

UNIVERSAL KITCHEN INTERIOR DESIGN

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ABSTRACT

Background:

Interiors define arranged spaces equipped with furniture used by people, general with access and usage issues. All types of interior designs concern the interaction between people and their environment, which is a two- way process. If is taken one area such as a home kitchen, can be seen how social attitudes, developing technology and many other factors are reflected in the design of its interior.

Universal design refers not just to a final product but also to a process of designing, which includes the functional needs of people with and without physical disabilities.

Results:

This research article shows a concept of universal kitchen design, a product with both aesthetics and functional usage for everyone. The design process is based on the barrier- free designing with usage of innovation technology, in order to give access to inaccessible kitchen elements.

Kitchen counters with several height positions, cabinets with roll- out shelves and ergonomic designed kitchen parts, offer disabled people in wheelchairs or ageing population and their families' accommodation of usage and free access to tools in the kitchen.

KEY WORDS

Universal kitchen design, physically disabled people, wheelchair, accessibility, functionality, aesthetics, ergonomics, anthropometric analysis.

1. INTRODUCTION

1.1. Introduction to Universal Design (“Barrier- Free Design”)

Space design that gets the needs of all users during their entire life is a major goal of “Universal design” or “Design without limits”. The ability to plan and design products and environments which can be used by multiple categories of users, including people with mobility limitations, people in elderly years, short people, children, people of all ages and physical abilities and disabilities are universal design features.

For specificity and different ergonomic conditions of persons with physical disabilities, standard home spaces are more than “unavailable”. Therefore, when universal design reflects on housing design, we get home environments that have features that are relatively easier to use in comparison to the traditional home designs. “Universal house design” enhances the comfort, safety and convenience of the home, regardless of user’s age, height or mobility.

1.2. Goal and Structure of the Research Article

This analytical research study has been carried out to present a kitchen model for wheelchair users and people with mobility impairments that reflects universal design concepts.

The main purposes of this article are:

1. To develop a model based on the concept of kitchen design, formulated as a combination of earlier studies and the criteria of universal design.

2. To present designing guidance needed to design kitchens for wheelchair users and people without physical disabilities, which can also be used as a preliminary educational tool for modifying existing kitchens.

The further of this document is divided in two parts:

- **Approach and state of research.**

The reader gets informed about the applied working methods used as approach to the research and basic information about “The principles of universal design”, which are of interest for understanding the theme to the people who are not familiar with the “barrier-free projecting” in every segment of interior architecture and furniture design.

- **Interior equipment of presented universal kitchen model.**

Through the projected kitchen model for disabled people who use wheelchairs or medical devices for movement and their families, is presented design approach applying the universal design principles, as well as recent innovative technologies and tools in accordance with modern trends and requirements of end users.

2. APPROACH AND STATE OF RESEARCH

2.1. Applied Working Methods

To carry out this study and design a model concept, professional literature and findings of former research on kitchens for wheelchair users were analyzed. The findings lead to thinking of trying to define a particular methodology of designing a universal kitchen space no different from the general purpose kitchen, updating the standards for the design, as well as, designing and adjusting kitchen elements for needs of persons with disabilities.

Resources such as books and references conclude this manual and give the reader an opportunity to find additional assistance in planning a home with universal design. Primary materials include plans, drawings, models, sketches, photographs and statements by designers and contemporary design critics, theorists and users of universal designs. Also published journals and internet materials are being used as source of information.

The main reasons reported as imperative to determine the theme of this work are:

- Define clearly expressed pathways that ensure consistency in design (furniture design).
- Improvement of industrial production synchronizes between housing and industrial furniture production.
- Increasing the impact of professional designers to plan relationship between quality designed kitchens and production quantity of the same.
- Improving the application of science to the furniture production, especially in the part where is specifically marked sensibility to potential users or buyers, promoting the connection between academic institutions dealing with designers and with the economy.

