Health and in-flight luxury service expecting passengers

What would the situation be if the problem did not exist, and what is the situation in the future if the problem persists?
Ideal solution
Flying with infants - least hassel from the flight environment
All Infants feeling comfortable as at home
Parents get comfortable flight experience as other passengers without infants
Trend forecast if the problem persist
Possible decrease in parents and infants flying
Provide opportunities for commercial baby product companies
Pressure from Aviation associations on airlines to provide a better, safer solution

Where does the problem take place?
The problem occurs in the flight

When does the problem have to be solved?
When infants travel in flight

Why is it important to solve the problem?
Solving this problem gives
To meet the expectation of current and future flight experiences
a new improved system for infants and parents to use
Improve the flight attendants and parents relationship
advantage in the aviation accessories market

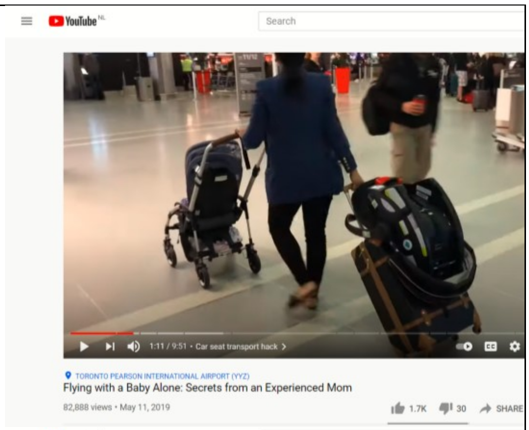
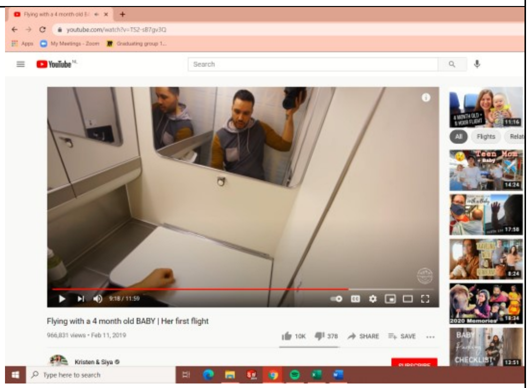
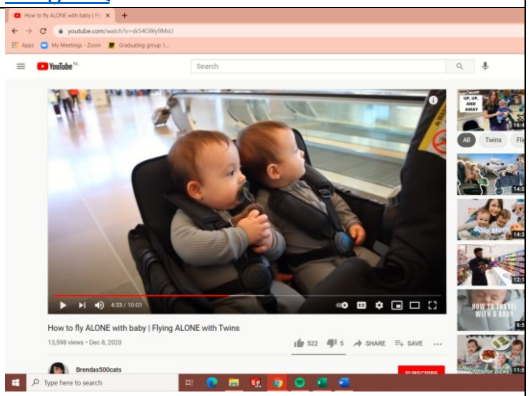
Is the problem temporary or permanent?
The problem has existed from the beginning of air transportation. Need to meet the advancement in adult passengers experience in flight

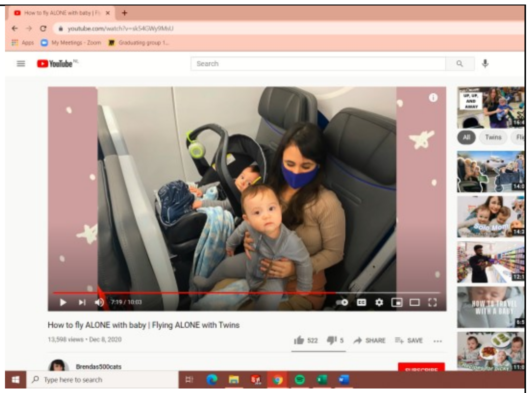
How many people are affected by the problem?
Mainly the infants, the parents taking care of them. Flight attendants who service them,

Does this analysis of the problem possibly affect existing knowledge, practices or protocols?
Initially this project might expose the drawbacks of current protocols but the solution at the moment need to fulfill the current standards to be able to relaised into the market soon.

Appendix D: Initial user observation

General info	Remarks	Contact
1. Infant: 6.5 months old 3 hour flight	Packed : Clip on high chair, Car seat, stroller, portable changing mat, nursing cover, baby carrier, pacifier Infant Tylenol : Pediatrician suggesting for ear blocking Inflight: Feed during take off and landing to avoid ears popping Pass between the parents to keep the baby entertained Put them to sleep most of the flight travel Lots of play time before flight to tire	Insta: Kallie_branciforte YT Link: https://www.youtube.com/watch?v=pjcvptu2n7Y
Eve Hemingway 11.5 months Long haul flight	Things in Check in bag 1. Baby food 2. Baby wipes 3. Nappies 4. Nappy rash cream 5. Milk and bottles 6. BIBS 7. Clothes 8. Plastic bags 9. A dummy 10. Fav toy 11. Stroller 12. Harness	YT Link: https://www.youtube.com/watch?v=4EdaL0cyUdc

Lisa Canning 9 month old Single parent	Carry car seat and stroller - Checkin the car seat at counter - Might need to put the stroller in belt at security - Check in the stroller at gate - Hold the baby in carrier - Choose back seats because anyway need to wait for the stroller, close to bathrooms and close to staff - Should not be strapped to parent while take off. **(need clarification)** - Strapped to parent while parent is eating (see image)	YT Link: https://www.youtube.com/watch?v=_F-H6YBJSmc&t=7s
4 month old 2 parents 7 hr flight	- Need elevators for stroller - Changing table in restroom	YT Link: https://www.youtube.com/watch?v=TS2-sB7gv3Q
Single parent Twins	Parents feel insecured and nervous in airports and flight Security is pain point (might check milk, food, stroller) Use car seat onto the flight Using white noise machine to block other noise	

		 YT Link: https://www.youtube.com/watch?v=sk54GWy9MsU
	Back seats can make baby anxious to wait for long	
	Babies over 1 yrs are not entertained in bassinets by crew Bbaies roam around airports Baby pukes in public places	
7 month old, 9 Kg Air Canada	Limit is 25 lbs, 12 kg - Will not provide bassinet if the baby can sit on their own -	https://www.youtube.com/watch?v=CCjxVUqmpHg

Appendix E: User research: Infants and Parents

Aim:

This study aims to understand the overall challenges faced by the infants and parents while flying in an aircraft. This specially focusses on their experience with bassinets and understand the needs of infants and parents to improve their flying experience.

Research question

The main question which is explored in this study is

1. How does infants flying affect the flight dynamics and what are the different factors responsible to good flying experience with infants?

2. What is the role of bassinets in this experience?

Procedure:

The interviews of this study were taken through online meeting, as this was the only option possible at the given time. It was still possible to understand the body language and observe any demonstrations through video streaming.

Introduction (2 min)

First, participants were welcomed to the interview session by the interviewer, who explained the course of the interview. Also, they were asked to sign the consent form.

Part 1: Narrating incident (5 min)
The participants are asked about their recent experience on flying with infants. The participants can recollect and narrate the incidents, which helps them to be more familiarized towards the subject of the interview.

Part 2: Discussion (5 min)
After completing narration, the interviewer asked further questions about infant on flight and usage of bassinets. This started a discussion, where the following questions were used as guidelines:

About bassinets:

Prior to flying

1. How did you come to know about the aircraft bassinets?
2. How did you procure a bassinet seat?
3. Were you aware of the weight and height restrictions of the bassinet?
4. Did you bring any other baby restraint system (car seat, stroller, Jetbeds etc)? What were they?
5. Where did you check in these (CRS) baby carrying products?

In the plane

1. How was the infant held during the take off?

2. Did you ask the attendants for bassinet?
3. What was the instructions given about using the bassinet?
4. Were you surprised by anything?

About bassinet

1. Why do you prefer/not prefer bassinets?
2. Does your infant feel comfortable in the bassinet?
3. What changes can improve the comfortability of the bassinets for the infants?
4. Does the bulkhead wall seats provide you and your infant comfort?
5. Were you comfortable with the placement of the bassinet?
6. What features from the conventional cribs, bassinets and car seats would improve the bassinet?
7. Does safety of the product is the prime requirement?
8. What do parents mean by safety - how can it be realised in bassinet?
9. How did you feed/nurse your infant on flight?
10. Any other issues?

Result

Infant details	1. Why do you prefer/not prefer bassinets?	2. Does your infant feel comfortable in the bassinet?	3. What changes can improve the comfortability of the bassinets for the infants?	4. Does the bulkhead wall seats provide you and your infant comfort?	5. What features from the conventional cribs, bassinets and car seats would improve the bassinet?
Facebook					
P1	somewhere to put infant while they sleep or while you eat so you have free hands. They were really useful to me flying alone with an infant.	yes	maybe some sort of way of sitting it up slightly so they could sit in there while awake Some flights for 8 hours + I could barely use the bassinet as it was turbulence most of the way. Only mild though	yes. Once the child has their own seat, I prefer to be on the back row out of the way	a way of blocking out the light would be amazing! Also sitting up slightly so babies could sit in them while awake. On a 10 hour flight alone it's hard work constantly having to have your baby on your

			so she would of totally been fine in there if strapped in properly like a car seat. Infact babies would probably be safer in there strapped in than on a parents knee		knee all the time they are awake
P2			I agree! The only thing that was annoying for me was when there was any chance of turbulence having to take the baby out. Completely understand the safety of why, would just be good to have something so you didn't have to disturb them		
P3	I prefer bassinet so my baby can sleep without getting awaken up every time I eat or use bathroom.	Yes. Both of my kids slept great in it.	The location of bassinet. Or bathroom door. It's usually right by the bathroom door which at times makes louder noise when they open/close. That used to startle my baby every time.	Yes	If it could hold a heavier baby, that would be great. My 14 month old was already at the weight limit because he was chubby 🤣 Also, if there was anyway we could safely attach a car seat instead of bassinet on the bulkhead,

					that would be amazing as many babies are used to snooze in their car seats.
P4					but sleeping in car seats for extended periods of time isn't safe because positional asphyxiation. You wouldn't even know they're gone before they were...no one would, not you specifically. I'm sure they don't do that because of that. They have to have a break out of the car seat every 2 hours to keep it safe and I doubt you want your kid up every two hours on a 10-20 hour flight.

P5	**P5** We flew to England from nz so 36 odd hours in total.	Bassinet was great.		Where they were located didn't mind at all.		They does need to be something for them sit up in per say. Needs to be able to be made darker.
P6	**P6**					Maybe airline approved

						complimentary blow up (u-shaped) bumper guard for around infant during flight. Also a sun/light shield that pulls up over half of bassinet.
P7	P7 We flew from Canada⇄Japan, 12-13hrs flight when my second was 5 months old.	Initially I got a bassinet so that I could take a break, eat and take care of my first. But it didn't help me at all instead gave me a hard time. I preferred having a bassinet now I prefer not to.	No	It was so hard to put leather buckle on, also leather makes sounds woke my son every single time I put him in.	I think so because I can't even imagine what if we're on normal seats.	Maybe a comfortable mattress?
P8	P8					Make the bassinet safe enough so you don't have to remove the baby everytime the seatbelt sign comes on. Then everything is perfect.
P9	P9					So my grandparent

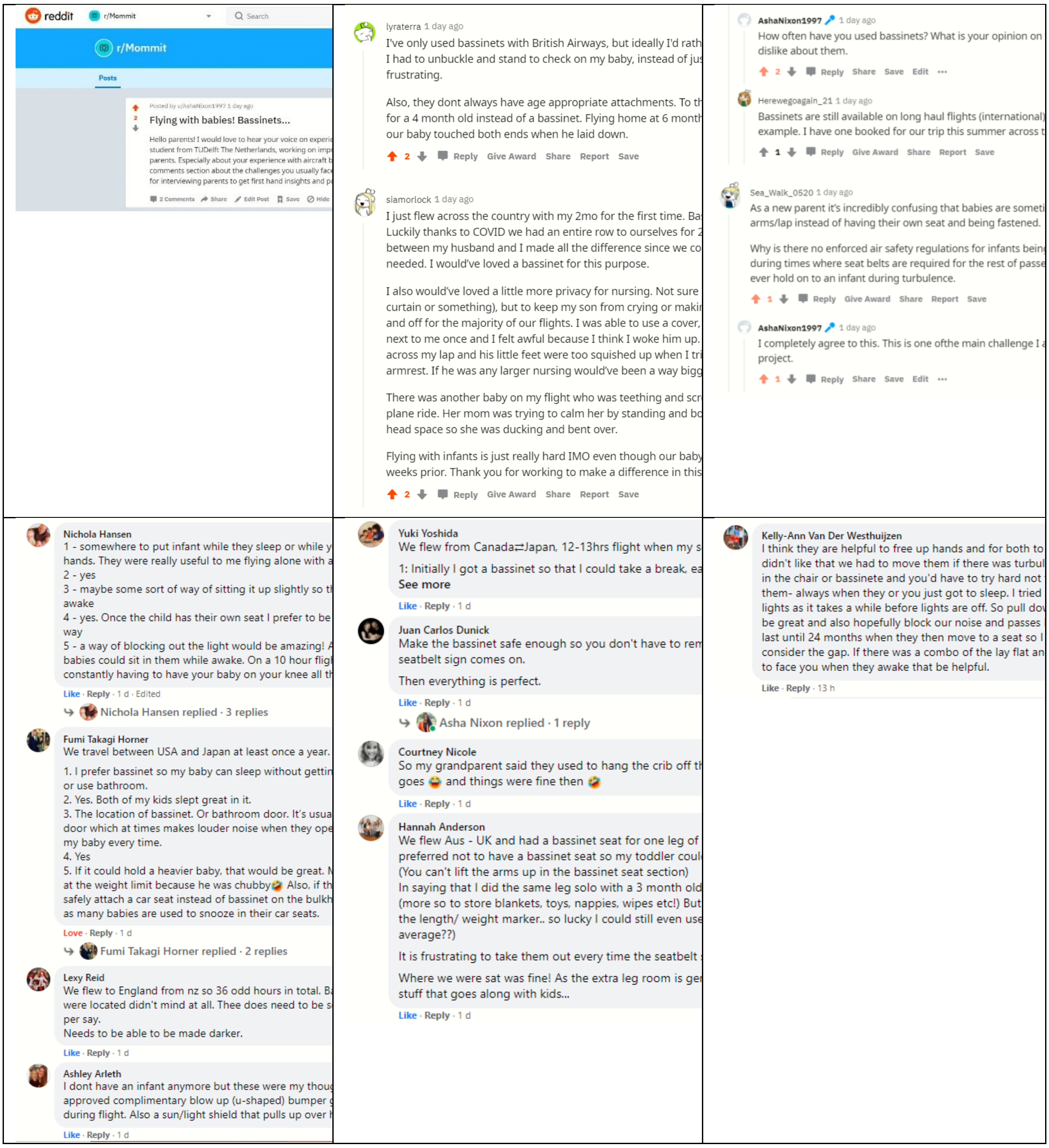
							said they used to hang the crib off the top where the luggage goes and things were fine then
P10	P10 We flew Aus - UK and had a bassinet seat for one leg of the journey	to be honest I preferred not to have a bassinet seat so my toddler could lie down on the seats! (You can't lift the arms up in the bassinet seat section)		In saying that I did the same leg solo with a 3 month old and the bassinet was handy (more so to store blankets, toys, nappies, wipes etc!) But I was told he was near on the length/ weight marker.. so lucky I could still even use it! (He's not above average??)	Where we were sat was fine! As the extra leg room is generally necessary for all the stuff that goes along with kids...	It is frustrating to take them out every time the seatbelt sign is on
P11	P11	I think they are helpful to free up hands and for both to sleep safely but I really didn't like that we had to move them if there was turbulance		I tried to make guard from the lights as it takes a while before lights are off. So pull down shutters of shorts would be great and also hopefully block our noise and passes by. Also felt the size doesn't last until 24 months when they then move to a seat so I think airlines need to consider the gap. If there was a combo of the lay flat and sit up options that swivel to face you when		as I felt they were safer in the chair or bassinete and you'd have to try hard not to wake them when moving them- always when they or you just got to sleep.

