Sitting Cane Design: For Older People

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SITTING CANE DESIGN
For Older People

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Thesis Committee Approval

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Abstract

The proportion of elderly people in the developed world is rapidly increasing. The book *When I'm 64: how boomers will change health care* mentioned that *Older adults are among the fastest growing age groups, and the first “baby boomers” (adults born between 1946 and 1964) will turn 65 in 2011. More than 37 million people in this group (60 percent) will manage more than 1 chronic condition by 2030.*[1] The number of elderly and the retired population is on the rise and they represent a more selective consumer group that is more highly educated and financially secure than past generations and have a more active role in the society.

The process of aging brings many physiological and psychological changes that influence the functioning of older people and their interaction with the environment. Real aging is stated by the body’s loss of reserve or ability to maintain its balance. There is a well-known riddle:” What goes on four legs in the morning, on two at noon, and on three in the evening?” The answer is: “a human being”. When a human is in old age, he/she often needs “a third leg” such as a walking cane to assist in walking.

It’s really a sad fact that people’s muscles shrink as they grow older. Elderly people often have trouble with balance, coordination and daily activities of living due to loss in leg strength. They usually need a seat while standing or walking for a long time. A cane is a tool that many older people would use every day and everywhere. I think it’s a good design idea to combine “seat” and “cane” together. The sitting cane design for the elderly should differ from those ordinary people options. General life satisfaction and even the health of older people may be related to design. I hope my design has the potential to improve the quality of life for older people, and I also hope that it can help them to maintain independent lifestyles and increase their ability to participate fully in society.
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Chapter 1 Introduction

1.1 Background Research

The proportion of elderly is rapidly increasing. In 2010, an estimated 524 million people were aged 65 or older, which is 8 percent of the world’s population. By 2050, this number is expected to nearly about 1.5 billion, representing 16 percent of the world’s population.

Most developed nations have had decades to adjust to their changing age structures. From the book An Aging World: 2008, It says It took more than 100 years for the share of France’s population aged 65 or older to rise from 7 percent to 14 percent. In contrast, many less developed countries are experiencing a rapid increase in the number and percentage of older people, often within a single generation.[2]
Definition of Elderly people:
Sağdıç (1997) categorizes the human life in three periods: childhood, adulthood, and elderly (Figure 2.2). In the elderly period, Sağdıç cited that Arber and Ginn (1993) classifies this period associated with chronological age as:

- **Young elderly**: 65-74 years old.
- **Old elderly**: over 75 years old.
- **The oldest old**: over 85 years old.

Dimensions of aging:

- **Biological Aging**: Structural and functional changes of the organs of the body and its systems with time.
- **Psychological Aging**: Transition in behaviors depending on life experience.
- **Sociological Aging**: Related to the changes of person’s norms, expectations, status and roles in society in the lifetime.
Changes of aging:
The process of aging brings many physiological and psychological changes that influence the functioning of the elderly and their interaction with the environment. One of the most significant results of diseases like Arthritis and Parkinsonism is making people dependent and unable to successfully engage in their daily activities. All senses like sight, hearing, taste, touch, and smell gradually decline in sensitivity as people age.

![Graph showing severe limitations of activities of daily living, by age](image)

**Table 4. Severe limitations of activities of daily living, by age**

Movement Limitations of Elderly people:
All activities of daily living (ADL) such as bathing, dressing, toileting, and feeding require some form of bodily movements such as walking, sitting, lifting, reaching, grasping, stooping, or bending. The aging process causes limitations in the ability to perform these movements.