Design is a general methodology that links all stages of a design system, from idea to its final realization. For these reasons methodology does not provide any solutions or fixed answers, but marks roads to them. Design methodology is a process of design, expressed with the general condition of experience in architecture, furniture design and shaping.

No.	Checklist	Features
1.	Adaptable design.	<ul style="list-style-type: none"> - The design should accommodate not only wheelchair users, but also their family members. - The height controls of kitchen appliances should be easy to reach.
2.	Safety- oriented design.	<ul style="list-style-type: none"> - The design should provide safe features and isolate or shield hazardous elements.
3.	Supportive design.	<ul style="list-style-type: none"> - The design should be used efficiently and comfortably with minimum efforts. - It should be designed for wheelchair users to store things at ease.
4.	Accessible design.	<ul style="list-style-type: none"> - The kitchen model should be created for people in wheelchairs to access it easily. - Kitchen cabinets and counters should be placed within the reach of wheelchair users.
5.	Aesthetics.	<ul style="list-style-type: none"> - The appearance of kitchen model should not be different from the kitchens which general people use. - The design should be harmonized with the interior where the kitchen model is located.
6.	Cultural / regional considerations.	<ul style="list-style-type: none"> - The design should reflect the specific dietary life of people.
7.	Cost.	<ul style="list-style-type: none"> - The kitchen model should be produced at an affordable price.

Table 1. Designing guidance based on a broad compilation of ergonomic resources.

2.2. The Principles of Universal Design

Universal design has practical and aesthetic values. The principles of universal design are defined as a philosophy of designing space which meets ever- changing needs of all individuals and families regardless of their age, size, physical advantages and physical limitations.

They produce qualities such as:

- Housing compatible for physically handicapped persons and their families.
- Residential areas which would be suitable for long- term housing, so people will not be forced to move out when they age or lose mobility.

“The seven principles of universal design” may be applied to evaluate existing designs, guide the design process and educate both designers and consumers about the characteristics of more usable products and environments.

1. **PRINCIPLE ONE: Equitable Use.**
2. **PRINCIPLE TWO: Flexibility in Use.**
3. **PRINCIPLE THREE: Simple and Intuitive Use.**
4. **PRINCIPLE FOUR: Perceptible Information.**
5. **PRINCIPLE FIVE: Tolerance for Error.**
6. **PRINCIPLE SIX: Low Physical Effort.**
7. **PRINCIPLE SEVEN: Size and Space for Approach and Use.**

3. DESIGNING UNIVERSAL KITCHEN MODEL

3.1. Anthropometric analysis of the target group related to dimensioning of universal space for food preparation

The represented kitchen model is made by combining the design concept with major findings of former studies and universal design principles. The wheelchair dimensions are key measures for this universal kitchen space design. Also, anthropometric measures are important for proper sizing of the given project, which covers the border area between human bodies and various components (furniture and equipment) from the interior of the project.

We use two basic types of anthropometric dimensions: structural and functional, as starting point in designing a universal kitchen space. Structural dimensions are called static dimensions and include measures of the head, torso and limbs in a normal position. Functional dimensions are called dynamic dimensions and include measures of the human body measured in different operating positions- standing, sitting or in motion when performing given tasks.