				they awake that be helpful.		
	Reddit					
P12	P12			but to keep my son from crying or making too much noise I nursed him on and off for the majority of our flights. I was able to use a cover, but his little feet kicked the guy next to me once and I felt awful because I think I woke him up.		I also would've loved a little more privacy for nursing.
P13	P13 I've only used bassinets with British Airways,	They have two options – shell/bucket seat and bassinet. But sometimes not appropriate on for the infants' age		I'd rather their bassinet height was lower. I had to unbuckle and stand to check on my baby, instead of just leaning over. It was really frustrating.		
P14	P14			incredibly confusing that babies are sometimes allowed to stay in your arms/lap instead of having their own seat and being fastened.		Why is there no enforced air safety regulations for infants being secured in an approved car seat during times where seat belts are required for the rest of passengers? There is no way you could ever hold on to an infant

						during turbulence.
	Interviews					
P15	P15 (1st time) 3 month baby (2nd time) 6 month (3rd time) 21 month London - India	Parents are free when the infant is sleeping Add more hassel during takeoff, landing, turbulence with extra belts which is almost useless	Yes. Mostly useful of infant below 6 months	- Limited number of bulkhead wall - Possibility to keep the infant when awake, playing. - Infant over 6 months need entertainment to stay calm for long duration (movies, toys) - Got bassinet only after 1 hr. Actually used the bassinet for very less time - Need smooth surface and baby blanket kits similar to adults. - Attach light sound toy, to help baby to sleep - Nice to provide	When travelling with 21 month infant, there is no possibility to use bassinet and also no extra leg room	- Parent is scared of the height at which the bassinet is installed - Don't like floor mounted as people might walk across - Believe that bassinets are not safe at all - Possibly restrict the number of babies of board so all get bassinets and extra leg room - Provide space for the

				rocking motion		partner near mom and infant to get their help - If the bassinet has a moving element, then it needs some fixture or clamp to feel safe
P16	P16 4 months Beijing – Malaysia Additional info: Need to leave early - Special arrangements – strollers - Easy Change diapers	Most beneficial for first time parents Helpful for long haul flight Happy that baby sleeps, air flight attendants are considerate	Infants are mostly quite comfortable with toys	- The baby feels quite comfortable and secured in car seats - Additional shades and music to entertain. -	Its luxury in economics class	- Cannot see baby when the parents are sitting - Quite relaxed with no baby in sight - The design looks primitive – light weight - There is hardly any associ

						ation to baby product – alienating -



reddit r/Mommit Search
r/Mommit
Posts
Posted by u/AshaNixon1997 1 day ago
Flying with babies! Bassinets...
2 Comments Share Edit Post Save Hide

lyraterra 1 day ago
I've only used bassinets with British Airways, but ideally I'd rath
I had to unbuckle and stand to check on my baby, instead of jus
frustrating.
Also, they dont always have age appropriate attachments. To th
for a 4 month old instead of a bassinet. Flying home at 6 month
our baby touched both ends when he laid down.
2 Reply Give Award Share Report Save

siamorlock 1 day ago
I just flew across the country with my 2mo for the first time. Ba
Luckily thanks to COVID we had an entire row to ourselves for 2
between my husband and I made all the difference since we co
needed. I would've loved a bassinet for this purpose.
I also would've loved a little more privacy for nursing. Not sure
curtain or something), but to keep my son from crying or makin
and off for the majority of our flights. I was able to use a cover,
next to me once and I felt awful because I think I woke him up.
across my lap and his little feet were too squished up when I tr
armrest. If he was any larger nursing would've been a way bigg
There was another baby on my flight who was teething and scr
plane ride. Her mom was trying to calm her by standing and bo
head space so she was ducking and bent over.
Flying with infants is just really hard IMO even though our baby
weeks prior. Thank you for working to make a difference in this
2 Reply Give Award Share Report Save

AshaNixon1997 1 day ago
How often have you used bassinets? What is your opinion on
dislike about them.
2 Reply Share Save Edit

Herewegoagain_21 1 day ago
Bassinets are still available on long haul flights (international)
example. I have one booked for our trip this summer across t
1 Reply Give Award Share Report Save

Sea_Walk_0520 1 day ago
As a new parent it's incredibly confusing that babies are someti
arms/lap instead of having their own seat and being fastened.
Why is there no enforced air safety regulations for infants bein
during times where seat belts are required for the rest of passe
ever hold on to an infant during turbulence.
1 Reply Give Award Share Report Save

AshaNixon1997 1 day ago
I completely agree to this. This is one ofthe main challenge I a
project.
1 Reply Share Save Edit

Nichola Hansen
1 - somewhere to put infant while they sleep or while y
hands. They were really useful to me flying alone with a
2 - yes
3 - maybe some sort of way of sitting it up slightly so th
awake
4 - yes. Once the child has their own seat I prefer to be
way
5 - a way of blocking out the light would be amazing! A
babies could sit in them while awake. On a 10 hour flig
constantly having to have your baby on your knee all th
Like · Reply · 1 d · Edited
Nichola Hansen replied · 3 replies

Fumi Takagi Horner
We travel between USA and Japan at least once a year.
1. I prefer bassinet so my baby can sleep without gettin
or use bathroom.
2. Yes. Both of my kids slept great in it.
3. The location of bassinet. Or bathroom door. It's usua
door which at times makes louder noise when they ope
my baby every time.
4. Yes
5. If it could hold a heavier baby, that would be great. M
at the weight limit because he was chubby Also, if th
safely attach a car seat instead of bassinet on the bulkh
as many babies are used to snooze in their car seats.
Love · Reply · 1 d
Fumi Takagi Horner replied · 2 replies

Lexy Reid
We flew to England from nz so 36 odd hours in total. B
were located didn't mind at all. Thee does need to be s
per say.
Needs to be able to be made darker.
Like · Reply · 1 d

Ashley Arleth
I dont have an infant anymore but these were my thou
approved complimentary blow up (u-shaped) bumper
during flight. Also a sun/light shield that pulls up over
Like · Reply · 1 d

Yuki Yoshida
We flew from Canada⇄Japan, 12-13hrs flight when my s
1: Initially I got a bassinet so that I could take a break, ea
See more
Like · Reply · 1 d

Juan Carlos Dunick
Make the bassinet safe enough so you don't have to rem
seatbelt sign comes on.
Then everything is perfect.
Like · Reply · 1 d
Asha Nixon replied · 1 reply

Courtney Nicole
So my grandparent said they used to hang the crib off th
goes and things were fine then
Like · Reply · 1 d

Hannah Anderson
We flew Aus - UK and had a bassinet seat for one leg of
preferred not to have a bassinet seat so my toddler coul
(You can't lift the arms up in the bassinet seat section)
In saying that I did the same leg solo with a 3 month old
(more so to store blankets, toys, nappies, wipes etc!) But
the length/ weight marker.. so lucky I could still even use
average??)
It is frustrating to take them out every time the seatbelt
Where we were sat was fine! As the extra leg room is gr
stuff that goes along with kids...
Like · Reply · 1 d

Kelly-Ann Van Der Westhuijzen
I think they are helpful to free up hands and for both to
didn't like that we had to move them if there was turbul
in the chair or bassinete and you'd have to try hard not
them- always when they or you just got to sleep. I tried
lights as it takes a while before lights are off. So pull do
be great and also hopefully block our noise and passes
last until 24 months when they then move to a seat so I
consider the gap. If there was a combo of the lay flat an
to face you when they awake that be helpful.
Like · Reply · 13 h

Consolidation of the factors

The common issues observed in the experiences of parents is consolidated and categorised into pros and cons of using bassinets in aircraft.

Pros	Cons
1. Place for infant while sleeping 2. Parents can relax, eat, use restroom 3. Comfortable bulkhead wall streets – to store stuff 4. Leg room to let infant stretch and play 5. Bassinet space to store baby stuff	**1. Infant need to sit and relax** **2. Use during take-off, landing and turbulence** **3. Block out light** **4. Block noise from passengers** **5. Hold all babies below 2 years** **6. Safety – provide protection** 7. Darker colour product 8. Bumper guard 9. Comfortable mattress 10. Bulkead wall seat's armrest don't lift cannot sleep on chair 11. Not enough space to feed 12. Keep bassinet at lower height 13. Equal availability of bassinets 14. Need entertainment 15. Rocking motion 16. Space for both parents near bassinet 17. Design looks primitive. 18. Need to provide aesthetic value of safety and hygiene

Conclusion

From the conversations online and interviewing parents(n=15) gave insights to the crucial issues (with minimum 3 parents agreeing) with using bassinets are listed as,

1. Must use bassinet during take-off, landing, turbulence
2. Must accommodate infant while awake – sitting
3. Must hold all infants below 2 years
4. Must provide safety factor of infants just like adults
5. Block out light
6. Block out noise

References

1. Current Statistics of Women in Aviation Careers in U.S. | Women in Aviation International. (2020). Women in Aviation International. https://www.wai.org/resources/waistats
2. https://www.facebook.com/groups/flyingwithkids/?multi_permalinks=788043002070047&notif_id=1614695283012061&notif_t=feedback_reaction_generic&ref=notif
3. https://www.reddit.com/r/Mommit/comments/m17t7z/flying_with_babies_bassinets/

Appendix F: User research: Flight attendants

Aim:

This study aims to understand the impact of infants travelling in flight on crew members. Furthermore, to understand their opinions on bassinets on easing the flight experience for infants, the parents, other passengers and crew members.

Research question

The main question which is explored in this study is

1. How does infants flying affect the flight dynamics and what are the different factors responsible to good flying experience with infants?

2. What is the role of bassinets in this experience?

Method:

To answer the research question, interviews were conducted to get the desired qualitative data. These interviews were conducted in a semi-structured way: participants are sensitised with flight experience with infants through narrating their last experience, while during and after narrating their stories the interviewer followed up on interesting comments from the participant. This allowed for two-way interaction and the higher chance of discovering potential latent needs (Kallio et al., 2016).

Participants

This study was focussed on flight crew members/ flight attendants. Available quantitative data suggests the flight attendants includes nearly 80% females (WAI, 2020). Also, nearly half of flight attendants are in age range of 25-35 years. Therefore, female flight attendants within the age group of 25 -40 was preferred for this research as the goal is to find motivations behind users' choices, which could differ over these attributes.

As the target group is niche, the aim of the recruitment process was to focus on people which could be reached for an interview in the short time frame available. The quickest way to reach participants was by professional contacts at KLM.

In Table 1, the selection of participants is detailed.

	<30	30 - 50	>50
male	P5, P6	P1, P10	P11, P12
female	P4, P2	P3, P9	P7, P8,

Table 1: detailed selection of participants

Procedure:

The interviews of this study were taken through online meeting, as this was the only option possible at the given time. It was still possible to understand the body language and observe any demonstrations through video streaming.

Introduction (2 min)

First, participants were welcomed to the interview session by the interviewer, who explained the course of the interview. Also, they were asked to sign the consent form.

Part 1: Narrating incident (5 min)
The participants are asked about their recent experience on flying with infants. The participants can recollect and narrate the incidents, which helps them to be more familiarized towards the subject of the interview.

Part 2: Discussion (5 min)
After completing narration, the interviewer asked further questions about infant on flight and usage of bassinets. This started a discussion, where the following questions were used as guidelines:

Flying with infants

1. Do they always have time and energy to look after the infants when asked?
2. How do they manage infants who are active in the aisle?
3. What do they think are the major challenges for infants in flight (on lap, on car seat)?
4. What option do parents prefer the most - on lap with loop belt, on lap and bassinet, infant in separate seat, in car seat,
5. How does infant impact the flight environment for other passengers?

About bassinets:

1. How frequently infants' parents request for bassinet?
2. Will it be provided without prior request?
3. How many bassinets do the flight carry?
4. What are the special safety procedures to follow while using a bassinet?
5. Do you provide any comfort accessories like blankets for infants?
5. What is your opinion of the location of bassinets?
6. Where are the bassinets stored?
7. Is it easy to access, install and store the bassinet?
8. Is the basket sent to clean after every usage?

About a concept

1. During a flight over 4 hrs duration. Could you describe how often do you use your seats inside the cabin?
2. What are your suggestions on improvement of the bassinet design?
3. Limitations of bassinet – height weight

Ergonomics:
Reaching the connectors
Attaching to the wall
Carrying the bassinet on their own

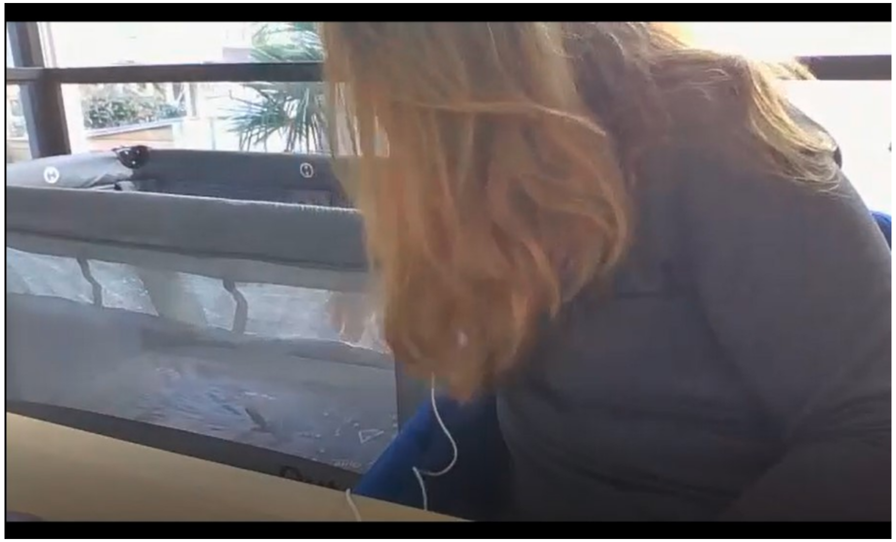
Parents eating and baby
Issues with nursing
Issues with parents during turbulence
Drawback of bulkhead wall seats

Results:

About bassinets:
1. How frequently infants' parents request for bassinet? 23000 bassinets are reserved on average per year
2. Will it be provided without prior request? Yes, we ask if they would like a bassinet if we see parents with babies embarking the aircraft
3. How many bassinets do the flight carry? 4
4. What are the special safety procedures to follow while using a bassinet? Only after take off. Bassinet is removed should it become turbulent.
5. Where are the bassinets stored? In dedicated cabinets in the aircraft
6. Is it easy to access, install and store the bassinet? Easy access; yes, to install requires some handiwork if you try to hang it by yourself as you have to suspend the bassinet in the air as you try to fix the pins into the sockets
7. Is the basket sent to clean after every usage? No, mostly the parent has an own blanket (or we provide one) to keep the bassinet clean. Bassinet are sent to clean upon visual inspection by cabin attendant.

Participant info	About bassinet	About infant in flight	About flight attendant experience
P1	Bassinets mostly used as extra storage Life jacket and extension belt storage space is required If its possible to make the material look through to enable parents look at the kids Storage space to keep stuff Possibility to keep the babies in bassinet during turbulence. Minimum 1 bassinet is used every flight	Can make cradle on the ground Try making bed on their economy seats Parents take turns to eat. But not all the flight attendants don't considerate Provide new blankets for	Assembling the bassinet into the wall is unhandy. It projects to parents that the flight attendants are unhandy with the bassinet further questioning the safety of infant in the bassinet Handling system can be big and

		babies and temporary covers	ergonomically sound Make report and notice sign in AMS. The fabric collects a lot of dust
P2	Parents always unclear when bassinet are installed They have to wait till after take-off and service Not enough bassinets [2 – 4] – young babies are given preference. Height restriction – delta airlines have longer bassinets Height: - Provide leg space - Parents cannot reach babies Safety – perceived as not falling from bassinet - Requiring cover for complete Protection Disturbing babies sleep even for mild turbulence by taking them out of bassinets	Provide extra blankets for comfort (when available) Usually parents come with lots of luggage – no proper space always available Providing food for parents while they have babies on lap is a hassle	Difficult to hang - Not reachable to far end - Could be lighter No major standards or training to help the infants and parents
P3	In biggest aircraft 2 – Business class 8 – Economy class location of bassinet is okay. Leg room is available Height can be adjusted to the eye level of the passenger	Usual overbooked. Parents assume that the bassinets is always available - Limited bassinets	Installation: Has a quick learning curve The bassinet is quite heavy to carry

	Great solution to leave the babies in the bassinet during turbulence The bassinets are never get cleaned according to her knowledge – removable cover would be a good addition Restrictions: 10 kg, 65cm height  The material can be see through to look at the baby It can be covered completely with breathable mesh to secure the baby (gives the parents baby is comfortable)	- Sudden change of aircraft No additional supplies: No microwave on flight on flight. Cannot heat baby food Forward facing of the child on lap is safer No additional comfort accessories is mandatorily provided. Need new standards to provide fresh blankets	No training to deal with providing food to parents Active Can bring issues
P4	Hanging mechanism: Dirty Height: Good height - enables parents to sit comfortably - Easy to get up and move - But harder to see the baby inside	New products are brought: Only accepted if - Passengers in front are not	Issues with handing mechanism: - Need to reach sideways - Hold with three fingers,

	Hygiene: - No extra blankets catered for just babies. - Need 2 blankets per bassinet. In the bassinet and over the bassinets - Blankets 100% onward and 90% return for weight consideration Cleaning procedure: 1. Notice the dirty bassinet 2. Hang a label 3. Ask the cockpit crew to make a log in aircraft maintenance log In practice: 1. Noticed just before landing 2. Cannot call cockpit crew 3. Closed the containers with label 4. Usually noticed in the next flight and grab a new one. Prefer some cover – breathable and hygienic On average 4 bassinets – bassinet positions	restricted to recline - Should not hang on tray as they have load limitation - If babies are not strapped with seat belts then parents should take them on lap There is a rule to also put the baby on the floor below the bassinet. But not the bassinet as it becomes a loose item. But take the mattress and put it down Perception of parents that baby on hard floor in cabin is not safe Seat belt sign is on – parents	- Very precise small holes - Heavy to carry with three fingers - Bassinet drops immediately after disengaging

		don't like to take the baby out during seat belt sign on Can it be turbulence proof? – G force – Boeing compliancy tests done Parents usually leave last. They need a lot of time to pack, carry everything, baby might be sleeping.	

