**CONCEPTUAL DESIGN DOCUMENT**

A logo of a person carrying a large table

Description automatically generated

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# ABSTRACT

In this document the proposed system and its components will be described in detail, and an explanation for each component’s inclusion will be provided. Such explanation will be supplemented with the list of design requirements derived from the problem statement, and how each component/design feature directly contributes to fulfilling the requirements and solving the problem presented.

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# PROBLEM STATEMENT

Transporting heavy furniture up and down the stairs is difficult and potentially dangerous.

2.0 REQUIREMENTS

## 2.1 FUNCTION

To achieve the goal set by the problem statement, the requirements of function are as follows:

2.1.1 - The system shall transport furniture repeatedly up and down one floor within a residential building.

2.1.2 - The system shall accommodate up to a 4-seater sofa.

2.1.3 - The system shall accommodate up to a 5-shelf bookshelf.

2.1.4 - The system shall be reusable.

## 2.2 INTERFACING

To ensure that the system is of a proper size that is capable of being transported and capable of fitting within the stairwells it operates in, the requirements of interface are as follows:

2.2.1 - The system shall fit within a standard stairway according to Section R311.7.1 of the 2021 International Residential Code (IRC)

2.2.2 - The system shall be transportable in the back of an average American pickup truck in addition to the transported furniture.

## 2.3 SAFETY

To ensure that the system is overall safe, and does not endanger the operator or environment, the requirements of safety are as follows:

2.3.1 - The system shall cause less injury and strain than an average moving job.

2.3.2 - The system shall not destructively alter the environment.

2.3.3 - The system shall not damage the furniture.

# 3.0 SYSTEM OVERVIEW

## 3.1 CONCEPT OF OPERATIONS

The standard practice for using the proposed device is as follows: First, the user will load the furniture onto the cart section and apply securing straps to ensure the stability of the system. Second, the user will grab hold of the handle at the front of the device and pull to guide the system up the staircase, taking care to avoid obstacles. Third, once the device has reached the upper landing the handle will be released, and the furniture removed from its straps.

## A cart with wheels and a handle Description automatically generated3.2 SYSTEM COMPONENTS

**Tread Block**

**Back Wheels**

**Cart**

**Handle**

### 3.2.1 Platform

**60”**

**25”**

The system includes a cart-like platform where the payload is set and secured before operation. The furniture rests on the cart and is kept secure with straps ensuring both the safety of the furniture itself and the environment around it, fulfilling requirements 2.3.2 and 2.3.3. The platform is sized so that its width does not exceed 25 inches, which fits both into the back of a pickup truck and within the minimum width of a stairwell according to the IRC residential code, thus fulfilling requirements 2.2.1 and 2.2.2.

### 3.2.2 Propulsion

The system is driven by a central motor and given additional torque by means of a gearbox. The motor drives a pair of treads located at the front of the system, while an unpowered pair of back wheel arrays. The front end of the tread block is angled upwards to better catch the edge of a stair and pull itself up, while the back wheels are arranged in order to roll up the stairs smoother than a single wheel would allow. Both features are required to fulfil requirements 2.1.1, 2.1.2, and 2.1.3 by providing the force necessary to lift the loaded system upwards, and by providing the necessary grip and support on an uneven surface respectively. Additionally, by providing the majority of the work involved in moving the furniture the amount of work required by the operator is severely reduced, thus greatly reducing the risk of injury and satisfying requirement 2.3.1.

### 3.2.3 Electronics

The system is fitted with a battery located in the tread block, which provides the necessary power to the rest of the system. This battery can be recharged, thus fulfilling requirement 2.1.4. The system also includes a control handle that works to keep the system a safe distance from the user while also requiring a minimal amount of force to activate. Combined with a dead man’s switch located on the handle, the system requires human oversight to act and is thus unlikely to ram into obstacles or the operator, fulfilling requirements 2.3.1 and 2.3.3

# 4.0 CONCLUSION

Through the above features, the system can reliably and safely transport its intended loads up and down a flight of stairs without endangering the operator and while reducing the overall strain on the operator compared to manually moving the payload up the stairs.

# 5.0 APPENDIX

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Requirement** | **Verification Description** | **T** | **A** | **O** | **R** |
| 1 | 2.1.1 | Test load and trial | X |  |  |  |
| 2 | 2.1.2 | Measurement/Trial | X |  |  |  |
| 3 | 2.1.3 | Measurement/Trial | X |  |  |  |
| 4 | 2.1.4 | Repeated Trials | X |  | X |  |
| 5 | 2.2.1 | Measurement and Comparison | X |  |  | X |
| 6 | 2.2.2 | Measurement and Comparison | X |  |  | X |
| 7 | 2.3.1 | Trial, followed by Analysis and Comparison | X | X | X | X |
| 8 | 2.3.2 | Trial and Observation | X |  | X |  |
| 9 | 2.3.3 | Trial and Observation | X |  | X |  |

**T** – Test and Measurement; **A** – Analysis and Simulation;   
**O** – Observation and Inspection; **R** – Reference and Datasheet

(*Requirements verification matrix. | download table - researchgate*) [1]

# 6.0 ACKNOWLEDGEMENTS

The design of the back wheel array is greatly inspired by the invention of Samuel Palumbo, found in US patent US11691660B2 [2] and significantly contributed to the design.

# 7.0 REFERENCES

[1]  
“Requirements verification matrix. | download table - researchgate,” ResearchGate, https://www.researchgate.net/figure/Requirements-Verification-Matrix\_tbl1\_269163835 (accessed Sep. 28, 2023).

[2]

Palumbo JR., Samuel, “Stair Climber for Casket,” US11691660B2, Jul. 04, 2023 Accessed: Sep. 14, 2023. [Online]. Available: <https://patents.google.com/patent/US11691660B2/en?q=(stair+climber)&oq=stair+climber>