Some familiar diseases for the elderly like Arthritis and Parkinsonism reduce the ability to discriminate between small motor movements and make controlled adjustments. From the book *INDUSTRIAL PRODUCT DESIGN FOR ELDERLY PEOPLE IN INTERIOR SPACES*, the agility, strength, and muscular control tend to reduce with aging. Older persons may also experience changes in their walking gait and posture. Their gait becomes more reserved, with broader and shorter strides to improve stability.\(^3\)
Table 5. Disability as a function of age

Figure 1. Muscle changes by aging
Muscle Problems:

People’s skeletal muscle mass starts to deteriorate as they age. A recent aging study from the book *What Happens to Aging Muscles* concluded that on average, people lose about 30 percent of their strength between ages 50 and 70, and another 30 percent of what’s left per decade after that. Generally, people lose about 1 percent of their lean muscle mass per year after age 40.[4] Loss of muscle mass reduces their strength, their movement slows and become limited. Older people get tired more easily and have less energy. The walking pattern becomes shorter and slower. Walking may become unsteady for them, and there is less arm swinging. These changes that occur with aging can lead to problems with a person’s ability to stand and move around. Less muscle mass means not only a loss of strength, but also increases the possibility of injuries from falling.

After the age of 65, the use of walking aids such as cane, walker, crutch, and wheelchair increases substantially. Elderly people need these elements that contribute comfort and conservation of energy because of weakness and the fact that they tire easily.
1.2 Designing for Aging

It’s really a sad fact that people’s muscles shrink as they grow older. Less muscle mass means not only a loss of strength, but also increases the possibility of injuries from falling. Older people often have trouble with balance, coordination and daily activities of living due to loss in leg strength, it is hard for them to stand or walk for a long time.

The increasing aging of the world population has created a phenomenon globally that affects every community’s life style. Designing for aging is a real opportunity for both designers and industries to bring ideas and products to the seniors’ market. This product aims to strengthen the quality of life for elderly people and connect them to dynamic social society.

1.3 Definition

The sitting cane design is a cane with a folding seat.

This design is for elderly people when they need a portable chair to take to events, or they just want a convenient way to stop and take a rest on a long walk. They can use it when waiting in long lines, traveling on vacation, attending sporting events, or even bird watching. This new option will suit many needs.
Chapter 2 Research

2.1 Research Methodology

Before designing anything, I determined a research strategy. Here are the details that I thought about during design, which helped me learn about people's behavior and identify the research problem clearly.

Figure 5. Consumer research
From the mindmaps above, I determined three ways to gain information:
• Questionnaire Survey
• Relevant Product Research
• Face-to-face Interview

2.2 Questionnaire Survey

I published an online survey on the Survey Monkey website and had 57 respondents.
Here are the results of the online survey:

**Gender of the elder person in your home or around you:**
Answered: 57  Skipped: 0

- Female: 30, 52.63%
- Male: 27, 47.37%

Table 6. Gender of older person

**The age of elder person in your home or around you:**
Answered: 57  Skipped: 0

- 60-70: 22, 38.60%
- 71-80: 24, 42.11%
- 81-90: 6, 10.53%
- 90<: 5, 8.77%

Table 7. Age of older person
In your opinion, less people use the cane because:

- Inconvenient to carry: 21, 36.84%
- Functions don’t dress person’s needs: 34, 59.65%
- Other (please specify): 2, 3.51%

Table 8. Disadvantages

Do you think all elder persons need a cane when they go out?

- Yes, like electric car: 7, 12.28%
- Yes, like cane or walkers: 46, 80.70%
- No: 4, 7.02%

Table 9. Needs
Table 10. Attributes of necessary tools

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable</td>
<td>2, 3.51%</td>
</tr>
<tr>
<td>Easy to carry</td>
<td>19, 33.33%</td>
</tr>
<tr>
<td>Safe to travel with</td>
<td>12, 21.05%</td>
</tr>
<tr>
<td>Right prize</td>
<td>2, 3.51%</td>
</tr>
<tr>
<td>Includes additional features like lighting</td>
<td>15, 26.32%</td>
</tr>
<tr>
<td>Fashionable style</td>
<td>7, 12.28%</td>
</tr>
</tbody>
</table>