Conclusion:

Initial user research was done to understand their interaction with infants on board, with the bassinet itself. This results from interviewing flight attendants who have experience with flying with infants is documented and analysed. The key pain points highlighted by all the flight attendants include difficult hanging system of bassinet and the complex cleaning procedure. This contributes to prioritise Ergonomic and Hygienic factors in the problem scope. These are used to map the emotional experience in user journey map. Further, the different aspects of these challenges are mentioned as,

Ergonomic factors

- Hold the bassinet from the sides
- Locate and insert pins into small holes
- Hold the safety pins with three fingers

- Open the lever and push pin simultaneously with 2 fingers while holding
- Hold the bassinets immediately after disengaging the pins
- Parents need to see the baby without compromising their

Hygiene factors

- The fabric collects lot of dust
- No blankets are mandatorily allocated
- Cleaning roughly on air
- Cumbersome cleaning procedure

References

1. Current Statistics of Women in Aviation Careers in U.S. | Women in Aviation International. (2020). Women in Aviation International. https://www.wai.org/resources/waistat

Appendix G: Program of Criteria (POC)

Solution	
1. Implement in 3 years a. No change in aviation standardisation b. SHOULD be produced in existing facility 2. MUST meet current ICAO regulations for bassinet 3. Aviation tests a. Strength test b. Flammability test FAR 25.853(a) c. MUST have JAR25.603 certificate for all materials 4. Storage efficiency - measurements 5. MUST be cleaned after every use 6. MUST enable repairability of frame and basket 7. SHOULD cost less than €150 per product 8. NICE to have continuous production 9. SHOULD have versatile colour options to compliment airlines' aesthetics 10. MUST not hinder parents activities a. Accessing entertainment system b. Access tray c. Sleeping d. Exit to aisle 11. SHOULD have no/small learning curve for parents and flight attendants	Belgraver, 2021 User research: Parents, Flight attendants
Bassinet frame:	Source
1. SHOULD accommodate all infants till 2 years – Height - 95cm 2. SHOULD accommodate all infants till 2 years – Weight - 24kg 3. MUST weigh 3.7kg or less 4. MUST accommodate active (non-sleeping) infants during cruise 5. MUST be installed from the aisle 6. MUST be locked and unlocked with one hand 7. MUST have secured locking system when installed	(WHO, 2006: P99) (16kg, Factor of Safety 1.5 (WHO,2006 : P99) Current bassinet weight 3.7 kg User research Context observation Context observation
Bassinet basket	
1. MUST make parents and infants feel safe a. MUST prevent infant from falling b. MUST secure infant in sleeping position c. MUST secure infant in active position – eat, play, move 2. MUST be hypoallergenic 3. MUST be breathable material 4. MUST be clean for every use 5. SHOULD block the light when infant is sleeping	User research: Parents User research: Parents User research: Parents User research: Parents (Sheppard, 2009) (Sheppard, 2009) User research: Flight attendants (National Institute of Child Health & Human Development, 2007)

6. SHOULD provide quiet environment 7. CAN monitor baby when left unattended 8. NICE to include entertainment for infants 9. NICE to be able to remove infant without waking during turbulence	(National Institute of Child Health & Human Development, 2007) User research: Parents User research: Parents User research: Parents, Flight attendants
Mattress	
1. Must be flat surface 2. Must be firm 3. Must have soft tactile feature 4. MUST be water/dust resistant 5. NICE to provide familiar environment – olfactory senses	(National Institute of Child Health & Human Development, 2007) (National Institute of Child Health & Human Development, 2007) User research: Parents User research: Flight attendants User research: Parents
Bassinet Placement	
1. Must prevent infant from falling 2. Must not reduce parents' leg room 3. Must not hinder parents to stand 4. Infant Must be visible to parents	User research: Parents User journey map User journey map User research: Parents

Ranking of criteria

1. Implement in 3 years
    a. No change in aviation standardisation
    b. SHOULD be produced in existing facility
2. Aviation tests
    d. Strength test
    e. Flammability test FAR 25.853(a)
    f. MUST have JAR25.603 certificate for all materials
3. Storage efficiency - measurements
4. MUST be cleaned after every use
5. MUST enable repairability of frame and basket
6. MUST not hinder parents activities
    e. Accessing entertainment system
    f. Access tray
    g. Sleeping
    h. Exit to aisle
7. MUST accommodate active (non-sleeping) infants during cruise
8. MUST be installed from the aisle
9. MUST be locked and unlocked with one hand
10. MUST have secured locking system when installed
11. MUST make parents and infants feel safe
    d. MUST prevent infant from falling
    e. MUST secure infant in sleeping position
    f. MUST secure infant in active position – eat, play, move
12. MUST be hypoallergenic
13. MUST be breathable material

14. MUST be clean for every use
15. Must be flat surface
16. Must be firm
17. MUST be water/dust resistant
18. Must prevent infant from falling
19. Infant Must be visible to parents
20. SHOULD cost less than €150 per product
21. SHOULD have versatile colour options to compliment airlines' aesthetics
22. SHOULD have no/small learning curve for parents and flight attendants
23. SHOULD accommodate all infants till 2 years –Height - 95cm
24. SHOULD accommodate all infants till 2 years – Weight - 24kg
25. SHOULD block the light when infant is sleeping
26. SHOULD provide quiet environment
27. CAN monitor baby when left unattended
28. NICE to include entertainment for infants
29. NICE to be able to remove infant without waking during turbulence
30. NICE to provide familiar environment – olfactory senses
31. NICE to have continuous production

Regulations

1. Aviation tests
    a. Strength test
    b. Flammability test FAR 25.853(a)
    c. MUST have JAR25.603 certificate for all materials

Manufacturability

2. Implement in 3 years
    a. No change in aviation standardisation
    b. SHOULD be produced in existing facility
3. MUST enable repairability of frame and basket
4. SHOULD cost less than €150 per product
5. NICE to have continuous production

Comfort

6. MUST make parents and infants feel safe
    a. MUST prevent infant from falling
    b. MUST secure infant in sleeping position
    c. MUST secure infant in active position – eat, play, move
7. MUST be breathable material
8. MUST accommodate active (non-sleeping) infants during cruise
9. MUST not hinder parents activities

a. Accessing entertainment system
b. Access tray
c. Sleeping
d. Exit to aisle

10. Must be firm
11. Must be flat surface
12. SHOULD accommodate all infants till 2 years – Weight - 24kg
13. SHOULD accommodate all infants till 2 years –Height - 95cm
14. SHOULD block the light when infant is sleeping
15. SHOULD provide quiet environment
16. NICE to provide familiar environment – olfactory senses
17. NICE to include entertainment for infants

Hygiene

18. MUST be hypoallergenic
19. MUST be clean for every use
20. MUST be water/dust resistant

Ease of Use

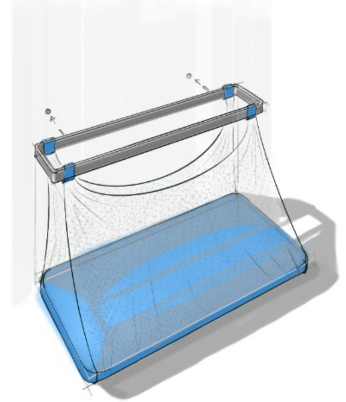
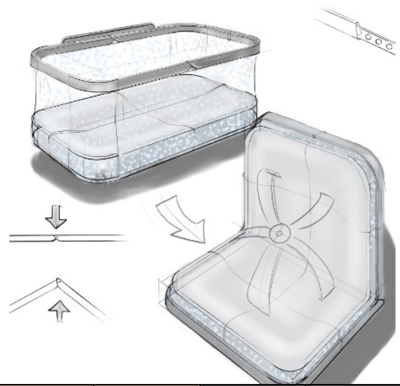
21. MUST have secured locking system when installed
22. Infant Must be visible to parents
23. Storage efficiency – measurements
24. MUST be installed from the aisle
25. MUST be locked and unlocked with one hand
26. SHOULD have no/small learning curve for parents and flight attendants
27. CAN monitor baby when left unattended
28. SHOULD have versatile colour options to compliment airlines' aesthetics

References:

WHO. (2006). *WHO Child Growth Standards WHO Child Growth Standards* (ISBN 92 4 154693 X). WHO Press. https://www.who.int/childgrowth/standards/Technical_report.pdf

Sheppard, J. (2009, October). *Protect Your Baby from Toxic Exposures*. Healthy Child. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.456.7578&rep=rep1&type=pdf

Appendix H: Concept Selection

Requirements	Concept: Cocoon				Concept: Flexi				Concept: Buddy				
													
1. Aviation tests a. Strength test b. Flammability test FAR 25.853(a) c. MUST have JAR25.603 certificate for all materials													
2. Implement in 3 years a. No change in aviation standardisation													
b. SHOULD be produced in existing facility													C1 has higher complex frame

3. MUST enable repairability of frame and basket													C1 Complex part in frame, moving part in C3
4. SHOULD cost less than €150 per product													C2 has least parts
5. a. MUST prevent infant from falling													C1 has rigid backet
b. MUST secure infant in sleeping position													C2 has lower rigidity – can lead to swaying
c. MUST secure infant in active position – eat, play, move													All concepts have enclosed structures to secure infants
6. MUST be breathable material													C2, C3 has light, thin fabric cover
7. MUST accommodate active infants during cruise													C1 has regid structure to acco movements of active infants
8. MUST not hinder parents activities a. Accessing entertain. sys													
b. Access tray													
c. Sleeping													
d. Exit to aisle													
9. Must be firm													C1 has plastic structure, C3

													has thick mattress
10. Must be flat surface													Constant flat surface is achieved in C3
11. SHOULD accommodate all infants till 2 years – Weight - 24kg													Frame is more sturdier in C3
12. SHOULD accommodate all infants till 2 years – Height - 95cm													C1, C3 can hold big infants in sitting position
13. SHOULD block the light when infant is sleeping													Shades to be provided
14. SHOULD provide quiet environment													C1 is more enclosed from environment
15. SHOULD have versatile colour options to compliment airlines' aesthetics													The colours of frame, basket and mattress can be customised
16. MUST be hypoallergenic													C1 has more contact with infant body
17. MUST be clean for every use													C2 has completely disposable/ washable
18. MUST be water/dust resistant													C2 is mostly fabric

19. MUST have secured locking system when installed													C3 has least movable lock system
20. Infant Must be visible to parents													C1 is solid structure in sleep pos
21. Storage efficiency – measurements													C1 bulk storage, C2 almost no storage
22. MUST be installed from the aisle													C2,C3 has simple locking mech
23. MUST be locked and unlocked with one hand													C1 need 2 hands for complex lock
24. SHOULD have no/small learning curve for parents and flight attendants													C2 versatility resembles conventional solutions
25. NICE to provide familiar environment – olfactory senses													C2, C3 personal blankets can be used
26. NICE to include entertainment for infants													C2 does not have entertainment provision
27. CAN monitor baby when left unattended													Motion tracking sys can be used
28. NICE to have continuous production													Cont prod of mattress/ inlay

Appendix I: Analysis of dual and single orientations of the bassinet

Stationary position Horizontal orientation	Dynamic position Horizontal n vertical orientation
Comfort Accommodate sleeping infants **Ease of use** One time installation per use **Hygiene** **Manufacturability** Simple frame design Ease of standardisation and testing Less parts Possibly light weight	**Comfort** Accommodate big infants Accommodate active babies – play, eat Accommodate sleeping infants Comfort for infants for long duration Increased visibility for parents **Ease of use** No need for parents to hold the infants on lap Parents can multitask Parents can move around **Hygiene** **Manufacturability**
Comfort Need to hold active infants on lap Parents cannot multitask It does not hold big infants **Ease of use** **Hygiene** **Manufacturability**	**Comfort** **Ease of use** Storage complexity **Hygiene** **Manufacturability** Complex mechanism Need new standards for a mechanism

	Heavy alternate

Availability of vertical and horizontal orientations on concept Cocoon provides a

- higher degree of comfort by accommodating all infants, during different activities
- increase multitasking capabilities for parents.

The increased complexity of this dynamics positioning creates

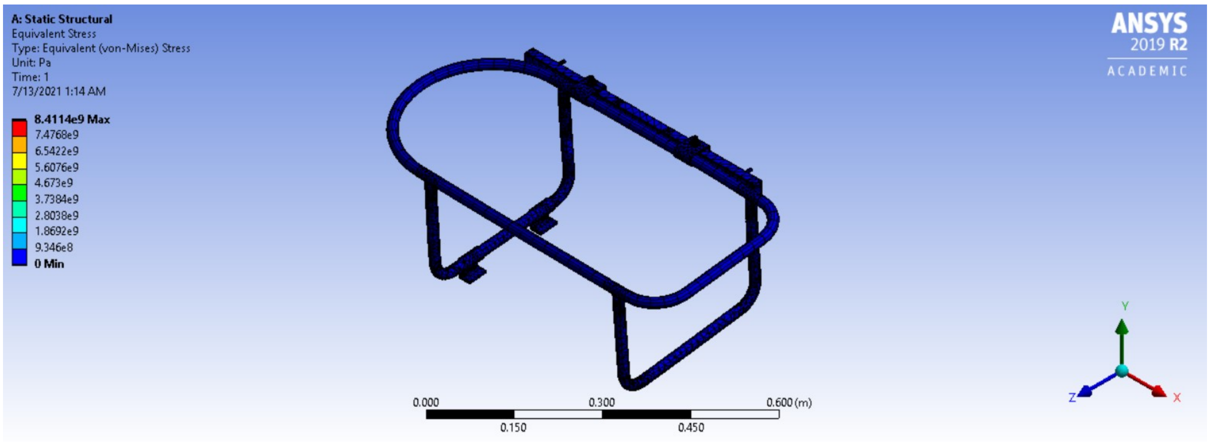
- a challenge in the design and
- manufacturability of the frame,
- which needs newer standardisation tests to sustain the safety factor of the bassinet.

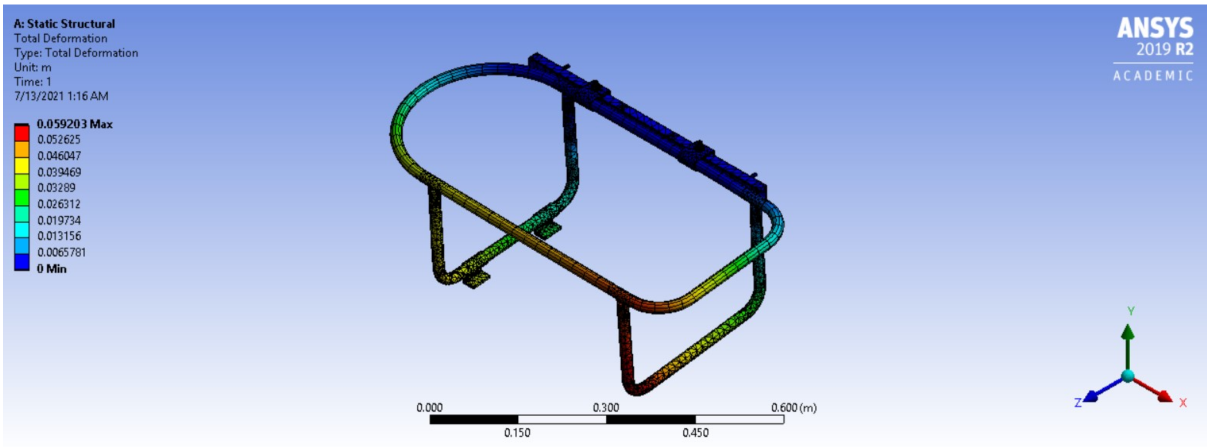
Appendix J: Simulation

The design selection of different components: frame tube, bracket, attachment housing, push pin lock, and telescopic push lock are based on theoretical calculations to withstand the 16G impact aviation standard test.

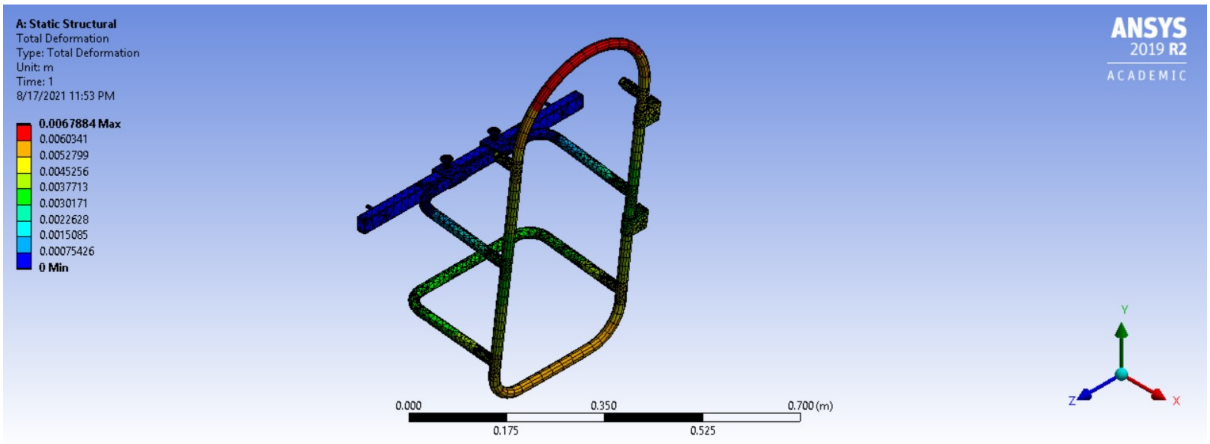
The frame assembly was modelled in Solidworks, and FEA analysis is done in Ansys software. Simulating the 16G crash test was not possible due to the complexity of the assembly and the time frame of the project. The results of the static tests reflect the concept behaviour under the usage of maximum baby (2 years) weight of 16kg (WHO Department of Nutrition for Health and Development, 2006).

