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Boheng Huang
bh5034@rit.edu

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Kitchen Cooking System Designed for Wheelchair Users

By

Boheng Huang

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Thesis Committee

Prof. Lorraine Justice – Chief Advisor

Prof. Alex Lobos – Graduate Director / Associate Advisor

Kitchen Cooking System Designed for Wheelchair Users

Boheng Huang

Keywords: countertop height for wheelchair users, food preparation from wheelchair, kitchen ergonomics for wheelchair users

Abstract:

This project is a system to help wheelchair users use the kitchen more conveniently. The kitchen is an indispensable place in everyone's daily life. However, for wheelchair users, the height of the kitchen countertop is too high, which makes them unable to easily take the items on the kitchen countertop and causes difficulty, complexity and a lack of safety to their daily life. The kitchen system project in this paper can solve the problem that the height of the kitchen console is inconsistent with that of wheelchair users. A small table that can adjust the height of the desktop can be firmly installed on the wheelchair, which can replace the function of the kitchen workspace and solve the problem of wheelchair users due to different heights in the kitchen.

Introduction:

For wheelchair users, the biggest problem in daily life is the height difference between them and work surfaces that are too high because they remain seated. Because most products in life are calculated according to the body size of standing people, it can cause difficulties in their life. This includes the problem of using the kitchen, which has caused great trouble for wheelchair users in handling ingredients, taking objects from high places, and moving objects and liquids that are hot.

Global wheelchair market background:

From 2016 to 2020, the global demand for wheelchairs showed an upward trend. This phenomenon was caused by the increase of the elderly population and the increase of global traffic accidents.

By 2019, the global population over the age of 65 has accounted for 9.1% of the total global population, which has met the United Nations social standard for aging, and the ratio will reach 15.9% in 2050. This means that more and more elderly groups will need to use wheelchairs in the future¹.

Disability caused by car accidents is also one of the reasons for the increase in the demand for wheelchairs. According to the data of the World Health Organization (WHO), about 15.0% of the population has some form of disability and needs action assistance².

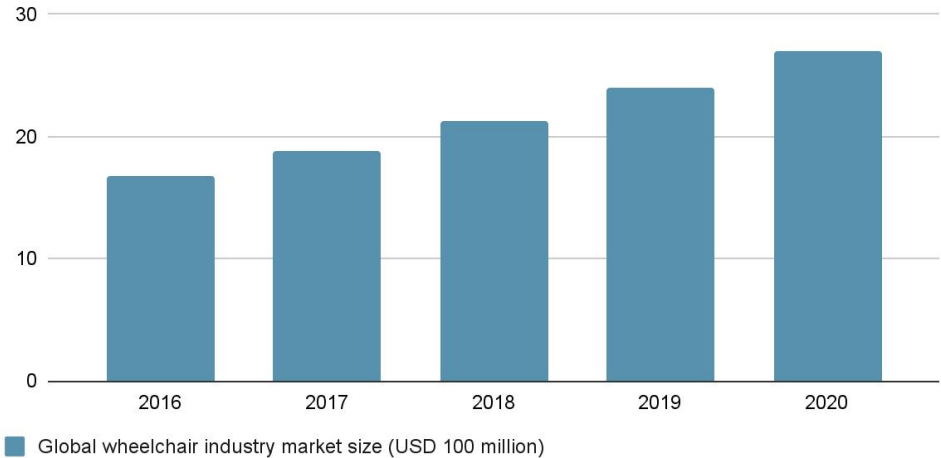


Figure 1. Market scale statistics of global wheelchair industry from 2016 to 2020³

¹ United Nations. Global issues. 2019

² Grand View Research Prospective industry research institute. Market scale, market segments and regional distribution of the global wheelchair industry in 2021 North America dominates the wheelchair Market. 2021

³ Grand View Research Prospective industry research institute. Market scale, market segments and regional distribution of the global wheelchair industry in 2021 North America dominates the wheelchair Market. 2021

According to the data, manual wheelchairs will dominate the market in 2020. Because manual wheelchairs have the advantages of low price, simple structure and light weight, more consumers are willing to buy manual wheelchairs. However, with the development of economy and technology, more and more high-performance electric wheelchairs appear in the market, which is provide more choice for consumers.