Table 11. Price for a good cane design

<table>
<thead>
<tr>
<th>Price Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; $50</td>
<td>13, 22.81%</td>
</tr>
<tr>
<td>$50 - $100</td>
<td>12, 21.05%</td>
</tr>
<tr>
<td>$101 - $200</td>
<td>28, 49.12%</td>
</tr>
<tr>
<td>$200 &lt;</td>
<td>4, 7.02%</td>
</tr>
</tbody>
</table>
If there are other functions could be added to the cane, please rank these choices:

Answered: 57  Skipped: 0

Table 12. Functions ranking 1

Table 13. Functions ranking 2
Online Survey summary:

- Gender of older people:
  Female: 52.63% > Male: 47.37%

- Age of older people:
  71-80: 42.11% > 60-70: 38.60% > 81-90: 10.53% > 90+: 8.77%

- Disadvantages:
  Functions don’t address person’s needs: 59.65% > Inconvenient to carry: 36.84% > Other: 3.51%

- Needs:
  Yes, such as a cane or walker: 80.70% > Yes, such as an electric car: 12.28% > No: 7.02%

- Attributes of necessary tools:
  Easy to carry: 33.33% > Includes additional features like lighting: 26.32% > Safe to travel with: 21.05% > Fashionable style: 12.28% > Right prize: 3.51% = Durable: 3.51%

- Price for a good cane design:
  $101 - $200: 49.12% > $50-: 22.81% > $50 - $100: 21.05% > $200+: 7.02%

- Functions ranking:
  With seat > Changeable length > Small storage space for keys and medicine > LED light > Intelligent alarm > Catcher > GPS voice system > Radio

From the online survey, I determined that the most important part of my design direction is the “Functions Ranking” with “With seat” ranked the first in all of the listed functions. Combined with previous aging process research, I determined that designing a cane with a seat would meet the most requirements of older people.

### 2.3 Relevant Product Research

For a better understanding of the pros and cons of existing canes, I searched on Amazon.com and found some relevant products and their reviews. These reviews helped me to evaluate the existing products and identify their disadvantages. It also helped me to improve my process and avoid similar mistakes in the future design process. Here I use two representative products as examples.
• The HurryCane

103 of 115 people found the following review helpful
1.0 out of 5 stars
Disappointed with this typical piece of crap, November 22, 2012
By Disappointed
I walk a lot. I need a cane because of my balance. I was disappointed with the cane. First of all, if the surface is uneven, the cane will not stand alone. If touched while standing, it falls over easily. It will not stand alone on carpeting. The rubber feet fell off in less than two weeks.\[^5\]

The key words of his description:
**Surface, Balance, Stand alone**

• Travelchair Slacker Chair

4 of 4 people found the following review helpful
1.0 out of 5 stars
AWFUL!!, April 29, 2014
By L. Peterson "ayra32" (Minnesota)

This is the most UNCOMFORTABLE thing I can ever imagine to sit upon. Even though I am a small woman - the two back corners dig into the buttocks - after seconds it's irritating. Worse is the front of the saddle style seat - think of the WORST, most horrible bike seat you've ever sat upon......that front corner pushes into the privates - NOT pleasant.\[^6\]

The key ideas of her description:
**Gender, Shape of seat, Comfort**
2.4 Face-to-face Interview

After I confirmed my thesis topic, I went to Rivers Run Active Adult Living Community in Rochester, New York, to learn more about the cane design. Here I met two women and one gentleman, who showed me their canes, shared their experiences and in particular their wishes for a better cane design.

Figure 11. Face-to-face interview in Rivers Run Active Adult Living Community
2.5 Research Summary

From my online survey, relevant product research and face-to-face interviews, I found that existing products are generally designed for walking support, and do not have the function of a seat. Imagining these scenarios: your older parents or other relatives are taking a walk outside when they want to stop and have a rest, but there is no bench around, or they are waiting in a long line and they just want a convenient way to take a rest, but there is no chair available.

Also from the online survey, the most important part of my design direction is the “Functions Ranking” with “With seat” ranked the first in all of the listed functions. Combined with previous aging process research, I determined that designing a cane with a seat would meet the most requirements of older people.