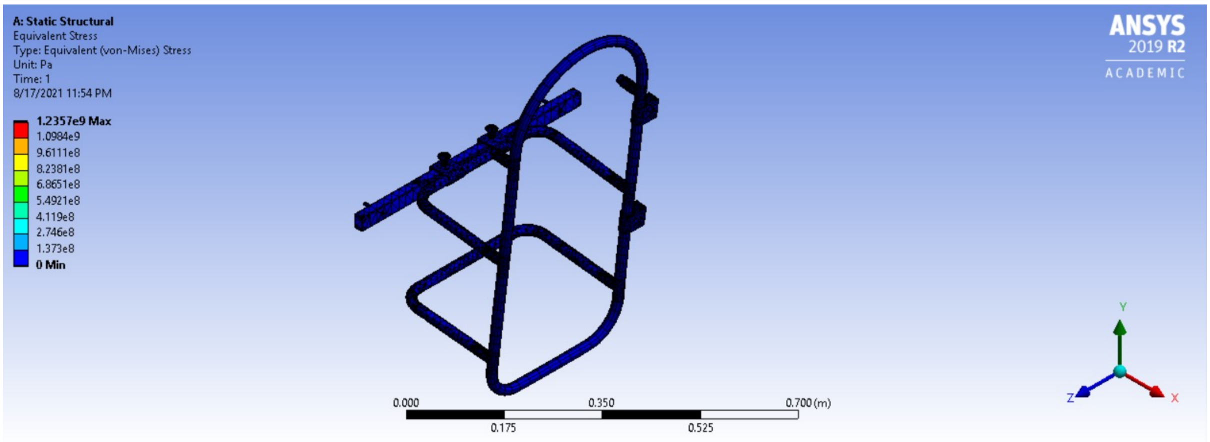
Static test of horizontal orientation





Static test of vertical orientation





The principle stress are within the safe limits with Factor of safety of 1.5.

However, Deformation is higher – rubber stopper should be included in the design

Appendix K: Fastener load calculation and design

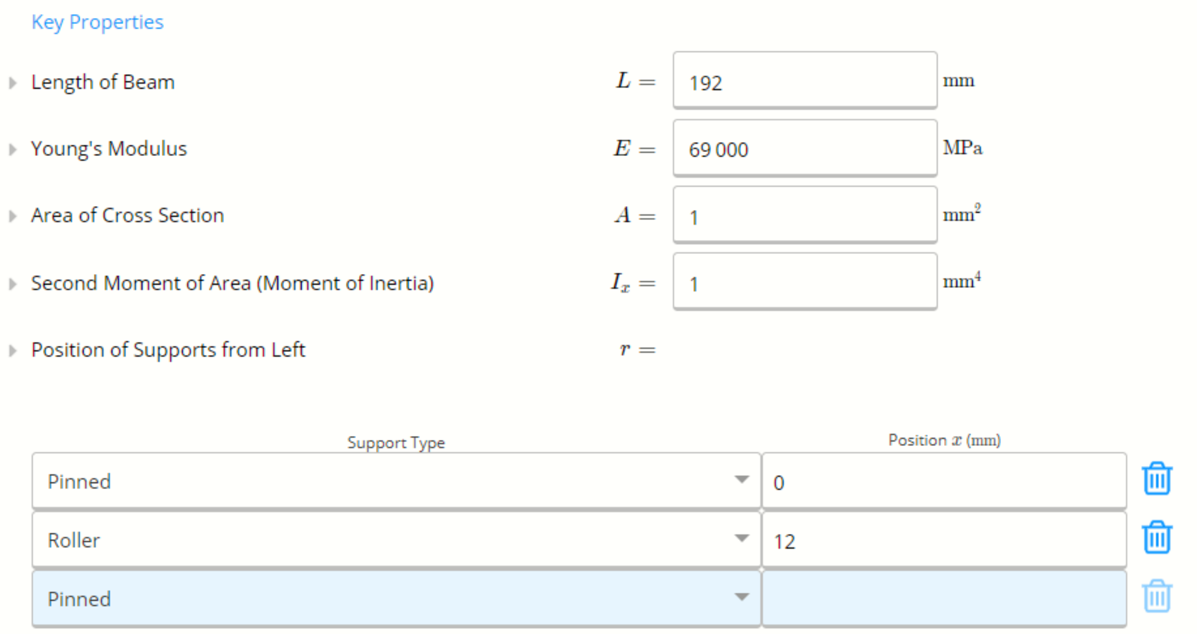
Fastener load calculation:

Free body diagram illustration

Max Weight of infant = 16kg (Ref FIXME)

Factor of Safety – 1.5 (Federal airworthiness regulation part 25.303) (C. T. Modlin, 2014)

ClearCals Free beam calculator: https://clearcalcs.com/freetools/beam-analysis/au

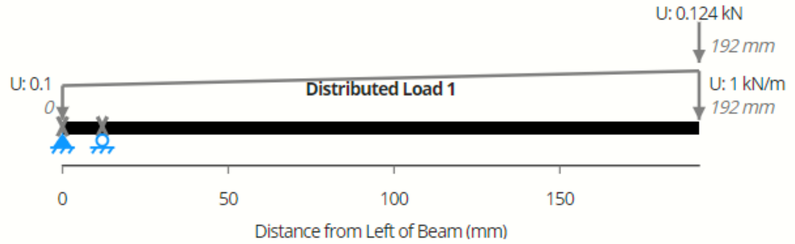


Key Properties

Length of Beam	$L =$	192	mm
Young's Modulus	$E =$	69 000	MPa
Area of Cross Section	$A =$	1	mm^2
Second Moment of Area (Moment of Inertia)	$I_x =$	1	mm^4
Position of Supports from Left	$r =$		

Support Type	Position x (mm)
Pinned	0
Roller	12
Pinned	

Simple Loads



Distributed Loads $w =$

Label	Start Magnitude w_s (kN/m)	End Magnitude w_e (kN/m)	Start Location x_s (mm)	End Location x_e (mm)
Distributed Load 1	0.1	1	0	192

Point Loads $P =$

Label	Magnitude P (kN)	Location x (mm)
	0.124	192

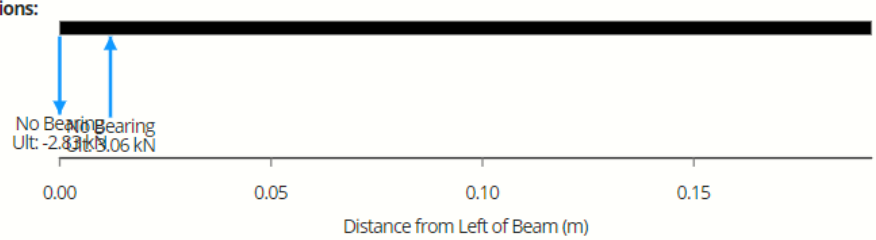
Summary

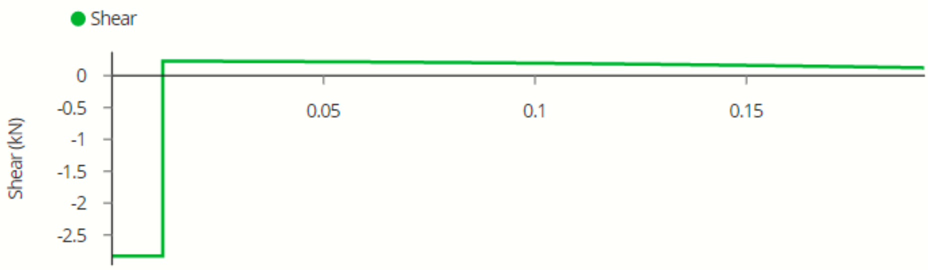
Moment Demand $M^* = -0.034 \text{ kN} \cdot \text{m}$

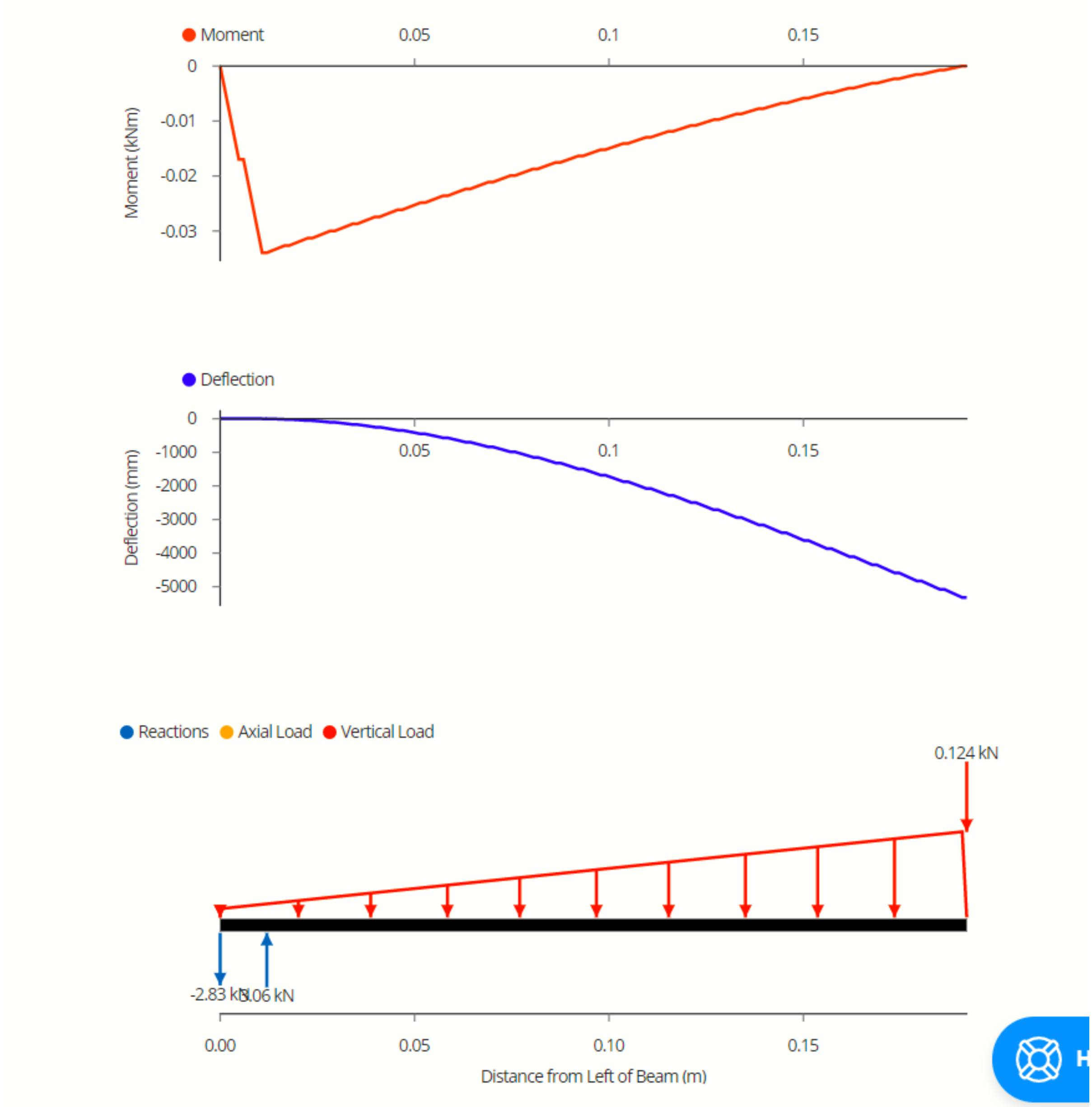
Shear Demand $V^* = -2.83 \text{ kN}$

Deflection $\delta = -5320 \text{ mm}$

Reactions:







Result:

Axial load on each fastener = 2.83kN

AmesWeb – Rough calculation of Metric Bolt size
https://amesweb.info/BoltedJoint/BoltedJointEstimate.aspx

Metric Bolt Sizing Calculator:

INPUT PARAMETERS		
Parameter	**Value**	
Axial Load [F_A]	2830	N
Transverse Load [F_Q]	0	
Min. friction coef. between clamped parts [μ]$^+$	0.1	-
Axial load type and introduction location *	Static and concentric	
Tightening technique	Simple tightening spindle	
Bolt Strength Grade	G8.8	
Calculate		

APPROXIMATE VALUES FOR STATIC FRICTION COEFFICIENTS ATTHE INTERFACE (Source: VDI 2230 Part-1 page 114)		
Material combination	Static friction coefficient	
	Dry	Lubricated
Steel - Steel	0.1 to 0.23	0.07 to 0.12
Steel - Gray cast iron	0.12 to 0.24	0.06 to 0.1
Gray cast iron - Gray cast iron	0.15 to 0.3	0.2
Bronze - Steel	0.12 to 0.28	0.18
Gray cast iron - Bronze	0.28	0.15 to 0.2
Steel - Copper alloy	0.07	---
Steel - Aluminum alloy	0.1 to 0.28	0.05 to 0.18
Aluminum - Aluminum	0.21	---

RESULTS			
Parameter		Value	
Required preload	F_{Mmax}	10000	N
Required bolt size for selected grade		M8	---

Result:

Required bolt size: M8

Appendix L: Vertical orientation: placement position

The current bassinet design is fixed in the bulkhead wall using a bracket whose position is determined by the airlines and out of project design scope. The bassinet in vertical orientation is connected through the attachment housing present in the leg (A from fig [FIXME]) closer to the head end. It is observed through anthropometric study and user testing (Appendix FIXME) in the B737 fuselage. Current placement obstructs the parent seats' legroom and blocks any movement of passengers to and from the aisle.

The height of bassinet placement should be higher without changing the bulkhead wall fixture dimensions to address this problem. Ideation for this design challenge in shown in fig (FIXME).

Height adjustment mechanism on the legs

Adding new leg position

Altering the frame height

The ideas are evaluated on these requirements,

1. Weight contribution
2. Mechanical strength
3. Comfort – infants and parents
4. Ease of installation
5. Foldability

Requirements	Adding new leg position			Altering the frame height
	Third leg	Change leg fixture	Vertical member	Telescopic tube
Weight contribution	254.84g	52g	315.64g	54g
Mechanical strength	No significant change	No significant change	Improved restraint of legs and produce residual stress	Lowered bending strength
Comfort – infants and parents	Additional side constraint for sitting child	Bucket like system for the baby – freedom for movement	No disturbance for the baby from the back,	Less space for the movement of the baby
Ease of installation	No additional action is required	Additional locking mechanism included	Additional locking mechanism included	Possible misuse of the height adjustment with baby in place

				Bukling of the fabric
Foldability	Foldable with higher hinge design	Foldable after removing the leg	Require additional hinge or extra space to store	Easy foldability

Conclusion:

Changing the leg fixture from top position to middle of the frame is selected for low weight

Calculations:

400mm – 94g

OT – 67.8g, IT – 38.5 = 110g

Couple – 34.4g + 15.87 = 50.27 * 2= 100.54g (reduce the weight of removed tube) ~ 50g

