FALL 2024  
MEC325: INTRODUCTION TO ENGINEERING DESIGN  
DESIGN PROJECT  
**PRODUCT REQUIREMENTS SPECIFICATION**



Assistive Transport of Children

when Walking

TEAM 1305

# team declaration

We, the undersigned members of Team 1305 in MEC325, agree that:

* all team members have abided by all Toronto Metropolitan University Policies and course rules, and
* one of our members has shared a properly completed Workload Distribution Form with our Teaching Assistant and our instructor.

We furthermore accept that any violation of Ryerson Policy or course rules will lead to a grade penalty or charges of academic misconduct.

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# 

# requirements

Set of requirements for each attribute

Internal Requirements

Functionality

1. The intervention must feature a mechanism that automatically engages to secure the folding mechanism when it is fully extended or fully retracted.

* A mechanism that automatically engages when the intervention is fully extended or fully retracted enhances child safety by reducing the risk of injuries like finger entrapment. It also ensures the intervention stays secure during use and prevents unexpected folding. See [SKB section 8.2](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=kix.fsehnb5a73g).

Producibility

1. The intervention must use fasteners that can be assembled and disassembled using a single tool.

* This requirement ensures that the intervention uses fasteners that can be assembled and disassembled with a single tool, supporting ease of repair and maintenance. Such a design eliminates the need for specialized tools or advanced expertise, making repairs more accessible for end-users. See [SKB section 7.2](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.entcd8119ypd).

1. All plastic components of the intervention must be manufactured using injection molding.

* Injection molding enables efficient, large-scale production with short cycle times, ensuring consistent quality and tight tolerances. It supports complex designs, material versatility, and cost-effective scalability, with reduced waste and labor costs due to automation. See [SKB section 7.1](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.askeq27njk1g).

1. The intervention must use off the shelf fasteners.

* Using off-the-shelf fasteners ensures accessibility, affordability, and ease of maintenance. Their standardization and wide availability make sourcing replacements straightforward, reducing repair delays even in remote or resource-limited settings. Additionally, their mass production and competitive pricing lower costs while enhancing compatibility and simplifying repairs, supporting long-term sustainability. See [SKB section 7.3](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.hb2gploys4wn).

Maintainability

1. The intervention must include modular components that are replaceable without specialized tools or expertise.

* Modular design ensures that parts can be replaced quickly and efficiently, supporting ease of repair for users. Access to spare parts and repair manuals further facilitates maintenance, reducing downtime and waste. Companies like SHIFT and Thermoplan exemplify how modularity enhances longevity, sustainability, and user accessibility. See [SKB section 7.4](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.entcd8119ypd).

Situational Requirements

Functionality

1. The intervention must fold to fit within a 25 cm × 40 cm × 50 cm space.

* This ensures compatibility with common storage areas in buses, trains, and airplanes, maximizing space efficiency in crowded environments. These dimensions align with industry standards for portable equipment storage. The compact size enhances usability, making it easier for users to store and retrieve the intervention while traveling. See the [environment section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.xj6fbnd38k0).

1. The intervention must support a weight capacity of 70 to100 lbs per child, inclusively.

* This weight range ensures the intervention can safely accommodate toddlers, who may weigh up to 50 lbs (22.7 kg), along with an additional 10–20 lbs (4.5–9 kg) of cargo, such as diaper bags, toys, or groceries. A capacity of 70–100 lbs per child aligns with industry standards for child transport systems, ensuring stability, durability, and ease of handling for caregivers. It also supports the practical needs of families with growing children, offering a robust and reliable solution. See [SKB section 4.8](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=kix.8qhaj1x3h2qe).

1. The intervention must contain 2 to 3 cubic feet of storage, inclusively.

* This ensures that the intervention provides adequate storage for essential items like diapers, toys, and groceries, with a capacity of 2 to 3 cubic feet. Research highlights that this storage range is ideal for accommodating common items, as a diaper bag typically occupies 0.5–0.75 cubic feet, groceries need 1.5–2.0 cubic feet, and toys or blankets add 0.3–0.5 cubic feet. This capacity enhances both functionality and practicality when transporting newborns to toddlers. See [SKB section 4.5](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.1q4pz5ou1fyg).

1. The intervention must provide UV protection with a minimum UPF rating of 30

* Providing passenger comfort while protecting against skin damage from UV rays. See [SKB 6.2](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.8rqanszhainn).