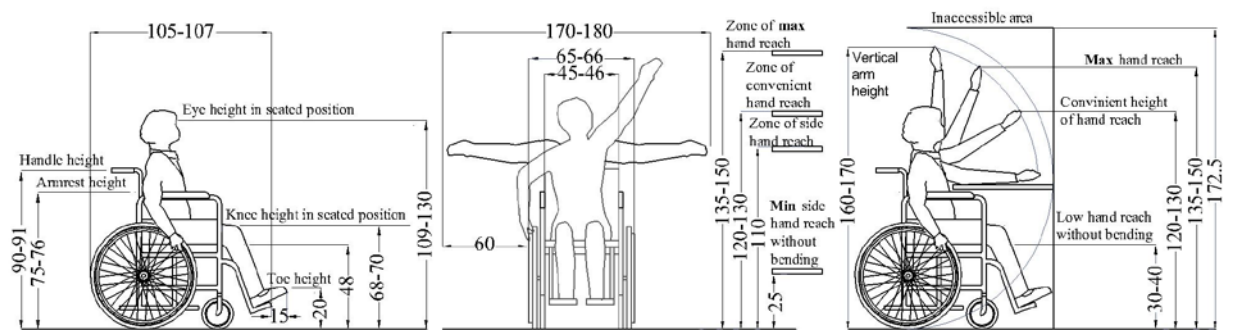


Fig. 1. Significant anthropometric measures and wheelchair dimensions for universal kitchen design.

The overall wheelchair dimensions are 63.5 x 106.7 cm. An average person who sits in a wheelchair has front hand reach with dimensions of 38- 122 cm, measured from the floor. Optimal front reach of an average tall man moving with a wheelchair in the kitchen catches in height range of 40- 120 cm from the floor without bending. If there is an obstacle (for example desktop), the reach is reduced to maximum of 110 cm. Side hand reach while sitting in a wheelchair without bending is 40- 135 cm. If an obstacle appears deeper than 25 cm, then the reach is reduced to 115 cm. Dimensions from 0- 40 cm as lower and 120- 150 cm as upper reach limit are most suitable for designing kitchen elements. The design of the lower kitchen cabinets with knee space that provide wheelchair users easy access to desktop, is with open space of min 75- 90 cm wide, 70 cm in height and 45-50 cm in depth. Also important anthropometric factor is to provide enough kick space for the feet in a wheelchair, with withdrawal of the kick space base for 25- 30 cm in height and 15 cm in dept.

3.2. Functional analysis of the universal kitchen space (Spatial factors and ergonomic design measures affecting the universal kitchen model)

When exploring the relationship between dimensions of the human body and kitchen space (the table unit), sitting space around the table and space for horizontal communication and movement are the most valuable for interior kitchen design.

