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A Smart Walker that reduces falls and injuries

By

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A Thesis submitted
in Partial Fulfillment of the Requirements
for the Degree of
Master of Fine Arts in Industrial Design

School of Design
College of Art and Design
Rochester Institute of Technology
Rochester, NY
May 2, 2022

Thesis Committee

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A Smart Walker that reduces falls and injuries

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Keywords:

Walker for the elderly, walking assistance device, preventing falls

Abstract:

Most of the elderly fall in their homes. As a result, the elderly may be socially, psychologically, fatally affected. Living spaces and the safety of residents are essential factors so that the elderly can lead an independent life. The purpose of this study was to develop a protective product for the elderly that will decrease the impact of falls and reduce injuries. Living alone, a slippery floor, a lack of exercise, spatial cognitive ability problems, dark environment or low vision, are the top five factors that showed the highest risk of falls. The results of this study is expected to be used for specific and various solutions to design a new product that will decrease falls. The resulting design is a new concept for a walker that can provide more stability and spatial flexibility.

Introduction:

Falls are frequent accidents for the elderly and are challenging to all caregivers. In the case of conventional internet technology (IT) convergence product services for the elderly, most of them are focused on responding to emergency situations and utilize Global Positioning System (GPS) tracking functions to alert caregivers of a fall. However, these technologies can only help with accidents after they happen. In Korea, calls to aid the aging society are urgently being made due to an increase in life expectancy and a decrease in fertility rates, and the proportion of the population over 65 years old is expected to reach 18.1% by 2025, and 23.4% by 2030.¹ The main class that makes up the super-aged

¹ Sanderson, Warren, and Sergei Scherbov. n.d. "World Population Ageing 2019: Highlights." April 21, 2022.

society is the New Silver Generation, which has the advantage of being familiar with technology unlike the existing Silver Generation. In particular, those born in the 1950s have directly used and developed the Internet, mobile devices, and Information Technology (IT), so it is predicted that future Internet Of Things (IOT)-based products will also have a great influence on this population.

With the development of these technologies, there is a need to study products with safer human-centered interfaces. More specifically, it is time to develop products and services for those 65 or older that promote comfort and decency for their remaining years. In response to these findings, I conducted a study on the results of products and services combining smart sensors and walker structure.

Problem Statement

There is no system or product to help prevent elderly falls that can result in injury or death. How can the walker be redesigned to help prevent and eliminate falls for the elderly.

Project Overview:

1) About Elderly

The definition of the elderly is explained by various preceding researchers. Usually, the elderly are classified by age group, but the elderly refers to 60 years of age or older, and in some cases 70 years of age or older or 50 years of age or older. However, the specific definition of the elderly may vary slightly depending on the interpretation of society, classification, and scholars. In recent years, they are classified according to social situations. It is said that the elderly are also defined by functional methods such as retirement age, economic location, and consumption tendency.² Previous studies that consider 65 years old as the standard for the elderly were often viewed mainly as the official time of retirement or the time when disease starts in the body.³ Based on this research I choose 65 plus as the elderly start age for my proposed case study. As humans age, their physical tissues and functions are lost. These elderly people have noticeable physical

² Hoon Chul Kim (1992) URL: http://www.kasinet.co.kr/intro/intro_01.asp

³ Murray and Lopez(1996) : Morchis, G. P., Marketing at older consumers : A handbook of information for strategy development. Quorum books.

changes. The same goes for psychological and social changes. As the elderly age, their movements become slower and functions decrease. These include skeletal function, muscle function, physiological function, and sensory function. In addition, deterioration of the nerves that assist with mobility may cause dangerous situations even in daily life.⁴ Aging is a part of the human development process that everyone experiences. Each part of the skeleton and body is reduced, as there is a reduction of 5-10 cm compared to younger adults. Due to reduced elasticity and bone hardening, the perceptual response speed slows down and overall mobility reduces.