1. The intervention must reduce vibrations experienced by passengers by at least 4% during travel.

* The intervention must reduce vibrations by at least 4% during travel to ensure passenger comfort and safety. Reducing vibrations by 4-6% has been shown to significantly enhance comfort without compromising the system's functionality​. For newborns, who are especially vulnerable to strong vibrations, this reduction helps protect their delicate skulls and developing brains. Excessive vibrations can lead to discomfort or developmental issues, so it is critical that devices remain gentle and avoid excessive shaking. See [SKB section 2.2](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.p4h2m01dhj0t).

1. The intervention must be capable of coming to a complete stop within a range of 1 to 2 meters when moving at moderate speeds of approximately 1-2 m/s, inclusively.
   * This requirement ensures that the intervention's stopping mechanism offers reliable control in dynamic environments, such as public transportation, where sudden vehicle movements could destabilize the intervention. A responsive mechanism reduces the risk of tipping or unintended movement, especially in crowded or confined spaces where caregivers need to navigate or when secure parking is not an option. Furthermore, these specifications comply with ASTM F833-19 standards, which establish safety guidelines for infant and toddler products, including requirements for braking systems, stability, and overall performance to ensure user safety. See [SKB section 8.1](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.gb1ve545w5y3).
2. The intervention must incorporate a mechanism that halts movement and securely holds the stroller stationary on inclines up to 12 degrees.

* This ensures enhanced safety and stability for users, particularly in dynamic environments like public transportation. By ensuring that the intervention's stopping mechanism can securely hold on inclines of up to 12 degrees, it minimizes the risk of unintended movement, tipping, or accidents during sudden stops, starts, or turns. This functionality not only supports user confidence but also aligns with ASTM F833-19 standards, which mandate this capability to prevent the intervention from rolling on slopes. These measures are crucial for maintaining control in high-risk settings, ensuring the stroller remains stationary and secure, reducing potential hazards for users and bystanders alike. See [SKB section 8.1](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.gb1ve545w5y3).

1. The intervention must allow for precise control and maneuverability of the intervention with minimal effort.
   * Enabling users to navigate between indoor and outdoor environments and through crowded spaces with narrow clearances (60-80 cm), such as John when he travels to the grocery store, navigating busy streets and rough terrain. See the [environment section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.xj6fbnd38k0) and SUC: John takes his toddler with him to the grocery store.
2. The intervention must move at a speed that matches the user's walking pace with the reasonable force they apply while walking.

* Devices that adjust to the user's gait and speed reduce fatigue and resistance, providing a smoother experience. For example, treadmills adjust to walking speed for comfort and ease. This principle applies to strollers and carts, ensuring the force needed to move them aligns with the user's effort, reducing strain and improving usability. See [SKB section 4.7](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.ul374g2nudkc).

1. The intervention must turn with a minimum turning radius of 4 feet.

* A minimum turning radius of 4 feet ensures that the intervention can be maneuvered in confined spaces, such as narrow doorways, tight hallways, and crowded areas, without excessive force. This capability improves usability by enabling quick directional changes, making it more convenient and less physically demanding for caregivers. Additionally, it enhances safety by reducing the risk of collisions and tipping, especially in crowded environments with limited space. See [SKB section 5.6](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.g4g9uclw5juw).