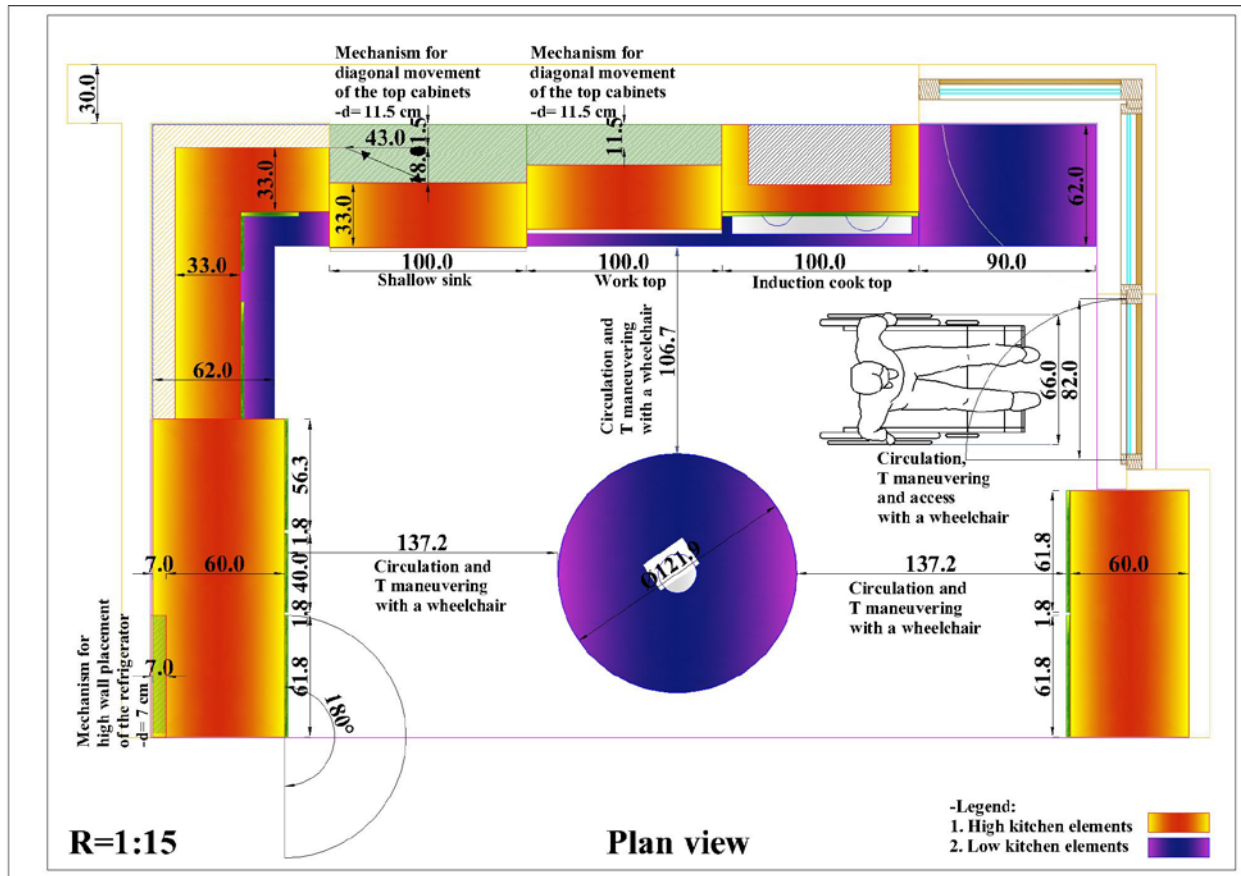


Fig. 2. Plan view of the presented universal kitchen model.

The distance between the table edge and wall or other physical barrier must provide space for at least two of these elements: (1) space for wheelchair’s manipulation (“T” maneuvering), (2) maximum width space for passage of one man in a wheelchair and one physical able man and (3) space for access the dining table with wheelchair.

The table design takes into account width of 61 cm which would allow sufficient space for maximum width of body in a sitting position with open elbows and common area in the center.

3.3. Interior circulation in the universal kitchen space

Required width of 91.4 cm provides partial circulation in the kitchen space, with a wheelchair in two paths. Width of 137.2 cm allows physically capable individual to walk despite the wheelchair, also that space is suggested to approach the table with a wheelchair and a person standing behind or preparing food in the kitchen area. Wheelchair users can maneuver 360° in space with a width of 137.2 cm, with round movement around the right wheel of the chair. Access width of 106.7 cm is required to accommodate a person standing beside the wheelchair.

The wheelchair user needs space for side reach of the kitchen worktop surface (the kitchen working area). The path for horizontal maneuvering needs to be with minimum width of 86.4 cm and food should be set at maximum hand reach of 50.8 cm on the worktop.

The approach to the door when it opens inwards, as the balcony door shown in this case, should be with 120 cm width for direct access to the door and opening angle of 90°. Space of

152.4 x 152.4 cm is suitable for disabled users to maneuver a wheelchair and open a door to get out. Wheelchair can also be maneuvered in an area of 121.9 x 121.9 cm, but this dimension is extremely narrow and should be understood as absolute minimum. Door width of 91 cm is considered as optimal space for passage of wheelchair users.

For easy use by persons in wheelchairs, windows should be mounted in the wall at a height not higher than 130 cm. They should provide sight view through in a sitting position.

4. ANALYSIS OF SPACE, ITEMS AND EQUIPMENT OF THE KITCHEN MODEL FOR PERSONS WITH DISABILITIES

The presented “U- shaped” kitchen model for physical disabled people and wheelchair users is developed with applying the principles of universal design. The layout of the kitchen is organized into six basic areas: food storage, kitchen- items storage, food preparation, cooking zone, dish cleaning and food consuming zone. Each work area provides a choice of work heights appropriate to tasks performed while sitting or standing and should provide space for people working together on a task. The variety of working heights is achieved by using adjustable mechanisms integrated in the kitchen elements or with additional pull- out work surfaces, set few cm lower than the countertop. The food preparation area is connected to the cooking area with a continuous counter top, which permits sliding of prepared items between the two.