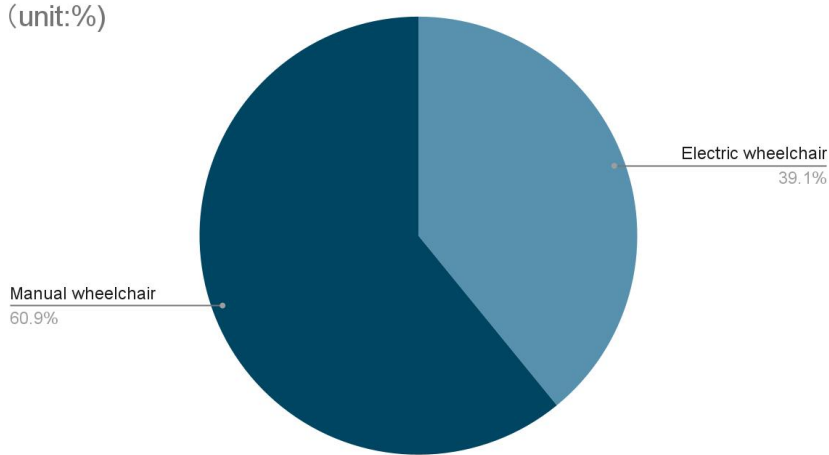


Figure 2. Global wheelchair product structure in 2020⁴

According to the data, the main users of wheelchairs are those who lose their mobility due to elderly diseases or disabilities. Especially with the increase of global aging, the adult wheelchair market accounts for a large proportion⁵.

⁴ Grand View Research Prospective industry research institute. Market scale, market segments and regional distribution of the global wheelchair industry in 2021 North America dominates the wheelchair Market. 2021

⁵ Grand View Research Prospective industry research institute. Market scale, market segments and regional distribution of the global wheelchair industry in 2021 North America dominates the wheelchair Market. 2021

Cerebral palsy is a common cause of children's mobility disorder. More than 10,000 babies in the United States are born with this disease every year, which leads to a certain proportion of the child wheelchair market⁶.

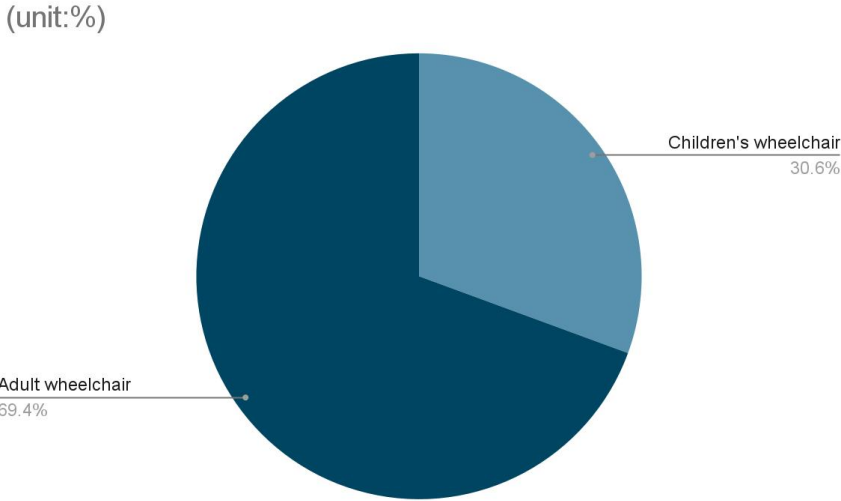


Figure 3. Applicable population structure of global wheelchair products in 2020⁷

⁶ Grand View Research Prospective industry research institute. Market scale, market segments and regional distribution of the global wheelchair industry in 2021 North America dominates the wheelchair Market. 2021

⁷ Grand View Research Prospective industry research institute. Market scale, market segments and regional distribution of the global wheelchair industry in 2021 North America dominates the wheelchair Market. 2021

Problem Statement:

From the research, a suitable countertop height for a wheelchair user is a minimum of 28" and should be no higher than 34". The counter for wheelchair users shall also have a space of at least 24 inches high and 30 inches wide to accommodate the legs of wheelchair users⁸, which are not available in ordinary kitchens. Transforming the kitchen into a barrier free place may be the best choice for wheelchair users. However, for a disabled person, he or she may not be able to afford the cost of such transformation. It is proposed that an adjustable food preparation table for wheelchair users is designed for safety, ease of use, and low cost.