2) Causes of falls

It is argued that age is a characteristic that greatly increases the occurrence of falls.⁵ Falls have many factors that can increase risk if there are various medical conditions. One cause of a fall is chronic disease. Neurological, cardiovascular, musculoskeletal, and psychological diseases are the most important disease factors. Additionally, neuralgia, stroke, and heart disease can be other falling factors. Elderly people with heart disease are 3.72 times more likely to experience falls than those who do not. It is 1.86 times more likely for an elderly person with neuralgia and arthritis to experience a fall.⁶ In other words, it is impossible to expect normal daily activities, since it seems that there is always a risk of falling accidents in the midst of sudden physical changes or movements for balance. For the elderly, the concept of a fall accident can be a risk factor that can appear as a chain and neural reaction caused by physical changes.

From a mental perspective, depression is the most common mental illness experienced by the elderly. The main causes are aging, retirement, and grief such as loss of a friend or spouse and these appear to be connected with physical diseases. The more depression they have, the lower the quality of life.⁷ In a study of the elderly, depression was identified as a major factor in falls. There is a correlation between falls and consciousness.

⁴ Dongil Choi (2017) A-ju University. pp.5

⁵ Kyunghwan Cho, Fall down 1997:18(11):1201-1204

⁶ Dongjoon Kim (2002) Home Safety Assessment for Fall Prevention in Elderly People in a Rural Community

⁷ Arfken CL., Etal(1994) The Prevalence and Correlates of Fear of Falling in Elderly Person Living In The Community. American Journal of Public Health. 84:565-570

3) Research method and study

As a case study, I chose ~~to do~~ a project that helps elderly avoid falls. I observed users in bathrooms and looked at their timeline diaries. The questions were asked to those who experienced the fall accident as follows: "Where did you fall?", "Where did you get injured?", "How did you handle your body when you fall?", "When did it happen?", "Why do you think you fall?" Interviews showed that most of them experienced falls in their homes. Injuries mainly occurred in various body parts such as pelvis, head, and waist. Depending on the degree of injury, the elderly need help when they fall. Most accidents occur early in the morning and late at night because the elderly usually use the bathroom alone. This is because the body is stiff in the early morning and late at night. It was found that the elderly were exposed to danger when they were alone when they were using the bathroom, especially at night or early in the morning in a half-asleep state.

Falls were classified into three stages: before fall, during fall, after fall. Before fall refers to the user's behavioral pattern just before falling. Fall occurs because there are numerous factors. For example, objects that are not normally present may be placed in a room, or things that are slippery in the bathroom. After the fall, many elderly are observed sitting down because they have no strength in their legs. After a fall occurs, all the elderly are unable to cope properly and cannot get up without help.

While many products are available in most markets to cope with after falls, there are no products for before and during falls. In the stage before falling, a device is required to monitor the user in real time and prevent accidents. And at the stage of falling, it is important for the user to properly grasp where the risk of injury is high and to prevent serious injury. In the last step, it should ~~be designed to~~ inform what happened in the previous step and provide quick first aid.

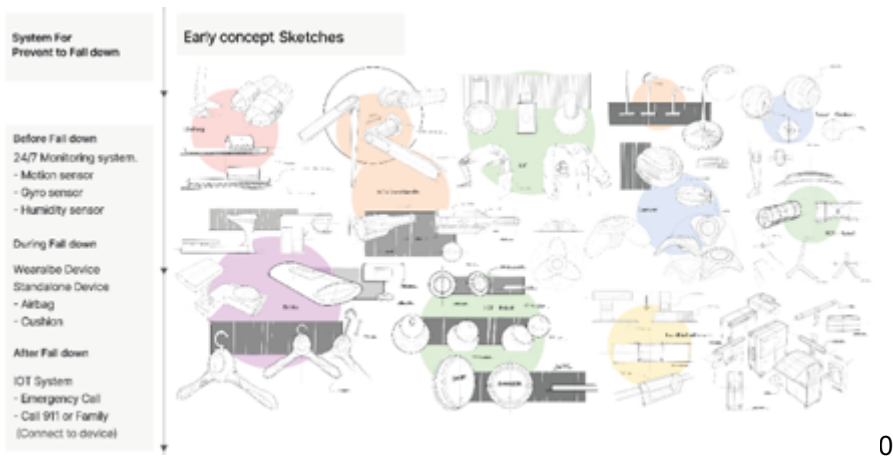


Fig. 1 Early concept sketches

4-1) Benchmarking



Fig. 2 Benchmarking board

A walker will help provide stability and support and allow elderly to maintain weight-bearing restrictions while walking. After an extended period of bed rest and recuperation, elderly may have weakness in one

or both legs. Their balance can also be affected after a period of bed rest.⁸ In the market, there are two walkers, one with and one without wheels. One without wheels is called a standard walker and the other is called wheeled walker.