As an important tool for daily use in both nursing homes and ordinary family domiciles, the cane is very important, especially for the elderly. The sitting cane design combines the function of a cane and a chair to suit their needs.
Chapter 3 Proposal

3.1 Simulation

In order to get a more authentic and deeper experience, I used some devices, equipping myself as an “older person”:

- Silicon glove: to simulate the insensitivity of the hand in terms of touching and feeling.
- Armband + small board: to simulate the body joints that hard to bend.
- A rope attached between both feet: to simulate the restricted movement of an older person.
- A bent pipe: to simulate a cane

After I spent 1.5 hours a day for 5 days wearing this equipment in my daily life, I had a deeper understanding and compassion for the older person. It is difficult to go up and down stairs because I couldn’t bend my knees too much; I couldn’t run or even walk fast because the rope limited my movement; I couldn’t pick up small things like a needle because I couldn’t feel it with the silicon glove on my hand. Some actions I can ordinarily do easily are much more difficult for older people. It further strengthened my conviction about this project, and my hope that my design will improve the quality of daily life for older people.
3.2 Structure Research

Here are several product structures I collected from Internet. Based on my design assumption—combining a portable chair and cane - I needed to figure out the folding structure for the chair part and the support structure for the leg part.

The tripod of a camera usually has three legs, which is the minimum required to be stable in three dimensions, the weight is laid of the pad and is equally distributed to its three legs.

Some folding chairs use canvas in order to be foldable. Canvas is an extremely durable plain-woven fabric, but for the stool, when you sit on it, your body will easily get stuck in it. Also the seat does not provide enough of a weight-bearing area, creating several pressure points including on the groin and inside thigh areas.

So my design structure went in the direction of three supporting legs and used a firm, flat board for the sitting area.
4.1 Design Thinking

Designing for older people is a little different from other design areas. My design should address the physical needs of older people, and also address the essential human element of aging. Now I’m thinking more carefully about how products are designed to enable older adults to maintain their independence, dignity, sense of self, and sense of purpose as they age.

- **Enable independence**: Loss of independence is one of people’s biggest fears about aging. If products are designed without attention to their needs, this will hasten the process of dependence. Older people should be able to go about their lives independently. Designers should look at usability broadly, considering the emotional, cognitive, and physical needs of aging users.

- **Easy to see**: More than five million American adults have vision loss so significant that they have trouble seeing even when wearing glasses or contact lenses. Millions more switch between multiple pairs of glasses for different viewing situations.[7]

- **Easy to Handle**: Aging hands are often subject to tremors, arthritis, limited tactility, and diminished strength, so designs should cater to the needs of aging hands.

- **Simple**: It is harder for the aging brain to memorize too many steps or interpret large volumes of information.

- **Indulge vanity**: Becoming physically disabled because of aging doesn’t mean becoming aesthetically handicapped. In fact, people exert extra effort to maintain their appearances as they age. A 2015 study revealed that baby boomers and older “matures” plan to spend more than $4 billion dollars this year on anti-aging products and treatments. Many assistive products contradict these efforts. Solution providers who apply strict usability guidelines without imagination create products that condescend to their users and stick out like a sore thumb, labeling them as frail, old and in need of assistance.[8]
4.2 Early Concept & Test

For my sitting cane design, the most important parts were the:

- **Sitting part:** This is the “chair” part. The design should consider the size, shape, surface, human dimension, comfort level, and strength.
- **Support part:** This is the “leg” part. The design should consider the support strength, size, shape, and length.