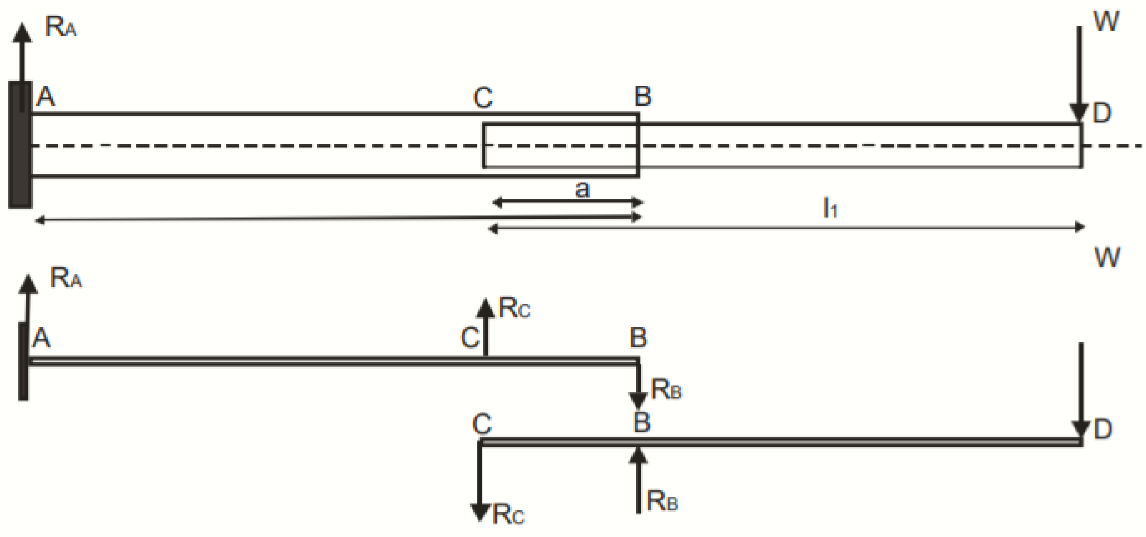
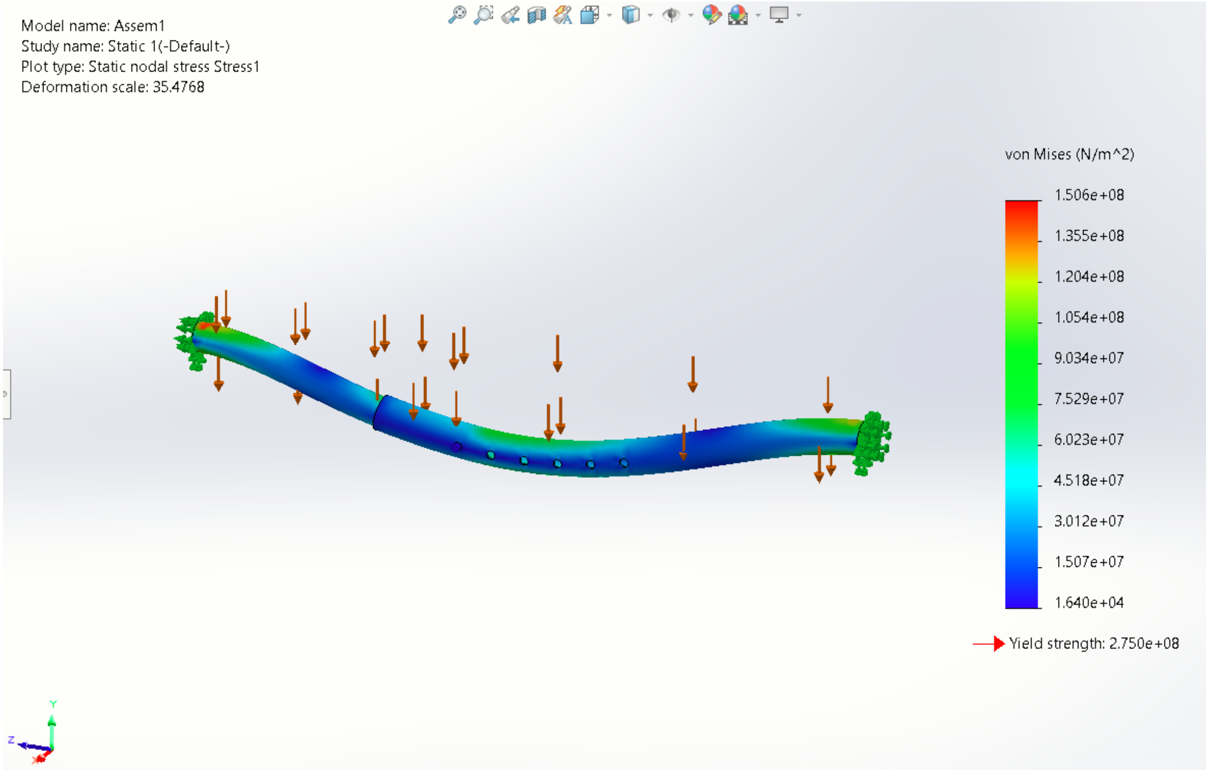
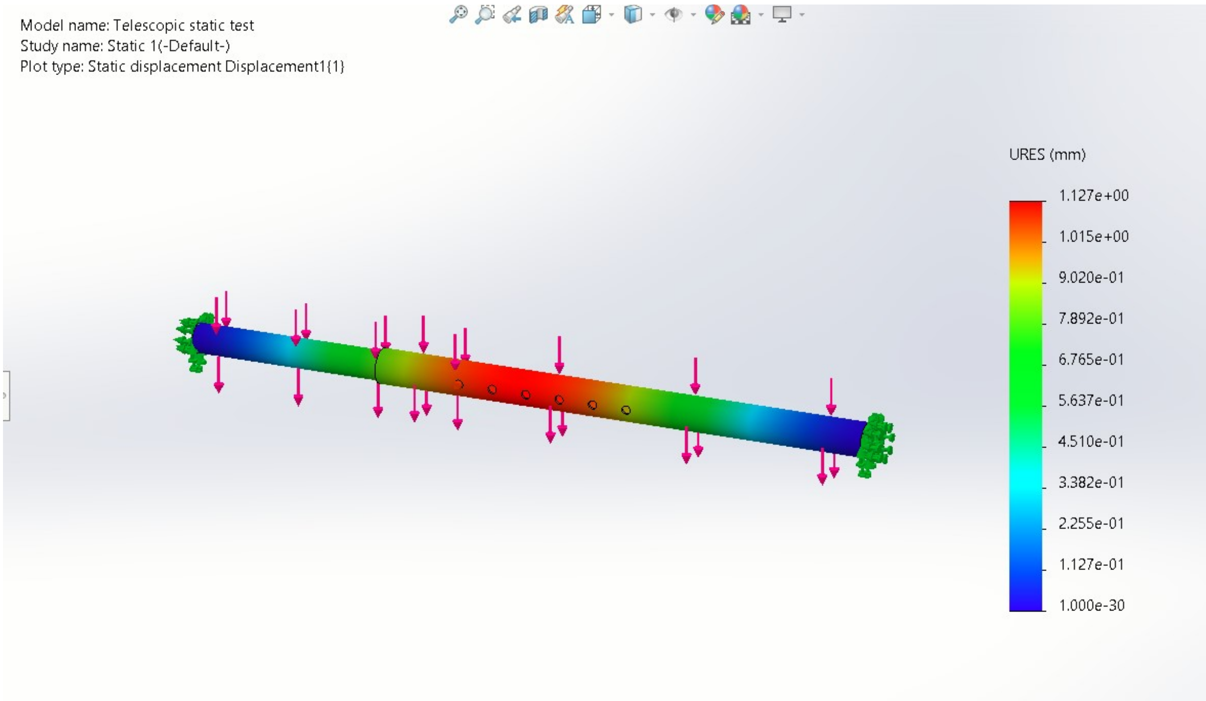


Figure 2: Free-body diagram of the telescopic cantilever beam sections



Model name: Assem1
Study name: Static 1(-Default-)
Plot type: Static nodal stress Stress1
Deformation scale: 35.4768
von Mises (N/m^2)
1.506e+08
1.355e+08
1.204e+08
1.054e+08
9.034e+07
7.529e+07
6.023e+07
4.518e+07
3.012e+07
1.507e+07
1.640e+04
Yield strength: 2.750e+08



Model name: Telescopic static test
Study name: Static 1(-Default-)
Plot type: Static displacement Displacement1{1}
URES (mm)
1.127e+00
1.015e+00
9.020e-01
7.892e-01
6.765e-01
5.637e-01
4.510e-01
3.382e-01
2.255e-01
1.127e-01
1.000e-30

Nordisk AVIATION PRODUCTS

ULD Fuel Saver Calculator

Expected annual hours flown	500(
Current cost of fuel per 1000Kg *	656.
Quantity of units per aircraft	4
Quantity of shipsets	1
Weight of existing units (Kg)	3.7
Purchase price of existing unit ($)	150
Purchase price of lightweight unit ($)	325
Weight of lightweight unit (Kg)	3.2

Calculate

Results

FUEL SAVINGS	
Weight of fuel required to carry 1Kg additional weight per hour	0.04 Kg
Expected annual hours flown	**5 000 Hours**
Weight of fuel required to carry 1Kg weight for one year	200 Kg
Current cost of fuel per 1000Kg *	**656.24 $**
Annual cost to carry 1 Kg additional weight for one year	131.248 $
Quantity of units per aircraft	**4 Units**
Shipsets	**1 Units**
Weight of existing units	**3.7 Kg**
Number of units required	4 Units
Purchase price of existing unit	**150 $**
Purchase price of lightweight unit	**325 $**
Weight of lightweight unit	**3.2 Kg**
Weight reduction in one aircraft	2 Kg
Fuel cost saving per year for one aircraft	262 $
Additional investment to buy a lightweight ULD	700 $
Payback	32 Months
Total saved	
Combined effect of reduced fuel burn and carbon reduction	312 $

Payback period	27 Months

Carbon savings

Carbon produced per Kg of Fuel	3.1 Kg
Total carbon produced to carry 1Kg for one year	620 Kg
Total carbon saving	1 240 Kg

Cost of Carbon per Ton	40 $
Annual carbon cost saved	50 $
Payback	169 Months

Weight saving calculator

Disclaimer: Nordisk Aviation Products does not collect any of the information you use in the calculator. The calculations are done entirely in your browser and no results are saved.

According to ATA, every dollar increase per barrel (42 gallons) drives an additional $415 millon in annual fuel expenses for U.S. passengers and cargo airlines. Fuel expenses now range from 25 to 40 percent of the total airline operating costs.

Modern lightweight freight containers offer a tremendous saving potential compared to the traditional aluminium containers. Enter your own data in the Fuel Cost Calculate and find out how much you can save going lightweight.

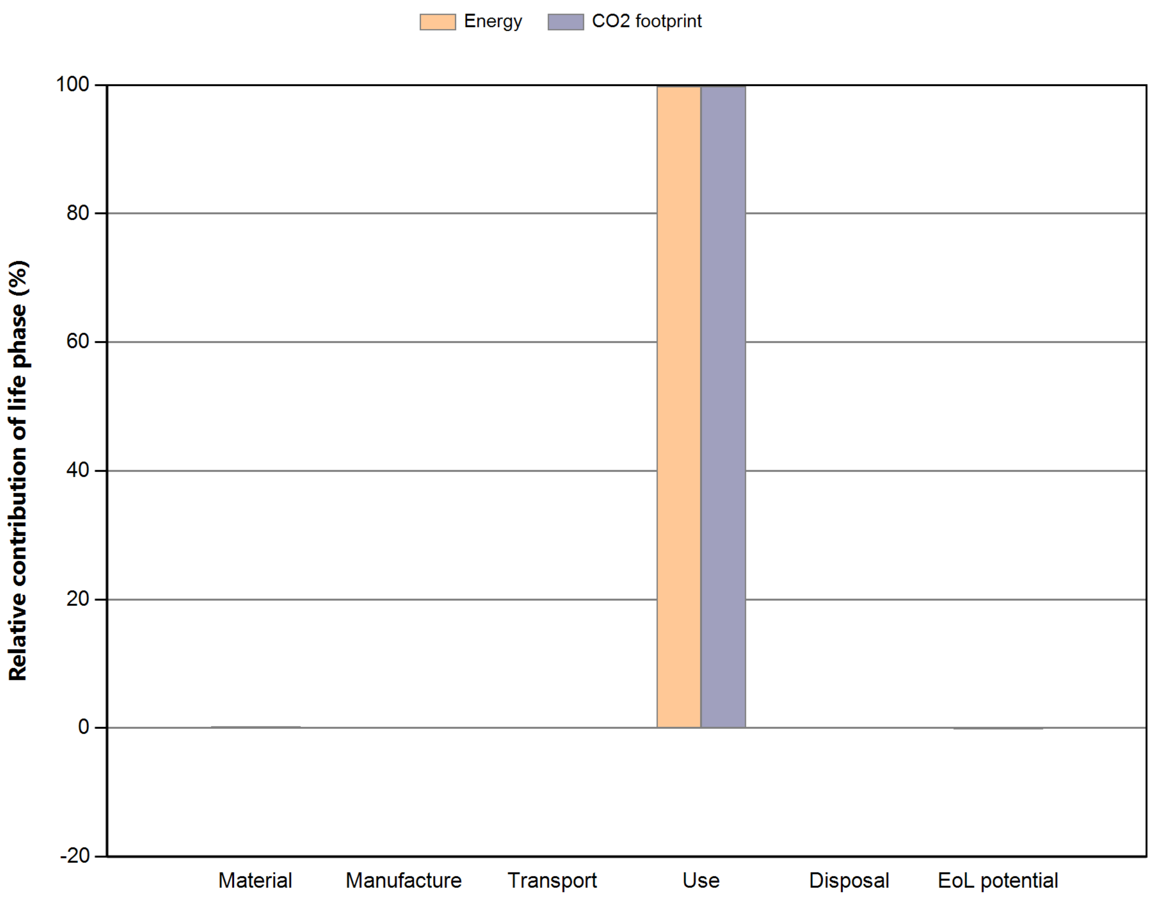
* Fuelprice from **IATA Jet fuel price monitor**

Email **Nordisk Aviation Products** for more information

Eco Audit Report

Product name	Bassinet frame
Country of use	World
Product life (years)	10

Summary:

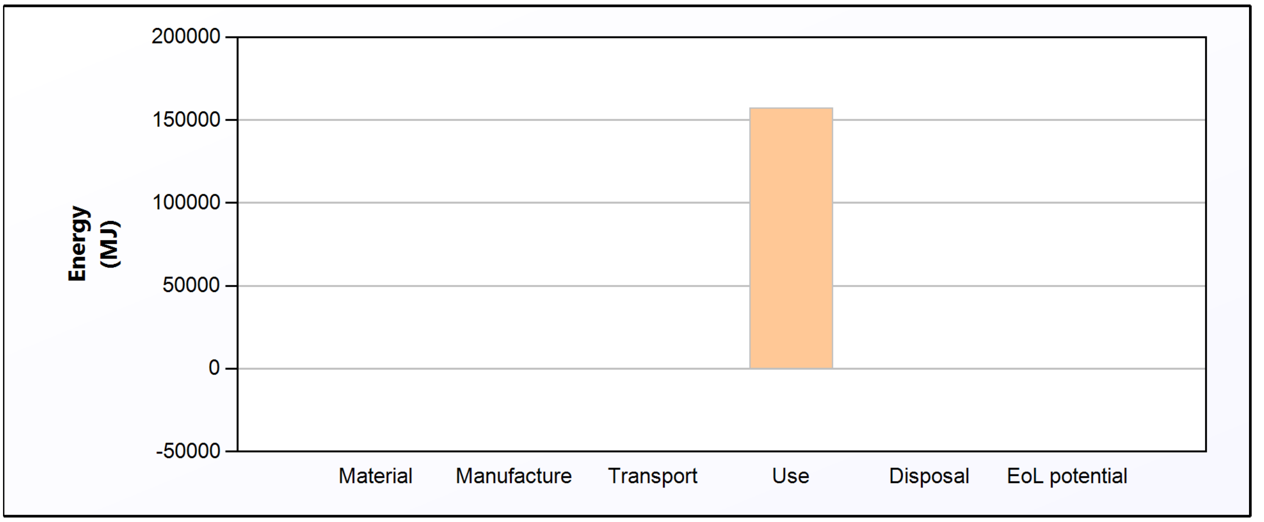


Energy details CO2 footprint details

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	366	0.2	23.6	0.2
Manufacture	33.6	0.0	2.52	0.0
Transport	0	0.0	0	0.0
Use	1.57e+05	99.7	1.13e+04	99.8
Disposal	1.33	0.0	0.0932	0.0
Total (for first life)	**1.58e+05**	**100**	**1.13e+04**	**100**
End of life potential	-303		-18.6	

Energy Analysis

Summary



	Energy (MJ/year)
Equivalent annual environmental burden (averaged over 10 year product life):	1.58e+04

Detailed breakdown of individual life phases

Material:

Summary

Component	Material	Recycled content* (%)	Part mass (kg)	Qty.	Total mass (kg)	Energy (MJ)	%
Frame	Cast Al-alloys	Virgin (0%)	1.9	1	1.9	3.7e+02	100.0
Total				**1**	**1.9**	**3.7e+02**	**100**

*Typical: Includes 'recycle fraction in current supply'

Manufacture:

Summary

Component	Process	Amount processed	Energy (MJ)	%
Frame	Extrusion, foil rolling	1.9 kg	34	100.0
Total			**34**	**100**

Transport:

Summary

Breakdown by transport stage

Stage name	Transport type	Distance (km)	Energy (MJ)	%
Total				**100**

Breakdown by components

Component	Mass (kg)	Energy (MJ)	%
Frame	1.9	0	
Total	**1.9**	**0**	**100**

Use:

Summary

Mobile mode

Fuel and mobility type	Kerosene - long haul aircraft
Country of use	World
Product mass (kg)	1.9
Distance (km per day)	6.4e+03
Usage (days per year)	2e+02
Product life (years)	10

Relative contribution of static and mobile modes

Mode	Energy (MJ)	%
Static	0	
Mobile	1.6e+05	100.0
Total	**1.6e+05**	**100**

Breakdown of mobile mode by components

Component	Energy (MJ)	%
Frame	1.6e+05	100.0
Total	**1.6e+05**	**100**

Disposal:

Summary

Component	End of life option	Energy (MJ)	%
Frame	Recycle	1.3	100.0
Total		**1.3**	**100**

EoL potential:

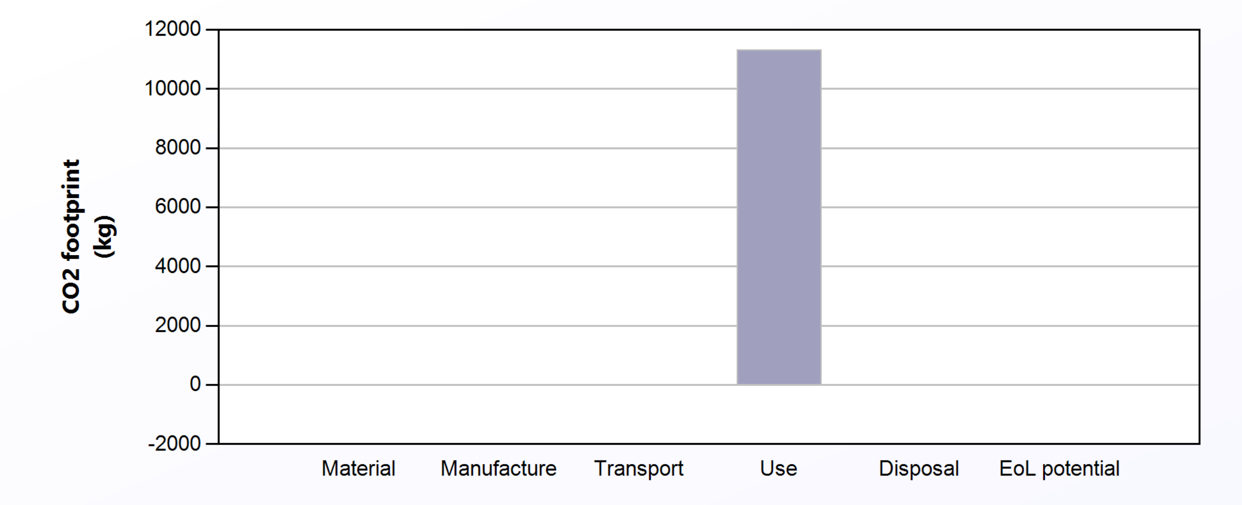
Component	End of life option	Energy (MJ)	%
Frame	Recycle	-3e+02	100.0
Total		**-3e+02**	**100**