The standard walker is typically an aluminum frame with four adjustable legs that contact the floor. There are small hand grips on the top to hold onto the walker. The legs help provide extra support while walking. An advantage of using a standard walker is that it provides a great amount of stability to help prevent loss of balance. One disadvantage is that user must use their arms to lift and advance the walker while walking. If their arms are weak, this may present a problem. The lifting and advancing of the walker can become tiresome. A standard walker usually has a folding mechanism that allows the walker to be folded flat for easy transport in a car or on public transportation.

A wheeled walker is usually an aluminum framed walker with two wheels on the front legs. This allows the walker to be pushed along the floor while walking and eliminates the need to lift the walker to advance it. An advantage of a wheeled walker is that it allows them to walk with greater speed. One disadvantage is that it is less stable than a standard walker and can easily be pushed away from them while walking. Like the standard walker, the wheeled walker is usually foldable for easy storage and transport. It is also not safe to use a wheeled walker to walk up and down stairs.⁹

In both cases, the function of the walker itself generally has distinct advantages. However, the use of walkers by the elderly reduces the risk of falls, but it does not mean that there are no falls completely. It was common for many users to slip or fail to use the product properly.

⁸ <https://www.verywellhealth.com/choosing-and-using-walkers-in-physical-therapy-2696057>

⁹ <https://www.verywellhealth.com/choosing-and-using-walkers-in-physical-therapy-2696057>

Age group



Fig. 3 Survey data

As a result of interviewing people of each age group, many users experienced falls even though they already used a walker. In the survey 87% of people responded that a walker is needed when they are walking around their home. 75% of people said they wished the walker would be more functional and 66% of people responded that a walker takes up a lot of space.

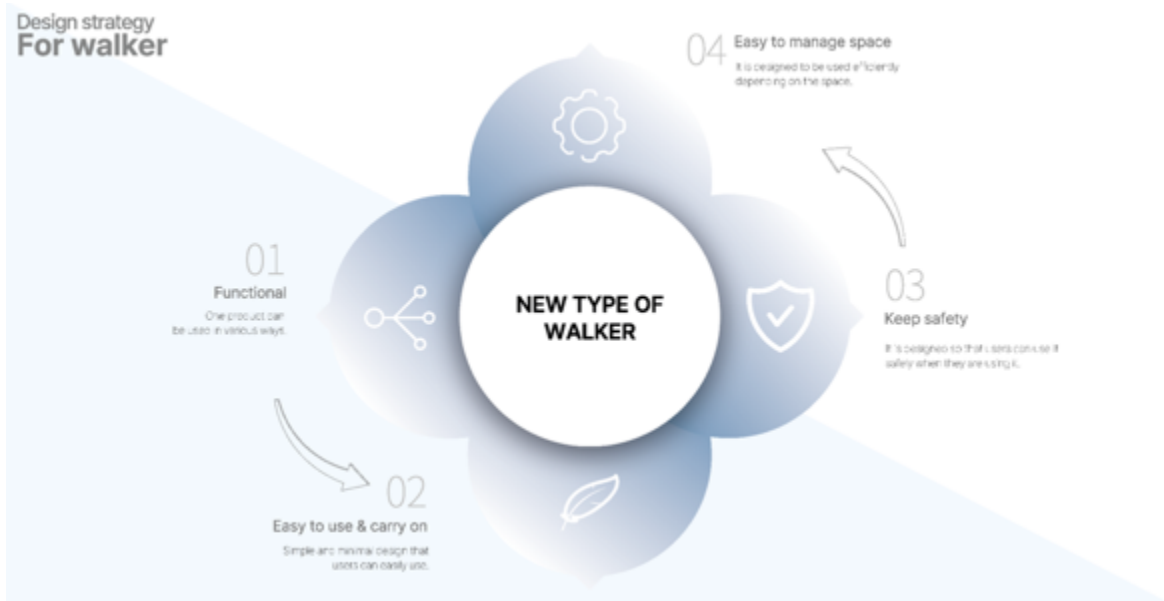


Fig. 4 Design strategy for new walker

4) Development of design

The goal was to design a new type of IOT-based product that combines various technologies by summarizing the advantages of existing types of walking assistance.