![Figure 16. Early concept 1](image)

![Figure 17. Early concept 2](image)
Figure 18. Early concept 3

Figure 19. Early test 1
4.3 Ergonomic Study

From the book *The Measure of Man and Woman: Human Factors in Design*[^9], I found four aspects of measurement data I needed:

**The 99% elderly US men age 65-79:**
- Forearm 45.3" to floor
- Low reach 38" to floor
- 18.7" for chair, Seat 5" adjust

**The 99% elderly US women age 65-79:**
- Forearm 34.3" to floor
- Low reach 30" to floor
- 14" for chair, Seat 2.3" adjust

---

[^9]: Figure 20. The Measure of Man and Woman: Human Factors in Design
4.4 Final Concept

Dimension (Inch):
32H X 14 CHAIR
The 99% elderly US women age 65-79:
Forearm 34.3” to floor
Low reach 30” to floor
14” for chair
Seat 2.3” adjust

Figure 21. Final concept
Figure 22. Components

Components:
1. Cane handle
2. Main part of the cane
3. Main rubber tip
4. Seat part
5. Seat support part
6. Support piece x2
7. Connection metal piece (for connecting 2 Support pieces)
8. Connection part x2 (for connecting Seat support part and Support piece )
9. Support leg x2
10. Rubber tip x2
How to fold the seat:
When the user want to fold the seat, just lift the seat part to the vertical position.

How to keep the seat folded:
This sitting cane design makes use of the properties of magnets to create this “folding” effect, by engaging magnets set in the seat part and the main part of the cane.
How to open the seat legs:
When the user want to use this sitting cane as a seat, just open the 2 small support legs. This triangle structure will maintain stability when the user sit on it.

Support structure:
There is a trapezoidal groove in seat support part. When the user open the seat, the end of the support piece will fit into the groove and support the seat.
Open whole seat:
To open the whole seat, just put down the seat part and open the 2 small support legs, you will get the seat that transformed from a cane.
4.5 Usage Scenario

Figure 28. Using diagram
The benefits of this design:

Figure 29. Benefit: enjoy scenery

Figure 30. Benefit: have a rest
This sitting cane design is for elderly people when they need a portable chair to take to events, or they just want a convenient way to stop and take a rest on a long walk. They can use it when waiting in long lines, traveling on vacation, attending sporting events, or even bird watching. I hope my design has the potential to improve the quality of life for older people, and I also hope that it can help them to maintain independent lifestyles and increase their ability to participate fully in society.
Chapter 5 Specification

5.1 SolidWorks Model

SolidWorks is a powerful, intuitive, and accurate 3D engineering software for industrial design. It helps improve product performance and quality by indicating how my design will behave before it is built. With this software I was able to figure out the real size, how every parts works, and how the parts connect to each other in my design.

Figure 32. SolidWorks model
5.2 Ideal Material

- **Carbon fiber:** The properties of carbon fibers, such as high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion, make them the ideal material for the sitting cane. It can support the users weighing up to 250 lbs by calculating.\[^{10}\]

- **Rubber tip:** Produces friction to prevent users from slipping.

- **Sponge handle cover:** Comfortable for using

- **Screws:** Connection parts
5.3 Product Rendering

Figure 34. Product rendering 1

Figure 35. Product rendering 2
5.4 How it Works

Figure 36. How it works 1

Figure 37. How it works 2
5.5 Making of Display Model

5.5.1 Material & Color

- **Materials:**
  Baltic Birch Plywood
  Plastic pipe
  Wood scrap
  Sponge
  Rubber tip
  Magnet
  Metal screws
- **Color:**
  Dark Brown (to simulate the color of carbon fiber)

5.5.2 Production Process

As a final model, the goal was to execute ideas about this project while making sure all functions can still work after assembly. The most challenging part was to optimize the connection of the cane and the chair part. I made several different lengths of the connection parts to test the angle of the chair when it is opened and folded, in order to make sure it has enough length to fold the seat up.

![Figure 38. Basic parts](image)
Figure 39. Structure test

Figure 40. Assemble seat

Figure 41. Final test & paint
5.5.3 Final Display Model

Figure 42. Final display model
5.6 Exhibition Feedback

The final prototype has been displayed about 1 month. During the exhibition, this prototype was tested by several users and visitors to the exhibition, some of them asked questions in accordance with their user experiences.

Here, I want to share the feedback from users and visitors to the exhibition. They were impressed by my design and believe that it is better than the cane they or their older relatives are using, but there are invariably enhancements that can be made.
• **Shapes**
  My design meet the function of sitting, but the overall shape is still need to be improved. Because this design is for the older people, it is better to use round corner instead of sharp corners.

