A. JAMES CLARK SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

**Mechanical Engineering Design Day**

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# Walk On – A Stable Walker for Stairs

## Objective

There are currently no safe and easy methods for users of walkers to climb up and down stairs.

### Customer Requirements
- Portability
- Ease of Movement
- Sturdiness
- Adjustable Height
- Comfort

### Engineering Characteristics
- Weight
- Ease of Actuation
- Collapsed Dimensions
- Base Area
- Maximum Moments

### Constraints
- Weight
- Size
- Collapsed Size
- Actuation Force

### Market Size

In 2008, almost 25% of Americans aged 65+ reported having an ambulatory disability. An aging population ensures the need for walking-assistance devices. [1]

### Physics

*Note: this calculation represents only one side of a walker (e.g. the left)*

$$F_1 + F_2 = .375 * W * \cos(\theta)$$

$$F_{fr} > .375 * W * \sin(\theta)$$

$$\Sigma M = .375 * W * \sin(\theta) * l_2 + F_2 * l_1 - .375 * d * W * \cos(\theta) = 0$$

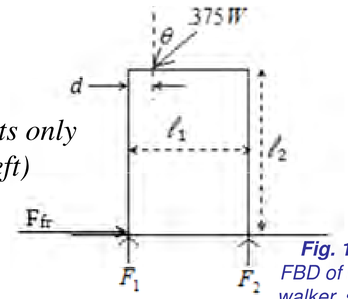
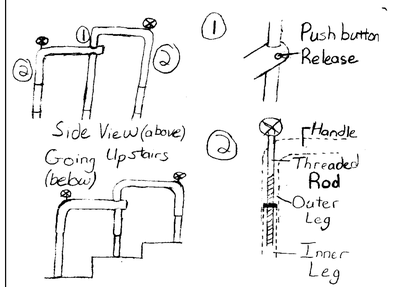
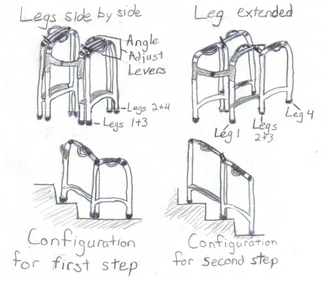



*Fig. 1: FBD of half walker, side view.*

## Concept Generation

| ALTERNATIVE CONCEPTS | | | |
|---|---|---|---|
| **Screws, Telescoping** | | **Side by Side, Angle Adjust** | |
|  | |  | |
| *PROS* •Continuous range •Light-weight | *CONS* •Hard to actuate •Handles too high | *PROS* •Stable •Quick and easy actuation | *CONS* •Heavy •Complicated |



| DECISION CHARACTERISTICS | |
|---|---|
| Moments (stability) | 25.9% |
| Weight | 17.8% |
| Collapsible | 6% |
| Ease of Actuation | 5.6% |
| Other Free Design Variables | 44.7% |

| TOP CONCEPT WEIGHTS | |
|---|---|
| Nested, Angle Adjust | 26.3% |
| Screws, Telescoping | 25.5% |

***Final Concept***

## Design

### Operation

•Joints (A) allow alteration of angle between handles and legs.
•The back handles (C) slide into the front handles (B) for smaller footprint during normal walking.
•Rotational joint (D) allows back handle (C) to rotate when fully extended.

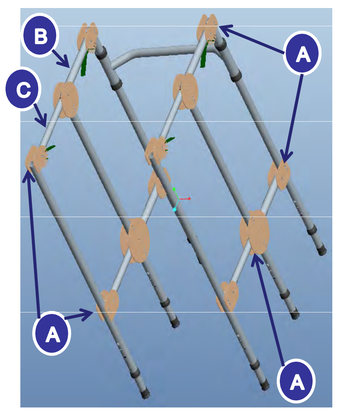



*Fig. 2 CAD model – isometric view.*

### Key Functionality

•Angle adjustment allows for stability on non-horizontal surfaces.
•Extra legs keep stability during angle adjustments.

### Tradeoffs

•Added stability
Increased footprint
•Angle adjustment
Increased weight

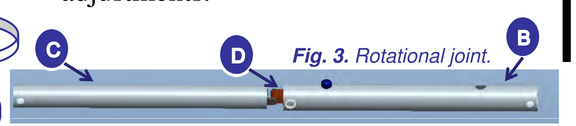



*Fig. 3. Rotational joint.*

## Prototype and Testing

### Prototype

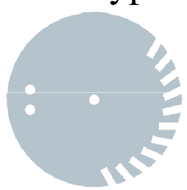


*Fig. 4 (left) CAD model of modified locking plate to fit our capabilities*

•Constructed of aluminum pipes, disks, and pins.

### Stability Test

•Walker is extended on three stairs.
•Lateral forces are applied and handle displacement is measured.

| | Right Displacement | Left Displacement |
|---|---|---|
| Average Value | 0.492” | 0.591” |

### FEA Analysis

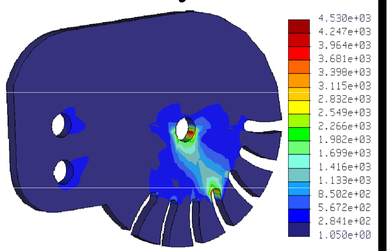



*Fig. 5 (right) FEA results of actuator plate, stress von Mises (psi).*

•Assuming 250lb user
•Results: max stress = 4.4 ksi

### Weight Test

•Varying weights are applied at different handle positions.
•Prototype withstood 150 lbs.
*Target value: 200lbs*

## Test Results and Future Work

### Summary of PDP

•Surveyed customers to define stair-climbing difficulties.
•Generated and evaluated designs for stair stability.
•Performed embodiment design to refine “Angled Legs” concept.
•Ensured robustness of the walker with FEA.
•Fabricated walker to test the final design.

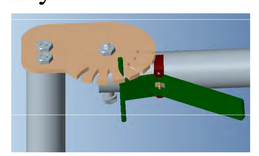


*Fig. 6 Ideal actuation method.*

### Recommendations for Future Design

•Refine DFM/ DFA to make ideal actuation method feasible.
•Perform life-cycle tests to verify design reliability and safety.
•Eliminate areas of overdesign to reduce weight.
•Begin marketing to create customer awareness, address concern

### Process Reflection

•Extensive concept generation and rigorous concept selection led to very strong design.
•Fabrication provided understanding of DFM, DFA concerns.

**ENME472 - Integrated Product and Process Design and Development**

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