Notes:

Summary

CO2 Footprint Analysis

Summary



	CO2 (kg/year)
Equivalent annual environmental burden (averaged over 10 year product life):	1.13e+03

Detailed breakdown of individual life phases

Material:

Summary

Component	Material	Recycled content* (%)	Part mass (kg)	Qty.	Total mass (kg)	CO2 footprint (kg)	%
Frame	Cast Al-alloys	Virgin (0%)	1.9	1	1.9	24	100.0
Total				**1**	**1.9**	**24**	**100**

*Typical: Includes 'recycle fraction in current supply'

Manufacture:

Summary

Component	Process	Amount processed	CO2 footprint (kg)	%
Frame	Extrusion, foil rolling	1.9 kg	2.5	100.0
Total			**2.5**	**100**

Transport:

Summary

Breakdown by transport stage

Stage name	Transport type	Distance (km)	CO2 footprint (kg)	%
Total				**100**

Breakdown by components

Component	Mass (kg)	CO2 footprint (kg)	%
Frame	1.9	0	
Total	**1.9**	**0**	**100**

Use:

Summary

Mobile mode

Fuel and mobility type	Kerosene - long haul aircraft
Country of use	World
Product mass (kg)	1.9
Distance (km per day)	6.4e+03
Usage (days per year)	2e+02
Product life (years)	10

Relative contribution of static and mobile modes

Mode	CO2 footprint (kg)	%
Static	0	
Mobile	1.1e+04	100.0
Total	**1.1e+04**	**100**

Breakdown of mobile mode by components

Component	CO2 footprint (kg)	%
Frame	1.1e+04	100.0
Total	**1.1e+04**	**100**

Disposal:

Summary

Component	End of life option	CO2 footprint (kg)	%
Frame	Recycle	0.093	100.0
Total		**0.093**	**100**

EoL potential:

Component	End of life option	CO2 footprint (kg)	%
Frame	Recycle	-19	100.0
Total		**-19**	**100**

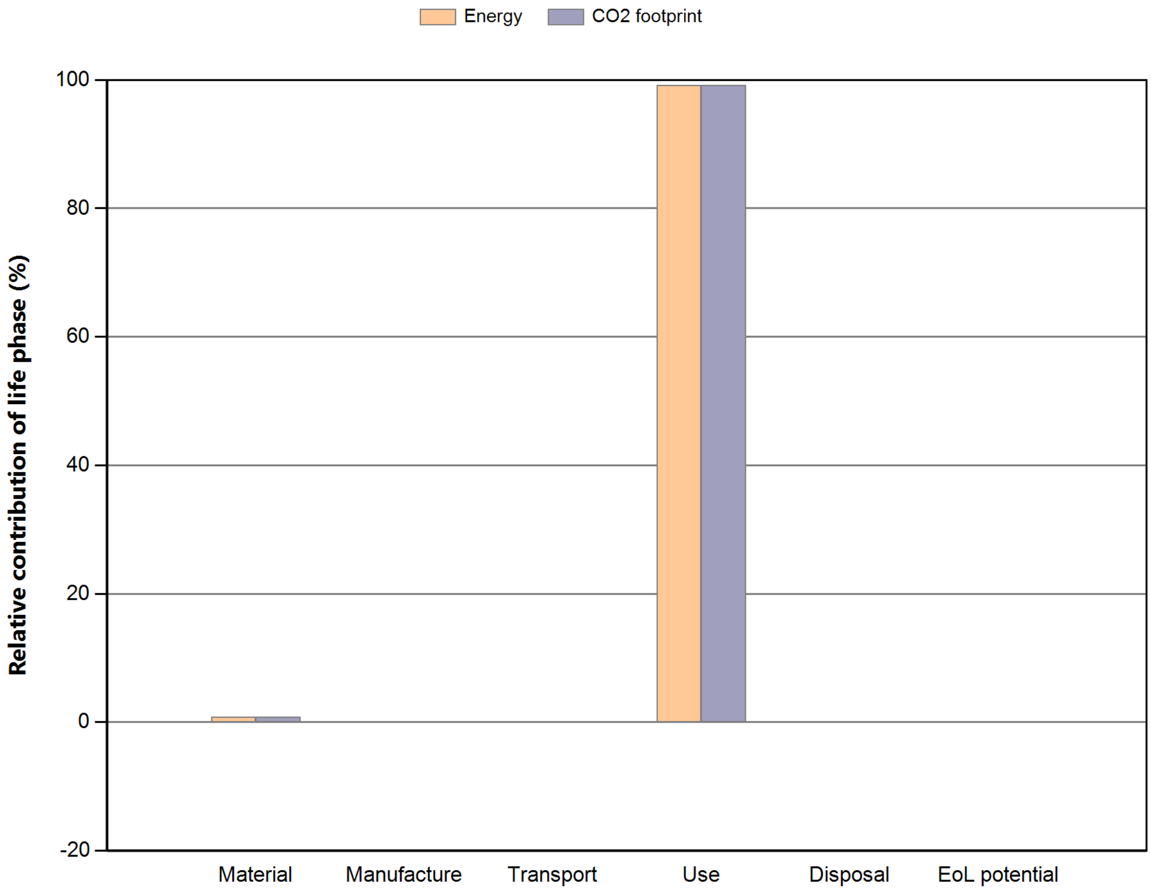
Notes:

Summary

Eco Audit Report

Product name	Bassinet frame CC
Country of use	World
Product life (years)	10

Summary:

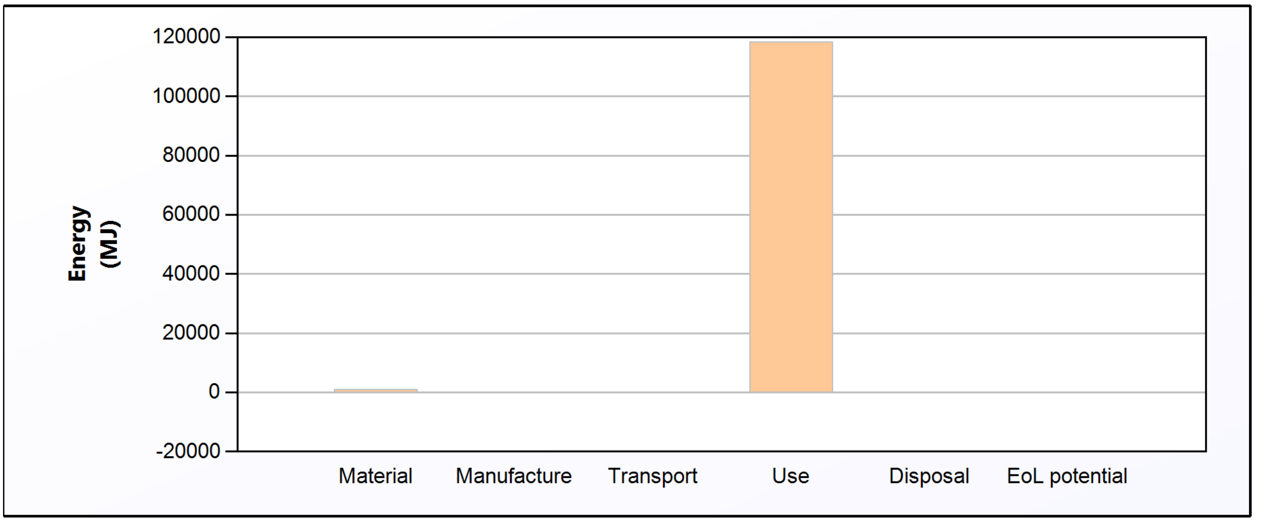


Energy details   CO2 footprint details

Phase	Energy (MJ)	Energy (%)	CO2 footprint (kg)	CO2 footprint (%)
Material	987	0.8	68.9	0.8
Manufacture	18.4	0.0	1.47	0.0
Transport	0	0.0	0	0.0
Use	1.19e+05	99.2	8.53e+03	99.2
Disposal	0.717	0.0	0.0502	0.0
Total (for first life)	**1.2e+05**	**100**	**8.6e+03**	**100**
End of life potential	-11.5		3.86	

Energy Analysis

Summary



	Energy (MJ/year)
Equivalent annual environmental burden (averaged over 10 year product life):	1.2e+04

Detailed breakdown of individual life phases

Material:

Summary

Component	Material	Recycled content* (%)	Part mass (kg)	Qty.	Total mass (kg)	Energy (MJ)	%
Frame	CFRP, epoxy matrix (isotropic)	Virgin (0%)	1.4	1	1.4	9.9e+02	100.0
Total				**1**	**1.4**	**9.9e+02**	**100**

*Typical: Includes 'recycle fraction in current supply'

Manufacture:

Summary

Component	Process	Amount processed	Energy (MJ)	%
Frame	Resin transfer molding (RTM)	1.4 kg	18	100.0
Total			**18**	**100**

Transport:

[Summary](#)

Breakdown by transport stage

Stage name	Transport type	Distance (km)	Energy (MJ)	%
Total				**100**

Breakdown by components

Component	Mass (kg)	Energy (MJ)	%
Frame	1.4	0	
Total	**1.4**	**0**	**100**

Use:

[Summary](#)

Mobile mode

Fuel and mobility type	Kerosene - long haul aircraft
Country of use	World
Product mass (kg)	1.4
Distance (km per day)	6.4e+03
Usage (days per year)	2e+02
Product life (years)	10

Relative contribution of static and mobile modes

Mode	Energy (MJ)	%
Static	0	
Mobile	1.2e+05	100.0
Total	**1.2e+05**	**100**

Breakdown of mobile mode by components

Component	Energy (MJ)	%
Frame	1.2e+05	100.0
Total	**1.2e+05**	**100**

Disposal:

[Summary](#)

Component	End of life option	Energy (MJ)	%
Frame	Combust	0.72	100.0
Total		**0.72**	**100**

EoL potential:

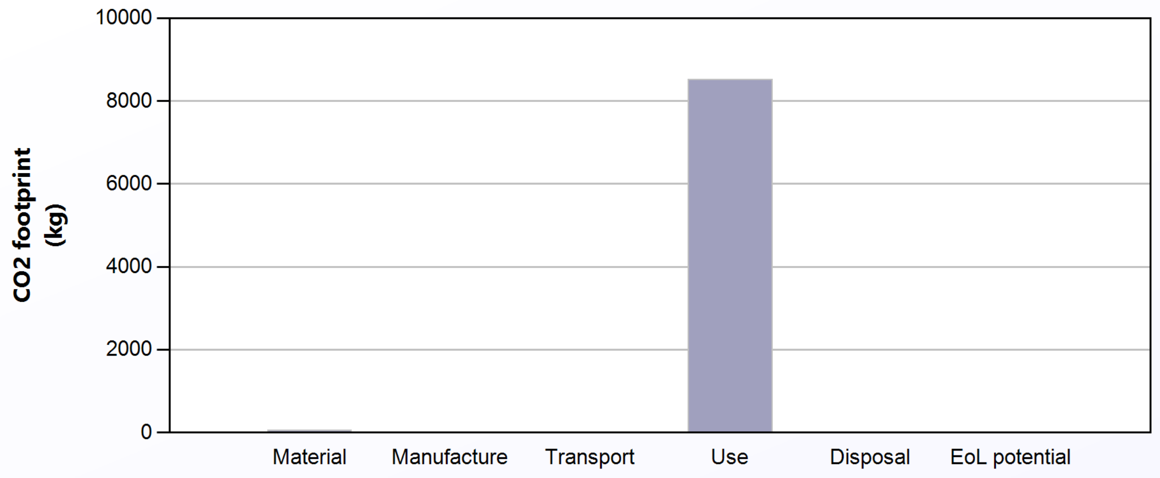
Component	End of life option	Energy (MJ)	%
Frame	Combust	-11	100.0
Total		**-11**	**100**

Notes:

[Summary](#)

CO2 Footprint Analysis

Summary



	CO2 (kg/year)
Equivalent annual environmental burden (averaged over 10 year product life):	860

Detailed breakdown of individual life phases

Material:

Summary

Component	Material	Recycled content* (%)	Part mass (kg)	Qty.	Total mass (kg)	CO2 footprint (kg)	%
Frame	CFRP, epoxy matrix (isotropic)	Virgin (0%)	1.4	1	1.4	69	100.0
Total				**1**	**1.4**	**69**	**100**

*Typical: Includes 'recycle fraction in current supply'

Manufacture:

Summary

Component	Process	Amount processed	CO2 footprint (kg)	%
Frame	Resin transfer molding (RTM)	1.4 kg	1.5	100.0
Total			**1.5**	**100**

Transport:

Summary

Breakdown by transport stage

Stage name	Transport type	Distance (km)	CO2 footprint (kg)	%
Total				**100**

Breakdown by components

Component	Mass (kg)	CO2 footprint (kg)	%
Frame	1.4	0	
Total	**1.4**	**0**	**100**

Use:

Summary

Mobile mode

Fuel and mobility type	Kerosene - long haul aircraft
Country of use	World
Product mass (kg)	1.4
Distance (km per day)	6.4e+03
Usage (days per year)	2e+02
Product life (years)	10

Relative contribution of static and mobile modes

Mode	CO2 footprint (kg)	%
Static	0	
Mobile	8.5e+03	100.0
Total	**8.5e+03**	**100**

Breakdown of mobile mode by components

Component	CO2 footprint (kg)	%
Frame	8.5e+03	100.0
Total	**8.5e+03**	**100**

Disposal:

Summary

Component	End of life option	CO2 footprint (kg)	%
Frame	Combust	0.05	100.0
Total		**0.05**	**100**

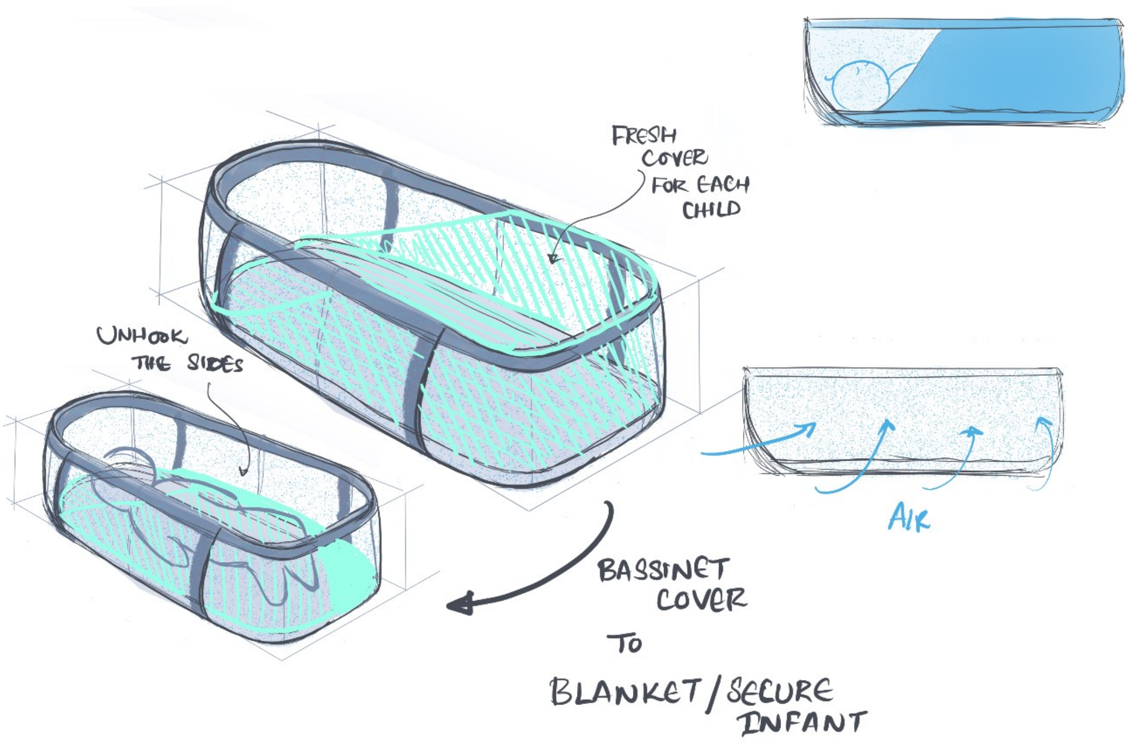
EoL potential:

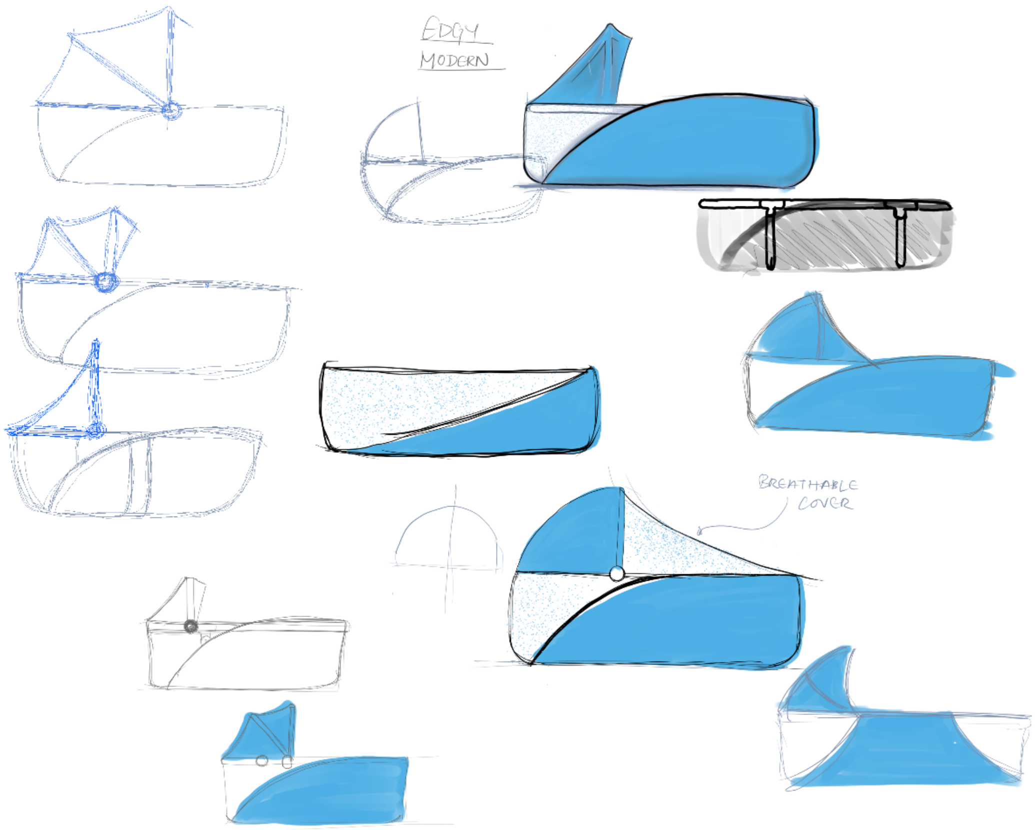
Component	End of life option	CO2 footprint (kg)	%
Frame	Combust	3.9	100.0
Total		**3.9**	**100**

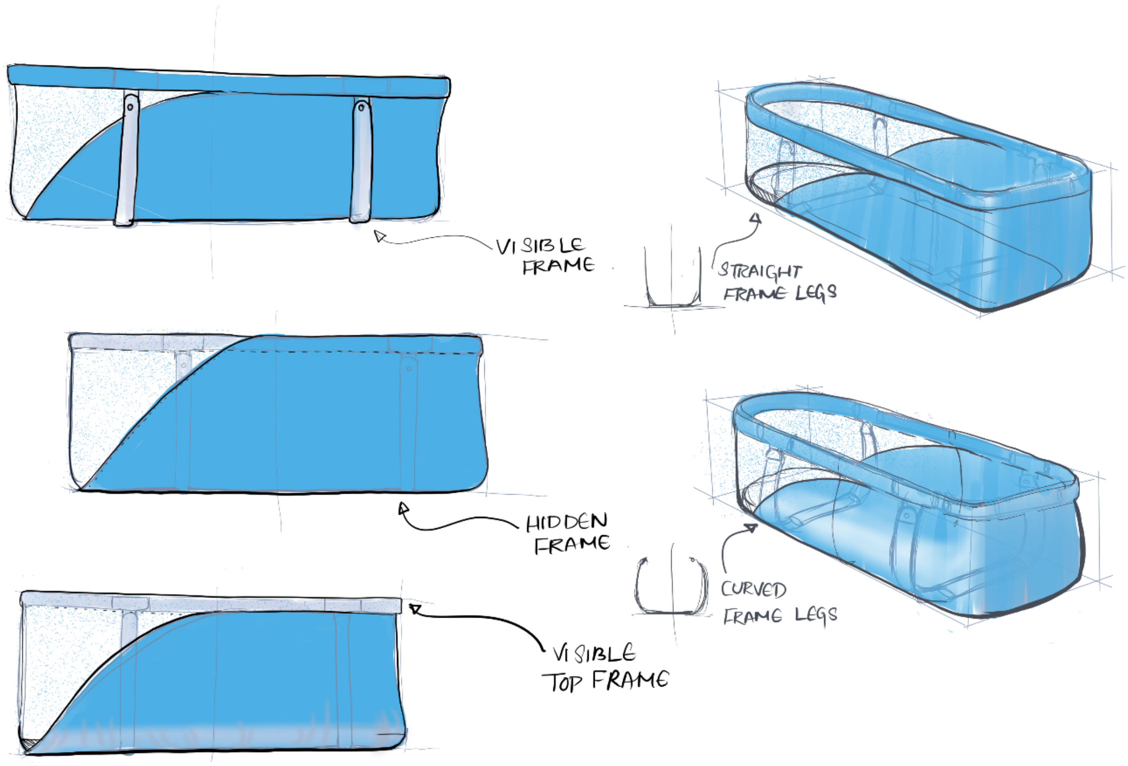
Notes:

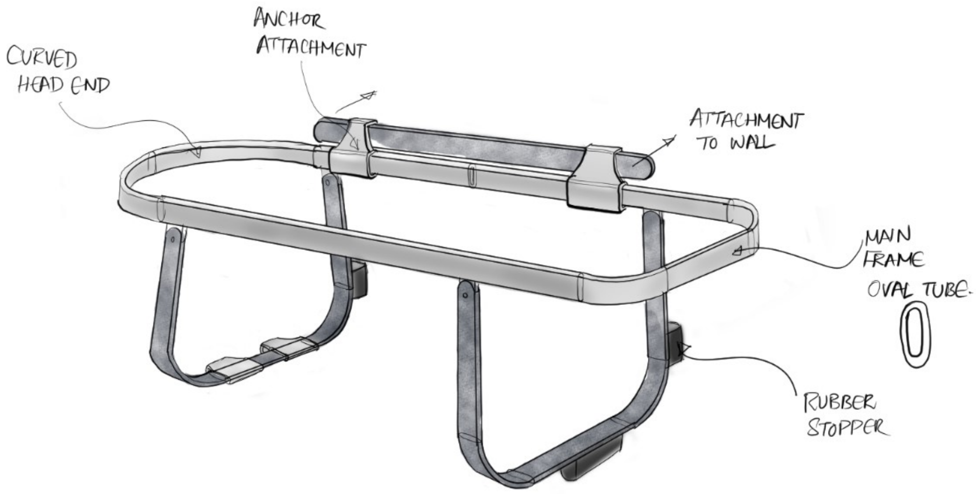
Summary

Appendix O: Basket Ideation

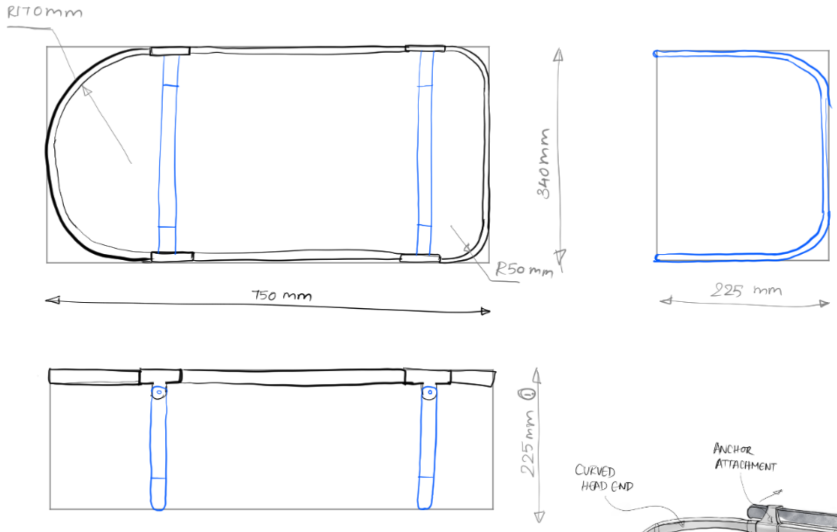




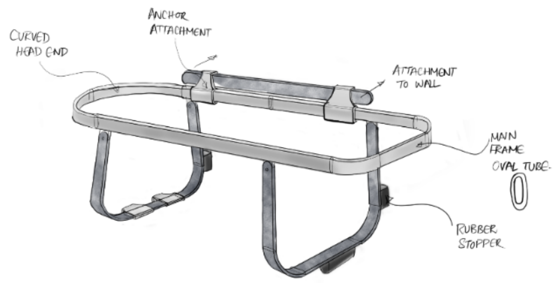

VISIBLE FRAME
STRAIGHT FRAME LEGS
HIDDEN FRAME
CURVED FRAME LEGS
VISIBLE TOP FRAME


ANCHOR ATTACHMENT
CURVED HEAD END
ATTACHMENT TO WALL
MAIN FRAME
OVAL TUBE
RUBBER STOPPER

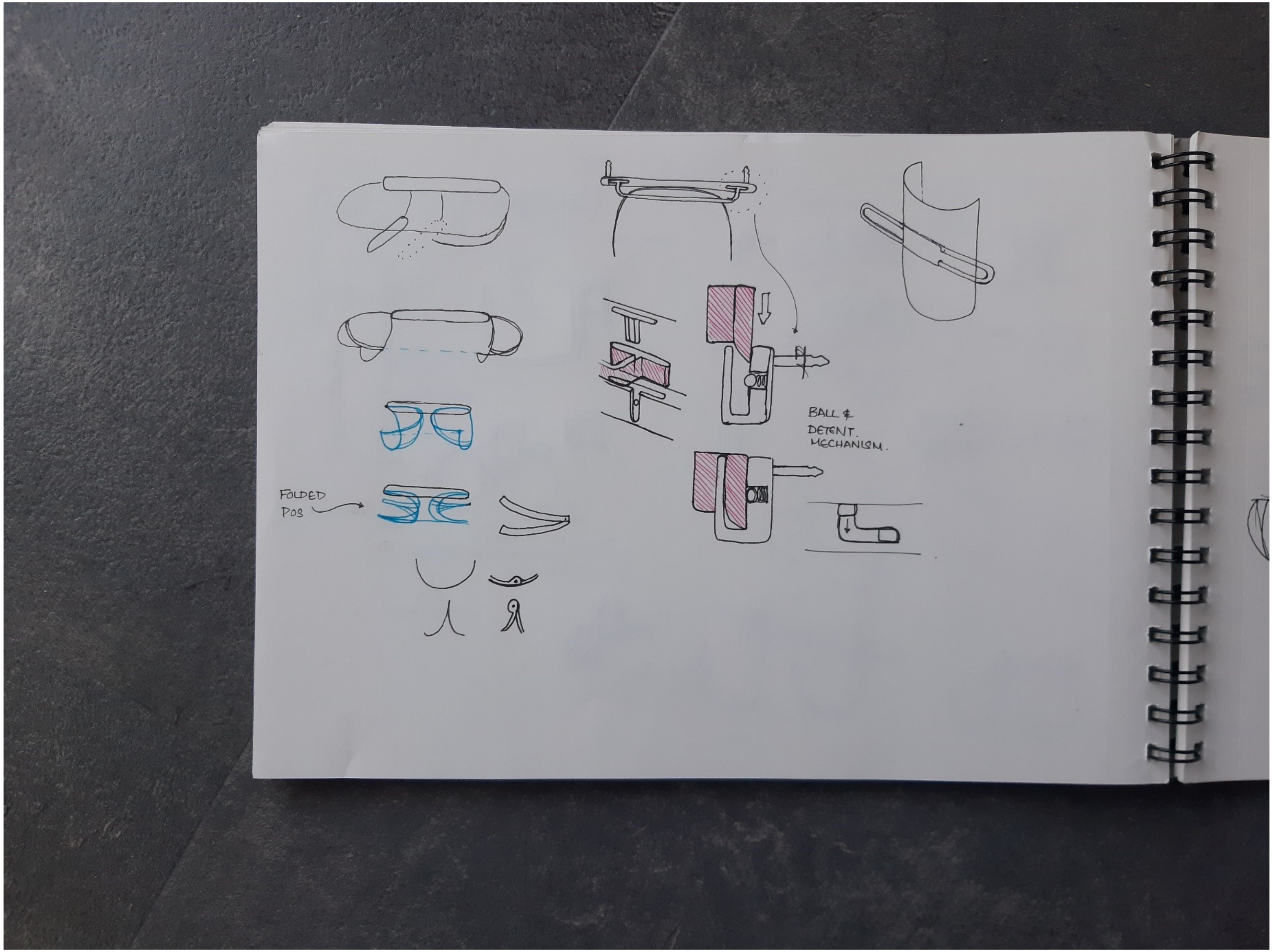
MAIN FRAME.