Usability

1. The intervention must operate effectively in ambient temperatures ranging from -10°C to 40°C, inclusively.
   * This requirement ensures the intervention can operate reliably in varied urban and suburban climates, where temperatures range from -10°C to 40°C. This temperature range reflects typical environmental conditions, with urban areas experiencing both freezing winters and extreme summer heat. Supported by climate data and standards like ASTM and ISO, this specification ensures the intervention can function safely and effectively across a wide range of temperatures, accommodating the needs of caregivers and children in diverse environments. See the [environment section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.xj6fbnd38k0).
2. The intervention must withstand light 2.5 to10 mm/hr, moderate 10 to 50 mm/hr, and heavy >50 mm/hr rain, as well as light up to 2.5 cm/hr, moderate 2.5 to 5 cm/hr, and heavy >5 cm/hr snow.
   * Precipitation levels are based on typical urban and suburban climates, where such conditions frequently occur. Urban environments experience diverse weather patterns, and the intervention must remain functional during various weather events. See the [environment section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.xj6fbnd38k0).
3. The intervention must operate within a relative humidity range of 30% to 90%, inclusively.
   * High humidity is commonly encountered during precipitation, and the intervention must be designed to function effectively under these conditions to ensure usability in urban environments where humidity levels fluctuate with weather events. See the [environment section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.xj6fbnd38k0).
4. Intervention Must include reflective elements or integrated lighting to ensure visibility in low-light conditions ranging from 5 to 50 lux, inclusively.
   * This is essential for safety in urban and suburban environments, where lighting can be dim, especially during dusk, dawn, or in shaded areas. In these conditions, illuminance levels typically fall within this range, common in places with limited street lighting. Reflective elements or lighting ensure the intervention remains visible to pedestrians and vehicles, preventing accidents. This requirement is backed by public safety standards for visibility in low-light conditions. See the [environment section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.xj6fbnd38k0).
5. The intervention must include a seat that can recline 180 degrees.
   * Ensures optimal comfort and health for the child. A fully reclined seat supports necessary lumbar and pelvic alignment, which is crucial for posture development and balance, especially for newborns. Research shows that a 180-degree recline is recommended for infants to ensure comfort and prevent strain. Additionally, a reclined seat position allows the child to rest comfortably, promoting relaxation when tired, while a flat seat fosters proper posture. This aligns with the needs for comfort, support, and health during early childhood stages. See [SKB section 2.1](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.v4ukt94gvls4).
6. The intervention must include adjustable seating heights.
   * Adjustable seating heights allow the stroller to grow with the child, ensuring proper posture support and comfort at various developmental stages. This adaptability minimizes discomfort as the child matures and eliminates the need for a new stroller, providing long-term value. See [SKB section 2.1](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.v4ukt94gvls4).
7. The intervention must allow for adjustment of the steering control to accommodate users of varying heights and provide ergonomic positioning.
   * Adjustable steering controls allow the stroller to accommodate caregivers of varying heights, ensuring ergonomic positioning and comfort during use. This adaptability helps reduce strain on caregivers, improving the stroller's usability over time. As caregiver needs evolve, the adjustable steering extends the product's lifespan, eliminating the need for a replacement stroller and providing long-term value. See the [users section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.e4t9ifj81xle) and [SKB section 4.6](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.sz6jjydfao6u).
8. The intervention must allow for adjustment to accommodate users of varying heights and provide ergonomic positioning.
   * Adjustable steering controls allow the stroller to accommodate caregivers of varying heights, ensuring ergonomic positioning and comfort during use. This adaptability helps reduce strain on caregivers, improving the stroller's usability over time. As caregiver needs evolve, the adjustable steering extends the product's lifespan, eliminating the need for a replacement stroller and providing long-term value. See the [users section](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.e4t9ifj81xle) and [SKB section 4.6](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.sz6jjydfao6u).

Maintainability

1. The intervention must use materials and design elements that are suitable for machine washing to facilitate efficient cleaning.
   * Machine-washable materials, like certain fabrics and plastics, improve convenience for users, especially in environments where hygiene is a priority, such as with products used by children.This feature helps reduce maintenance time and ensures the product remains in good condition throughout its lifecycle. See [SKB section 6.2](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.8rqanszhainn).

Sustainability

1. The intervention must consist of minimum of 50% recycled material.
   * using 50% recycled material reduces reliance on virgin resources, helping to conserve natural materials, cut waste, and lower carbon footprints. This aligns with global regulations like the EU’s Plastic Packaging Directive, which mandates 50% recycled content by 2025, and California’s goal for 50% post-consumer recycled content in plastic beverage bottles by 2030. See [SKB section 6.4](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=kix.yhs5xcisr7an).
2. The intervention must be packaged in biodegradable packaging.
   * Biodegradable packaging, such as mycelium composites, offers a sustainable alternative to plastic, reducing landfill waste and environmental impact. Mycelium packaging provides the necessary strength to replace materials like styrofoam, while being biodegradable. Despite higher production costs due to limited adoption, using biodegradable materials helps minimize the ecological footprint of product packaging. A cardboard box can still be used alongside these materials for added sustainability. See [SKB section 6.3](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.m7mjq6yois10).
3. The intervention must contain minimal packaging.
   * Minimizing packaging reduces environmental impact by lowering waste in landfills. Reducing packaging also decreases the carbon footprint associated with production and transportation, contributing to a more sustainable life cycle for the product. See [SKB section 6.3](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.m7mjq6yois10).
4. The intervention must include a refurbish program.
   * A refurbishment program for Assistive Transport of Children when Walking products extends their lifespan, reduces waste, and supports sustainability by minimizing the need for new materials. It offers cost-effective alternatives for consumers, promoting affordability and accessibility. Additionally, it fosters customer loyalty while lessening environmental impact, contributing to a circular economy by reusing and repairing products rather than discarding them. See [SKB section 7.4](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0#bookmark=id.k96svn60kjl7).

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# images

# references

[1] [Situational Knowledge Base](https://docs.google.com/document/d/1rz1rAIiTk1ZrDwnuDpjA3R7Bg03I_6vg5hg59ztqgEg/edit?tab=t.0)

# appendix 1

1. Only the last 5 digits of the student number are required. [↑](#footnote-ref-0)