Introduction:

Through interview and observation, cooking activities in the kitchen can be divided into: preparation, heating, moving, and cleaning. The preparation work can be divided into the following points: Taking ingredients or cooking tools from the locker or refrigerator, processing ingredients (including cleaning ingredients, pickling, shredding and so on).

"Heating" in this paper mainly refers to the behavior of heating food and the behavior that will be carried out during the process of heating food. It mainly includes: putting the processed food into the pot or oven or microwave oven, adjusting the size of the temperature, adding seasoning in the heating process.

"Moving" refers to transferring the cooked ingredients to a container such as a plate or bowl, and then moving the container containing the cooked ingredients to the table.

"Cleaning" refers to the removal and cleaning of dishes, tables, cooking utensils and kitchen worktables after eating.

Wheelchair users often encounter the following problems when performing the above behaviors in the kitchen:

⁸ National Mobility Equipment Dealers Association. Prep for the Holidays in a Wheelchair Accessible Kitchen. 2018

Height

Wheelchair users are unable to stand and squat, which makes them unable to take higher or lower objects smoothly.

Spread

Due to the height of wheelchair users, the grease splashed during cooking may directly scald their faces, which will cause facial burns.

Washing

The depth of the sink and the length of the arm will prevent wheelchair users from cleaning dishes and vegetables. Therefore, it is observed that wheelchair users prefer to use the dishwasher to clean tableware or cooking utensils after meals.

Operate

The height and distance of the kitchen console will hinder wheelchair users from handling ingredients.

Moving

Wheelchair users need one hand to control the wheelchair while moving, and the other hand needs to take items such as dinner plates, which will cause some trouble for their moving.

Space

Wheelchair-users occupy more space than those standing, which makes wheelchair users need to be careful when moving in the kitchen. It is worth mentioning that turning will take up a lot of space, which is very difficult for users who use both hands to control the wheels of wheelchairs. They need to pay attention not to bump into other items in the kitchen, so as to not damage the wheelchairs or themselves.

Solutions:

In order to prevent scalding, they will use deeper pots when cooking, so that the oil cannot splash out.

Wheelchair users need to tilt the pot to themselves at a certain angle every other period of time to observe the cooking progress of food in cooking.

Oven and microwave ovens are a good choice for wheelchair users to heat food, which effectively avoids scalding caused by the splash of oil during the heating process. However, it is inconvenient for wheelchair



Figure 7. Refined model

Testing method: Six people were asked to use the model follow the user steps in kitchen for testing (four of which were not disabled) using the model, and the other two provided feedback from wheelchair users through video.

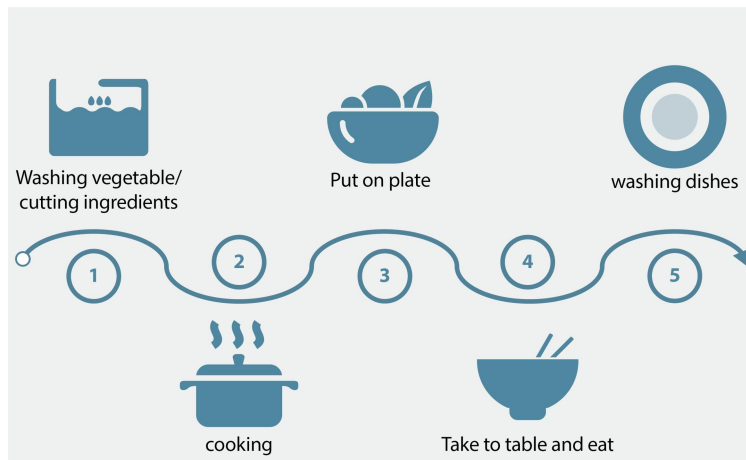


Figure 8. User steps in kitchen

Testing Conclusions:

After testing the new model, new problems are found. The following are the parts of the model that can be improved in the future:

- 1.The supporting structure of the wheelchair will occupy the space of legs

- 2.The process of assembling the wheelchair is too complicated
- 3.The process of raising the wheelchair is too complicated
- 4.Unable to quickly remove the desktop from the wheelchair (including remove all the items from the desktop quickly)
- 5.The chopping board is too small
- 6.Lack of use instructions for blocks (users do not know how to use, do not know the positive and negative poles)
- 7.Unable to lower desktop height
- 8.The table is too heavy
- 9.The tabletop cannot be disinfected with hot water

Final design:

The final design is named counter free. Is a kitchen operation table which can be installed on the wheelchair and the height can be adjusted.



Figure 9. Final Concept

Structure:

The overall structure of the table is composed of plastic tray, bar magnet, synthetic wood desktop, fixed support, pneumatic rod telescopic support.



Figure 10. Structural explosion diagram

The final design adopts the structure of pneumatic rod. When the user presses the handle on both sides of the desktop, the user can adjust the height of the desktop. When the user wants to reduce the height of the desktop, the user can press the handle and gently press the desktop to reduce the height of the desktop.

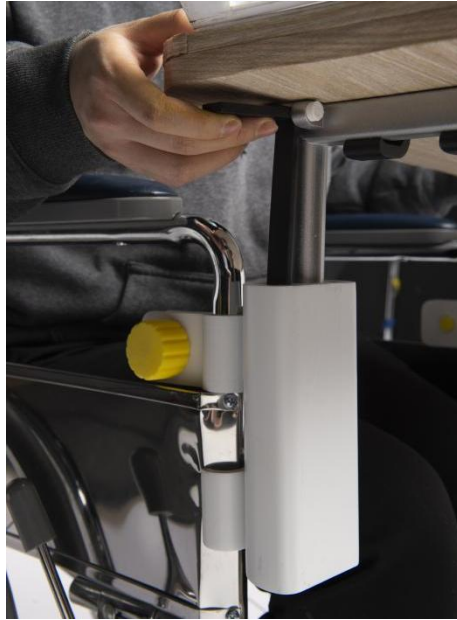


Figure 11. Table handle and support structure

The right bracket of the desktop is adjusted with three fixed supports. When users want to rotate the table to the other side, they need to rotate the right bracket to the right to separate the support rod from the fixed supports. In this way, the user can smoothly rotate the table to the other side.



Figure 12. Folding function

Considering that users may hold a large number of items on the desktop when wanting to fold the desktop, a movable tray is added to the desktop to facilitate users to move the items on the desktop to the dining table at one time. When no other items are stored on the desktop, the user can easily and quickly fold the desktop to the other side of the wheelchair. When the user wants to return to the wheelchair to continue working, he can also reinstall the tray on the desktop. At this time, the items on the desktop will be in the original position, which is convenient for the user to quickly carry out the original work.



Figure 13. Plastic tray

Six bar magnets are installed on the seat surface. The yellow side is the negative pole and the white side is the positive pole. A magnet is installed inside the tray on the desktop to absorb the magnetic strip. The magnetic strip can be used to fix the tableware on the desktop to ensure that the tableware will not overturn when the user moves the tableware.



Figure 14. Bar magnets

The connector of the wheelchair is fixed by tightening screws. When the desktop is not used at ordinary times, the user can choose to place the desktop on the kitchen table for easy access at ordinary times.



Figure 15. Tightening screws

Conclusions:

The height of the worktable in the kitchen is the most important problem for wheelchair users, but there are still other problems in the kitchen, such as the height of the stove that cannot be changed, high objects that cannot be reached, and so on. These problems cannot be solved by the desktop designed in this article.

The desktop designed in this paper still has the problem of inconvenient installation. Its installation structure should be redesigned to make it more convenient for installation and disassembly. In addition, it is also worth thinking about where the disassembled wheelchair should be stored to facilitate the next use of wheelchair users. Hoping these problems can be solved in the future.

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