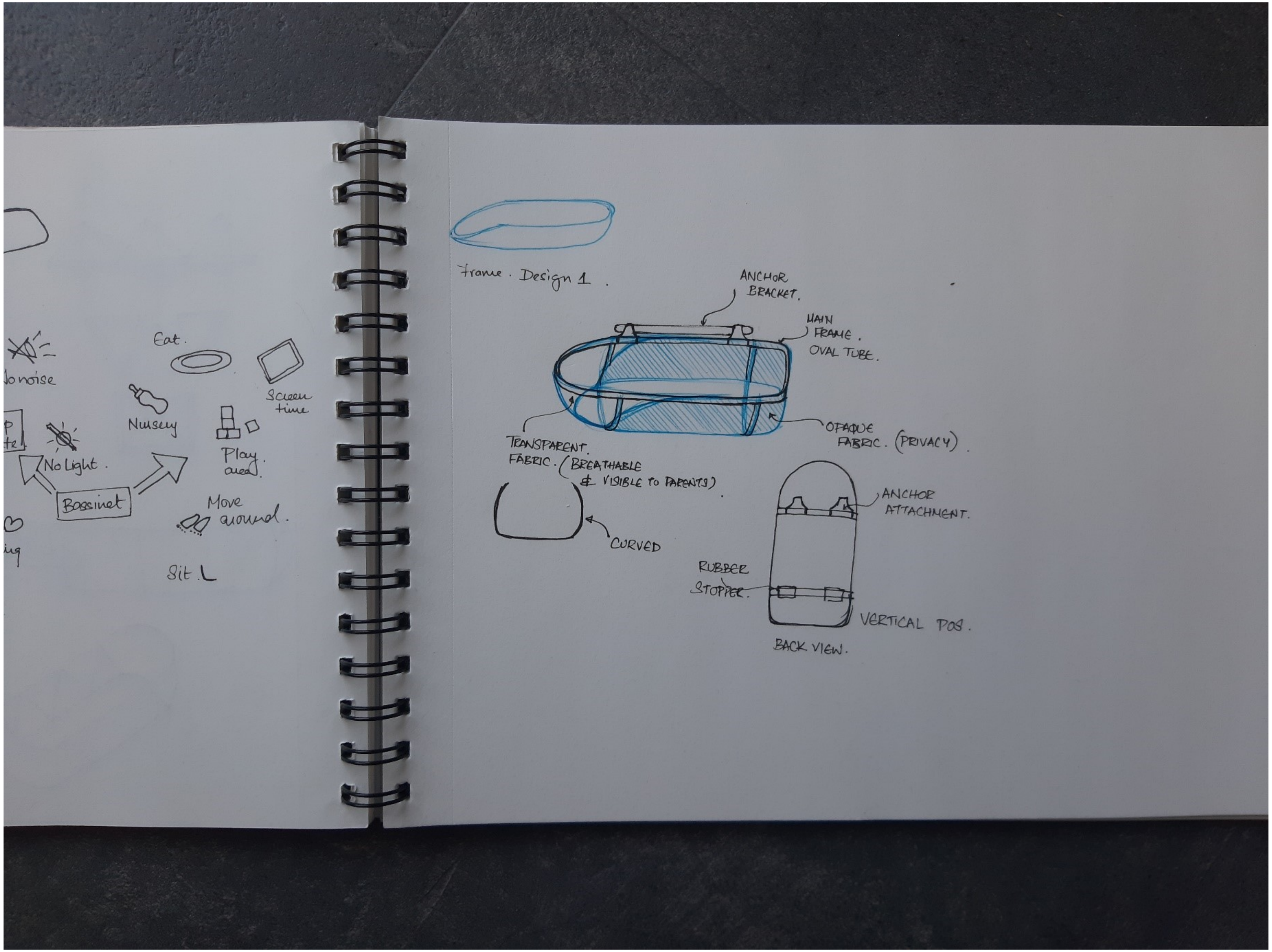


R170mm
340mm
R50mm
750 mm
225 mm
225 mm

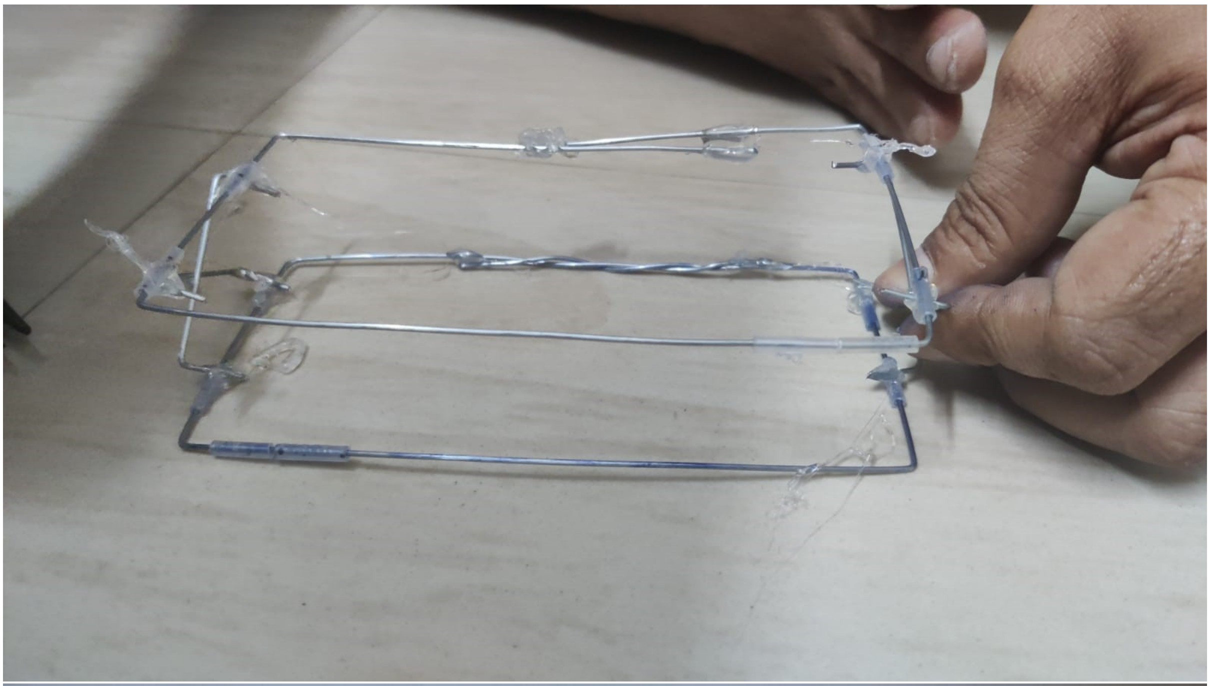


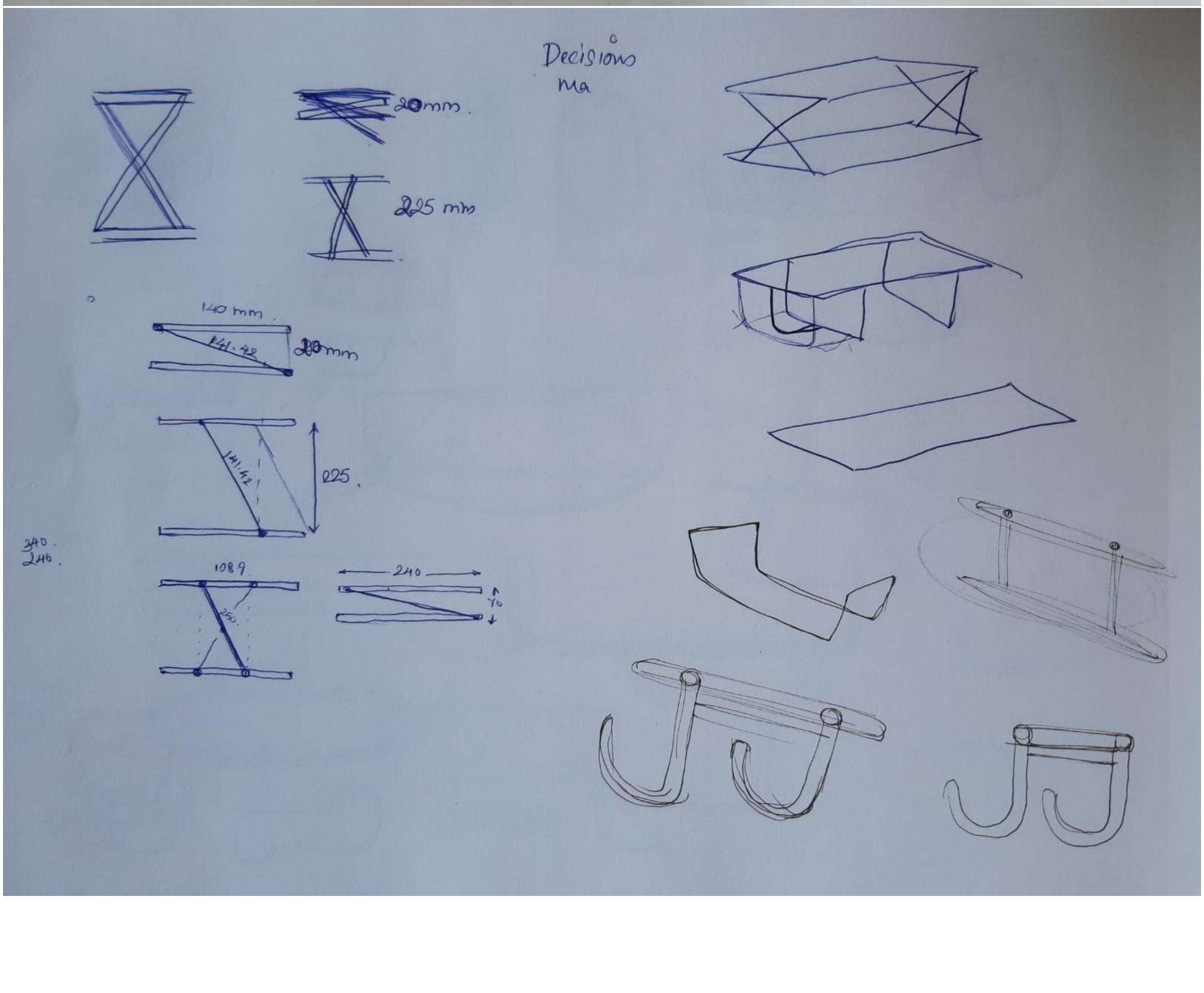
ANCHOR ATTACHMENT
CURVED HEAD END
ATTACHMENT TO WALL
MAIN FRAME OVAL TUBE.
RUBBER STOPPER


FOLDED
POS
BALL &
DETENT.
MECHANISM.

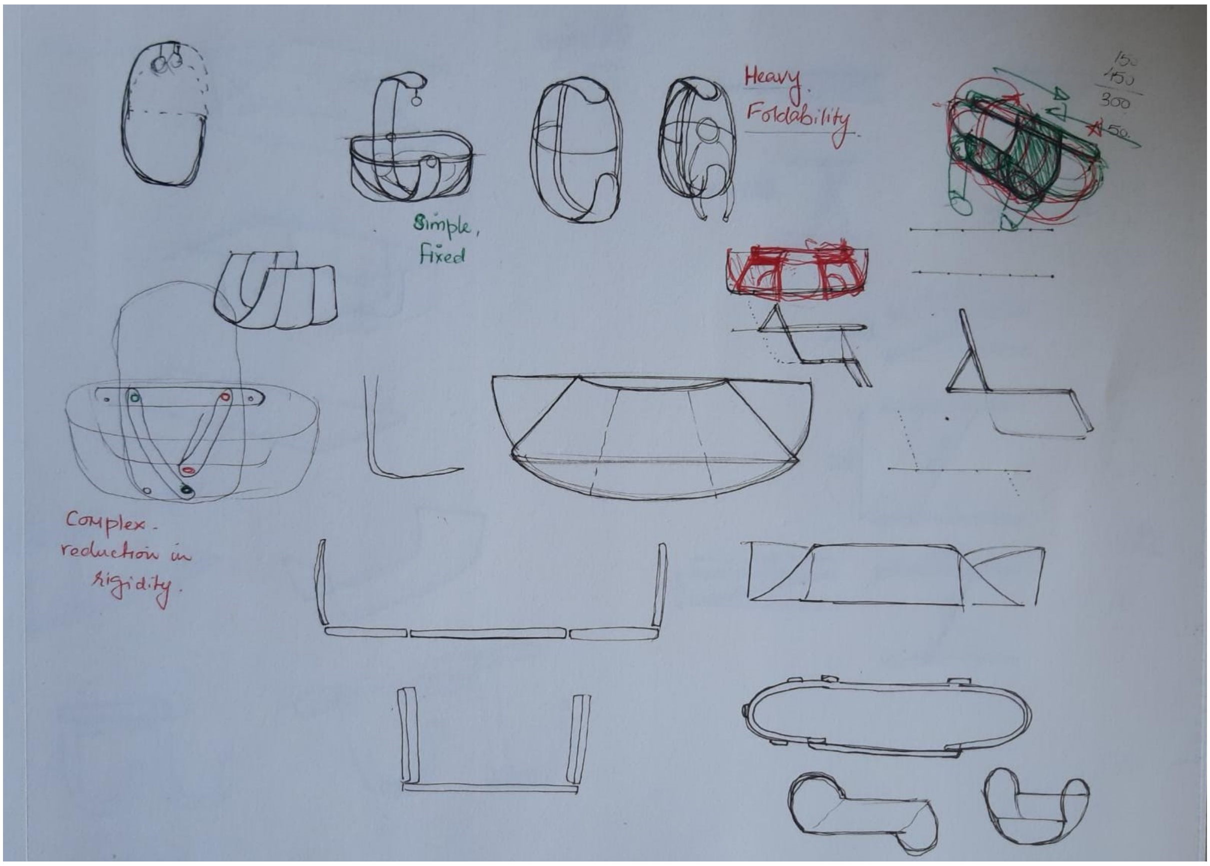


No noise
No Light.
Bassinet
Eat.
Nursery
Play area.
Screen time
Move around.
Sit.
Frame. Design 1.
ANCHOR BRACKET.
MAIN FRAME. OVAL TUBE.
TRANSPARENT. FABRIC. (BREATHABLE & VISIBLE TO PARENTS).
OPAQUE FABRIC. (PRIVACY).
CURVED
ANCHOR ATTACHMENT.
RUBBER STOPPER.
VERTICAL POS.
BACK VIEW.





Decisions
ma
20mm.
225 mm
140 mm.
141.42
20mm
141.42
225.
240.
240.
108.9
250.
240
70


Simple,
Fixed
Heavy.
Foldability
150
150
300
50
Complex.
reduction in
rigidity.

Appendix P : Fabric material evaluation

	FR	FR treatment to abide FAR/JAR	Hypoallergenic	Cleanability	Sustainability	Breathability
Cotton	Have high burning rate	Require high chemical finishes of FR	Most popular Hypoallergenic fabric	Washable but not stain resistant		
Linen	Have high burning rate	Require high chemical finishes of FR	Very good hypoallergenic	Washable but not stain resistant		
Wool	Comparatively flame retardant	Moderate FR finishes	Merino wool is better than cotton for infants	Highly absorbent and not strain resistant		
Polyester	Inherent flame retardant	Moderate FR finishes	Some can be allergic due to friction	Washable, low moisture absorption and strain resistant		
Acrylic	Inherent flame retardant	Moderate FR finishes	It is mostly hypoallergenic	Washable, sensitive to heat cleaning		

Appendix Q : Fabric load calculation

Fabric strength:

Fabric properties:

Mass = 450 g/m2 (Belgraver data sheet)

Length = 300mm (calculated from design)

Load = 265N (baby weight anthropometry, FoS 1.5 (reference))

Density of polyester-cotton blend = 1.4 g/cm3 (https://www.sciencedirect.com/science/article/pii/0010436186907500)

Specific stress = load/linear density = 265/(450/30) = 0.6016 N/(g/cm)

Stress, f = density*specific stress = 1.4*0.6019 = 0.843 N/cm2 = 0.00843 MPa

Formulas: https://textilestudycenter.com/tensile-testing-terms-and-tensile-testing-terms-definitions/

Redesigning Baby Bassinet for comfortable Flight experience

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 22 - 02 - 2021 06 - 08 - 2021 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Air travel has become increasingly convenient and accessible form of transportation every year ((Air travel and children's health issues 2007). Nearly 4.7 billion people travelled by air pre COVID 2020, this trend has dropped due to the pandemic which is forecasted to rise back to 2.8 billion in 2021 (Mazareanu, 2020). Among this many babies (under 2 years of age) travel on domestic and international airlines.

Air travel has some unique safety and health issues, especially for the infants carried on laps (Rotta et al., 2014). Baby bassinets are usually provided in long haul flights (see fig 1). These bassinets provide a comfortable journey for the babies and parents. However, the current baby bassinet design has never been renewed since early 90's when it was launched.

The current design is outdated with major drawbacks – it requires fixture on an airplane bulk head wall (the wall behind the galley, or toilets or another cabin). Hence the flexibility of the bassinet fixation is limited. Further, enhancement in the ergonomics and product aesthetics are vital to enrich the experience for the parents, babies and other passengers on flight. On the other hand, focus on improving the installation, storage and cleaning process will assist the flight crew members to provide efficient service. Since this product is integrated into the aircraft, it needs to meet different aviation safety regulations like 16G test, burn test and strength test. As mentioned above the main stakeholders for this project include Users – infants below 2 years of age, their parents, flight crew members, Belgraver, suppliers, aviation industries and airlines.

The main opportunity in this context is to redesign the baby bassinet, incorporate new materials and technology to meet the needs of different stakeholders and provide an improved product market for Belgraver aircraft interiors. This also provides market advantage in the aviation industry. The scope of this project could be limited by the constraints set by the aviation regulations on contrary it can also persuade new innovative solutions. Further, the development of this project can be tested by the time available which puts importance to prioritize different facets of the project.

space available for images / figures on next page

introduction (continued): space for images

image / figure 1: Baby bassinet in user context

image / figure 2: Current context of Baby Bassinet in aircraft

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Belgraver aircraft interiors will be responsible for the redesign and production of the baby bassinet to fit the needs of the current scenario. The initial scope of this graduation project is defined around tackling the following key challenges of the current bassinet product which will be refined during the project.

Comfort
1. The bassinet has a fixed dimension and weight restriction of a maximum of 71cm and 10kg respectively.
2. The fixture of bassinets is on headwalls and floor limiting the number of bassinets per flight
3. The fixture is permanent with no flexibility for parents
4. The bassinet is exposed to the flight environment.
Ease of Use
1. The bassinet requires storage space in the cabin.
2. The bassinet is heavy, weighing 3.7kg.
3. The bassinet cannot be used during flight takeoff, landing, turbulence.
4. Crew members need to assemble and disassemble the bassinet for the usage of each passenger.
Hygiene
1. The carry case needs to be removed manually and cleaned after every use.
2. The cleaning cycle of the product is not fully defined.

While addressing these issues of the current bassinet, the safety norms and aviation standards need to be achieved without compromise.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

The overall assignment is to redesign the current aircraft baby bassinet in long haul flights. I aim to research in detail and identify the vital problems of this outdated bassinet for the stakeholders in the current and future context. Further design a new infant handling solution which is developed with iterative physical models and user testing and evaluation.

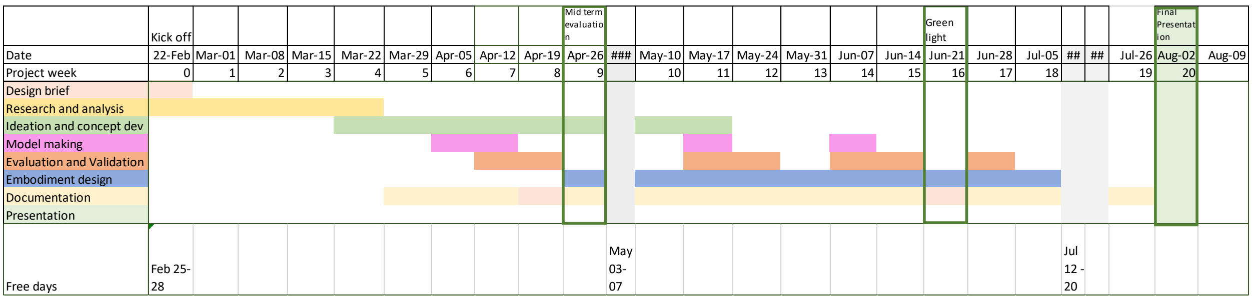
Envisioned Solution:

The outcome of this project would be a new design for a baby bassinet product or product-service system which enables a comfortable flying experience for all stake holders. The design would be highly human centric approach with understanding, analyzing and meeting the needs of baby, parent(s), crew members and aviation standards. It will be designed to meet the strenuous requirements of aviation industry and hygiene standards. This project focus will be more on the embodied design of the concept to facilitate application of the product by Belgraver.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 22 - 2 - 2021   6 - 8 - 2021 end date



This gantt chart represents the broad planning of this Graduation project. The planning is divided into different stages of design process starting with research and analysis of the design problem and its context. Key challenges are defined by the end of this phase. Further weeks the ideation and concept development will be carried out.

The Scrum agile process will be utilized to break down the assignment and work on sub sections individually. This also includes often simulation and evaluation of different aspects of the solution over the period of project.

In addition, the presentation weeks for Mid term (Apr 22-30), Green light meeting (Jun 23-Jul 2), Final presentation (Aug 02-06). The grey highlighted columns denote the duration of breaks.

Initials & Name A Nixon Student number 5064457

Title of Project Redesigning Baby Bassinet for comfortable Flight experience

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

During my master studies in IPD, I am more drawn to design problems that are closely related to users in a complex environment. I have liked working in the user-interaction and embodiment design phases of the project. In this assignment I can apply this knowledge and it fits to my interest of working with the special target group of babies in an highly constrictive aircraft environment with high demanding norms. There is a lot of complex interrelation of different user needs like comfortability, safety, handling and hygiene which leads to interesting design process to provide realistic solution.

My expertise include user research, concept development, iterative prototyping, embodiment design and validation will facilitate to solve this problem. I have also worked on a project to design a health monitoring system for elderly people and hence have experience of understanding the needs and working with special target groups. Furthermore, to work in the embodiment phase of the design process.

Broaden my design knowledge spectrum
Apart from this, working with client Belgraver Aircraft interiors will help me to explore the aviation industry and gain experience in this field. This project will introduce new challenges and opportunities in this complex environment.

Design approach
I like to apply framing and co-evolution of problems and solutions as inquisitive and efficient design theories, which I find helps to reflect in design and on design processes to look at the process in new perspectives. I want to consciously incorporate this into the project to tackle the challenges from different frames to provide feasible, desirable and viable solution.

Iterative prototyping and testing
This project focuses on a product that has multiple user's interaction and should fulfill their needs. During this project I desire to test different factors of the solution in an iterative manner with varying fidelity to meet the needs of the stakeholders.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.