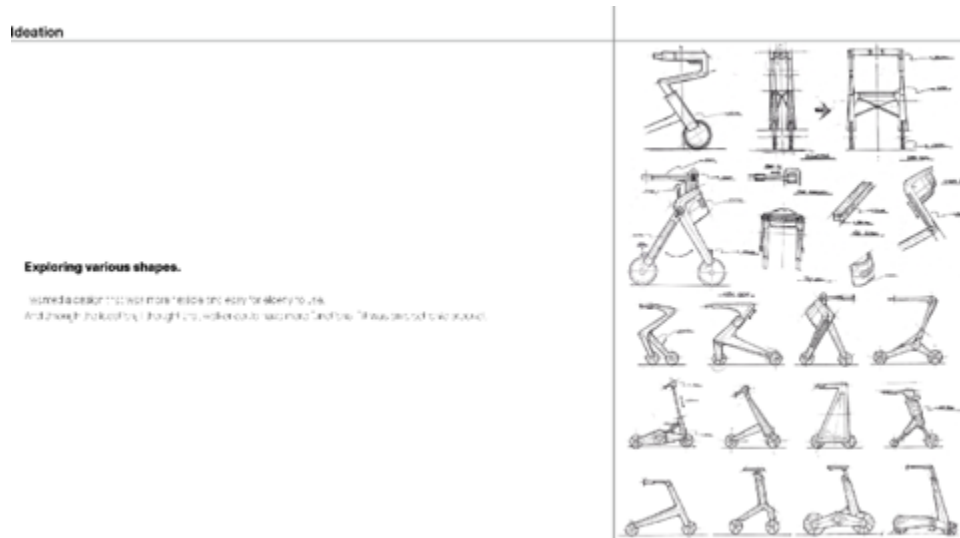


Fig 5. Ideation sketches

Various types of walkers and rollators were analyzed, and simple shapes were oriented to maintain their strengths as much as possible. In terms of technology, Arduino sensors were investigated, and the sensors used are location, dimensional sensors, mechanical, dynamic sensors, pressure sensors, electricity, magnetic sensors, humidity, moisture sensors and vision, image, Identification sensor.

The position and dimension sensor recognizes that the user is moving at a normal walking speed. In the event of sudden rapid movement, the danger is recognized first and a command to stop the product can be sent to another sensor. The mechanical and dynamical sensor adjusts the appropriate speed according to how much force the user moves the product. It contains the gyrosensor, it also procures commands to activate airbags by quickly recognizing users when they fall. The pressure sensor is attached to the handle, which can be designed so that the user does not move when constant pressure is not applied to the handle, so that the user does not slip. The electricity and magnetic sensors generate the power to operate the device. The humidity, moisture sensors, and vision, image, Identification sensors are considered the most important factors. The main factor of falls in the elderly is slipping due to water or

tripping because of objects that are not normally placed in the path of the elderly. These sensors identify the humidity of the user's surrounding environment, the user's pattern, and object identification, and through this, they inform the user of the risk in advance.

Based on these technologies and design languages, in the early prototypes, the structural characteristics of the walker that is most used were identified. It was a functional product in a simple form, all operations had a mechanism that worked manually. It is easy for the elderly to use simple, but it is easy to be vulnerable in the event of a fall accident.



Fig. 6 Early concept

Through the analysis of the rollators, products with wheels were convenient for the elderly to use. A mechanism was devised in which the wheel was attached to the product, but the wheel was automatically stopped in case of an emergency through the sensor. All product parts are designed to be foldable and able to be stored when they are not used.



Fig. 7 Summarize early concept's benefit point



Fig. 8 Final mockup

The middle structure is also designed to be folded when the user folds and raises it. When unfolded, a detachable chair is provided so that the user can easily sit and rest.