Fig. 3. Presented “U- shaped” universal kitchen model with mechanisms for height adjustments of the kitchen elements.

Spatial- organizational analysis of the kitchen model should adequately equip the premises and items for people with special needs in accordance with predefined anthropometric needs of the people who use them and provide clear space between all opposing cabinets,

countertops, appliances or walls to permit a full turn by a wheelchair user. The goal is to achieve smooth flow of operations in the kitchen working triangle.

4.1. Kitchen zones and equipment



Fig. 4. Legend with design details of the presented “U- shaped” universal kitchen model

*All base cabinets are projected with a kickboard placed 10 cm inwards, which provides toe or kick space with 20 cm height (higher than traditional height).

* In the kitchen construction are used hinges and mechanisms for easy touch opening and closing of drawers and doors. (Inside the kitchen elements is easy available in a sitting position).

No.	Kitchen zones with equipment	Features
I. "Consumables" zone		
1.	Built- in refrigerator for cold food storage	<ul style="list-style-type: none"> - dimensions: 60 x 60 x 160 cm - internal shelves with full pull- out extension - door hinges with full opening angle of 180° - installed on platform raised 22 cm from floor - built in cabinet high 212 cm
2.	High pull- out element integrated in the kitchen cabinet for dry food storage	<ul style="list-style-type: none"> - width: 40 cm - storage space - easy touch opening - full pull- out extension guides and rotation of 90° - integrated in cabinet high 212 cm
II. "Non- consumables" zone		
3.	Top cabinets	<ul style="list-style-type: none"> - height x internal depth: 70 cm x 33 cm - storage space - easy touch opening - project placement at a height of 142 cm measured from floor to the lower element surface - integrated lift mechanisms for diagonal height placement adjustment - variable height placement, adjustable in continuous range of 43 cm downwards and 18 cm forwards (min 99 cm height from floor in the max forward position) - sensitive touch sensors integrated in the lower surface for lift possible stop
4.	Top corner cabinet	<ul style="list-style-type: none"> - integrated task lighting under counters - project placement at a height of 142 cm measured from floor to the lower element surface - storage space - easy touch opening
III. "Cleaning" zone		
5.	Dishwasher	<ul style="list-style-type: none"> - dimensions: 54.5 x 54.5 x 45 cm - small capacity - internal shelves with full pull- out extension - front placed touch controls - located in the pantry at table height - raised 67 cm from floor
IV. "Preparation" zone		
6.	Base corner cabinet	<ul style="list-style-type: none"> - drawers with full pull- out extension - storage space - drawers with easy touch opening
7.	Base cabinet with integrated sink	<ul style="list-style-type: none"> - projected worktop height 85 cm from floor - total height of 18.2 cm