• **Support legs**
  For using the seat of my sitting cane design, the user need to open and close the 2 small support legs by hand. This is not easy for use, I need to find more solutions to make it easy to use.

• **Main seat**
  1. The middle’s width of the main seat is too narrow. My final prototype was made by wood. I have tested it during the exhibition, it can hold a 9 years old girls weight. My ideal material is carbon fiber and it can hold 250lb maximum. But the narrowest part of the main seat still need to be strengthened, like adding a metal piece inside the narrowest part of the main seat.
  2. The thickness of the main seat is too thin. Although the ideal material carbon fiber can hold the weight, but for a better user experience, it still need to increase the thickness of the main seat.

• **Color**
  For my final prototype I choose the color of the carbon fiber. It could be more colors for selection.
Chapter 6 Conclusion

6.1 Design Consequence

Through this thesis project, I put the knowledge I learned from class into real product execution practice. The value of my design for older people - no matter in nursing homes, in family homes, or living alone - is that this sitting cane provides sitting functions, which will improve the quality of their lives.

Figure 44. Mock-ups

Through this thesis design, I not only exercised my design thinking, but also exercised my problem solving capability especially hand crafting and modeling skills. In addition to generating and visualizing a concept, I learned how to make it happen physically with mock-ups and operational prototypes.

Figure 45. Thesis exhibition
From this thesis design exhibition, I hope more people can realize the importance of aging design in our society by viewing my work, I also hope that people can comprehend that medical equipment is just one of numerous possible design directions.

Figure 46. Photo of Rivers Run Active Adult Living Community

Thanks to Rivers Run Active Adult Living Community for helping me gather information from their residents. They shared their valuable experience with me, which expanded my understanding of design from the beginning to the end. I discovered many design opportunities there and hopefully, my imperfect solution can strengthen older people’s confidence. The entire design process has been a beneficial practice for me and it motivates me to continue doing research about aging design. I hope to do more for the nursing home community in the future.
6.2 Some Thoughts

• Designing for aging
Designing for aging is a very important direction in product design. It can improve the quality of older people’s lives and increase their ability to participate fully in society.

• Design thinking
Design thinking requires the designer to put themselves in the user’s shoes and combine empathy for their particular need with creativity and rationality to develop the best solution to fit their needs.

Figure 47. Some thoughts (Pictures from Internet)
References


[4] What Happens to Aging Muscles, By Brent Agin and Sharon Perkins from Healthy Aging For Dummies
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[8] Amazon customer review of Travelchair Slacker Chair
http://www.amazon.com/TravelChair-1389VBK-Slacker-Chair-Black/product-reviews/B000FXVAYW/ref=cm_cr_dp_qt_hist_one?ie=UTF8&filterByStar=one_star&showViewpoints=0


Appendices

The online survey I published on Survey Monkey:

1. Gender of the older person in your home or around you:
   A. Female       B. Male

2. The age of the older person in your home or around you:
   A. 60 – 70     B. 71 – 80     C. 81 – 90     D. 90 <

3. In your opinion, fewer people use the cane because:
   A. Inconvenient to carry       B. Functions don’t dress person’s needs      C. Other

4. Do you think all older persons need a cane when they go out?
   A. Yes, like electric car      B. Yes, like cane or walkers       C. No

5. If cane would be a travel tool for the older persons, what design attributes do you consider necessary?
   A. Durable       B. Easy to carry       C. Safe of travel with      D. Right price
   E. Includes additional features like lighting       F. Fashionable style       G. Other

6. If other functions could be added to the cane, please rank these choices:
   A. Intelligent alarm      B. GPS voice system      C. Changeable length
   D. LED light        E. Small storage space for keys and medicine      F. Radio
   G. With seat       H. Catcher

7. What would you pay for a good cane design?
   A. < 50      B. 50 – 100      C. 101 – 200      D. 200 <