Fig. 9 Testing with trunks

In addition, since the product is not used only at home, experiments for portability were conducted. As a result of loading it directly into the trunk it was suitable for all vehicles.



Fig. 10 Simulating aircraft aisle

The size of an aircraft aisle will be somewhere between 38 — 50cm. I was on a Boeing 777, and the plane had an aisle of 43cm.¹⁰ This aisle is the width for adults to move alone. There were surveys showing that no walking aids could pass through this narrow aisle, and it was also found that folding is suitable to compensate for this problem. For the experiment, actual-sized chairs and aisle were arranged and drawn on the floor, and an experiment was conducted to actually move the product. The use of this mechanism also resulted in the user being able to pass through any cramped aisle or passage without difficulty.

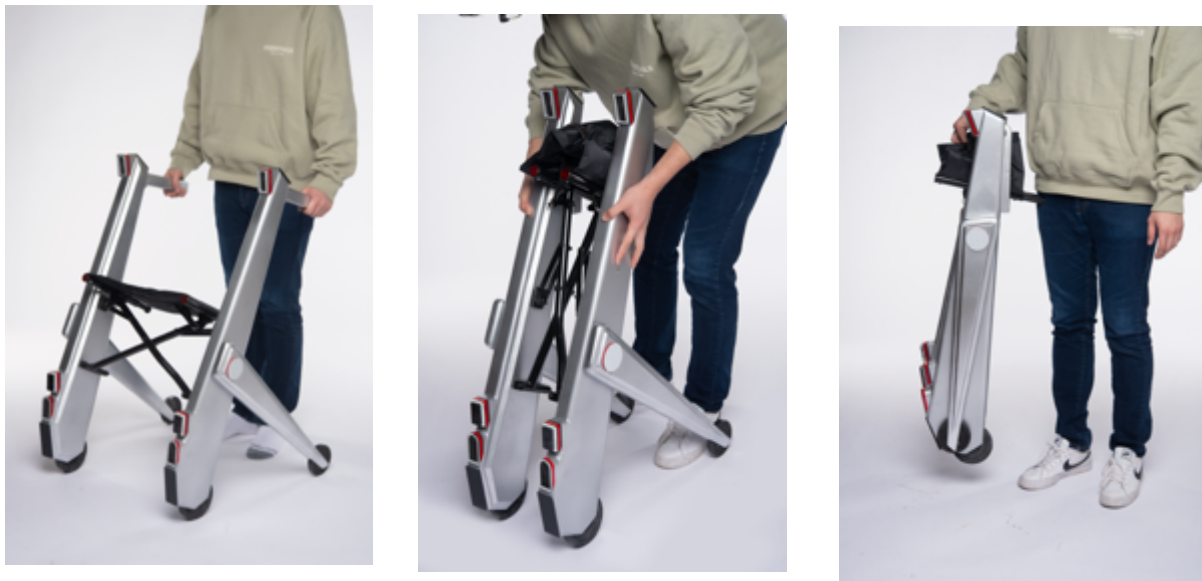


Figure 11. Final Design

¹⁰ Flight from hell: The brutal truth about aisle width John Burfitt July 25,2019

Conclusions:

This study relates to walking assistance used by the elderly among welfare products. In particular, the most important purpose of this study is to develop products that give smart technology to existing products while IT technology is emerging. To this end, various resources and experts collaborated to conduct research and devised ideas. At this stage, consumer-centered usability became safe, various emergency situations were identified and scenarios were secured. This study applied a process that can variously express the new development method and accessibility of elderly products viewed from a more user-friendly perspective. Various physical test items have brightened the use environment of the elderly with extreme usability and secured scenarios to avoid various possible risks. Smart walking assistants, which were initially conducted, will be attempted a lot to be applied in various related technical fields.

It will be necessary to secure objective information such as ergonomics for items that require safety for emergency situations for the elderly. First, when developing public products such as smart walking assistants, it is necessary to be reported from an authorized institution that can meet performance and physical requirements. Finally, developing a product to prepare for emergency situations for the elderly is a conclusion that a more user-centered design should be carried out.

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