<p>and cook top</p> <p>8. Stainless steel sink</p>	<ul style="list-style-type: none"> - total depth of 62 cm - projected worktop height: 85 cm measured from floor (normal position) - drawers with full pull- out extension - easy touch opening drawers - lift mechanism for worktop vertical height placement adjustment in continuous range from max 95 cm to min 65 cm height measured from floor, in continuous changing position intervals of 10 cm - additional roll- out worktop shelf made of fireproof material set under cook top, 3.2 cm lower from surface - open lower space for knees and wheelchair access with variable height adjustable from 47 cm to 77 cm measured from floor - button controls for lift mechanism mounted on the cabinet front - shallow sink bowl - dimensions: 61.6 x 52.5 x 12.7 cm - the battery is placed 58 cm from the front edge of the worktop
<p>V. "Cooking" zone</p>	
<p>9. Induction cook top</p> <p>10. Range hood integrated in the top cabinets</p> <p>11. Base cabinet</p> <p>12. High kitchen cabinet with integrated wall ovens</p> <p>13. Wall ovens</p>	<ul style="list-style-type: none"> - provided visually distinct "burner" areas - 45 mm in thickness - cook top surface 91.5 cm x 53 cm - installed in the top cabinet - operated with remote control - drawers with full pull- out extension - drawers with easy touch opening - storage space - drawers with full pull- out extension - drawers with easy touch opening - storage space - roll- out worktop shelves under wall ovens made of fireproof material - raised 59 cm from floor - middle oven grid is at a height of 86.5 cm measured from floor - doors opening on vertical axis - internal shelve with full pull- out extension - front mounted burners controls
<p>VI. "Food consuming" zone</p>	
<p>14. Round table</p>	<ul style="list-style-type: none"> - diameter: 121.9 cm - projected worktop height: 85 cm measured from floor (normal position) - lift mechanism for worktop vertical height placement adjustment in continuous range from max 95 cm to

	min 65 cm height measured from floor, in continuous changing position intervals of 10 cm
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Table 2. Design details of the presented universal kitchen model.

5. DISCUSSION AND CONCLUSION

5.1. Effectiveness of the major kitchen elements

1) “Consumables” zone:

Increased opening angle flap of 180° improves access to the interior of the fridge for disabled people who use wheelchairs and other medical devices for movement.

Accessibility is facilitated by extraction with full extension shelves, as well as its height position. The refrigerator is raised to a height of 20 cm from the floor, which interior is in the range of eye height in a sitting position from 80- 87 cm.

High dry storage element for food with a full pull- out and rotation of 90°, achieves visual inspection and increased accessibility of sorted items, as well as wheelchair users can take out items without bending.

2) “Non- consumables” zone:

The lift mechanism allows the storage in the wall cabinets to be lowered to a more easily accessible height in seated position, with no loss of cupboard space when the unit is folded downwards.

Wall elements are placed in normal height of 142 cm, corresponding to a vertical reach of hand of 185- 195 cm while standing. The internal width of these elements is 33 cm, which makes it available for use.



Fig. 5. Vertical height adaption of kitchen elements and round table.

3) “Cleaning” zone:

Raised platform makes dishwasher reachable in seated position, as well as obtains drawers space under the machine suitable for delay, within easy reach of seated people.

Dishwasher is raised at height 67 cm from the floor, which mean grid with full extraction is situated at a height of 89 cm, which is in the range of height vertical reach of the arm in a sitting position from 125- 130 cm and height of the eye in a sitting position of 80- 87 cm and the space under the machine is used for drawers suitable for delay. The door of the machine is a

small size making it easier manipulation vessels and is facilitated parallel access with a wheelchair.

4) “Preparation” zone:

Projected worktop height of 85 cm of base cabinets is in range of vertical hand reach of max 130 cm in seating position without bending, short people and children.

Sink and battery are anthropometric positioned from the front worktop edge for easy forward reach in a sitting position.

Shallow sink allows its installation in kitchen element with open space for the knees and wheelchair access, which allows a resident to work in a seated position.

Lift mechanism for worktop vertical height placement adjustment is being useful for wheelchair users and people with a short stature and children as well as general people.

The open space for knees under the element provides sufficient space so that wheelchair may partially enter below the lower surface of the element and have comfort at work while seating.

The sink is related to the cooking zone with work surface that provides continuity in the kitchen work.

5) “Cooking” zone:

Smooth cook surface allows pots to slide from hot cook surface to cold worktop, which makes it easier for those with limited strength lifting, as well as wheelchair users and enables the surface to be cleaned easier than other cookers in seated position and reduces the risk of burns and fire.

Furthermore, thin cook surfaces allow designing lower kitchen cabinets with small thickness and open under counter knee space for wheelchair users.

Visually distinct burner areas of the cook top and front positioned control panel buttons aid proper visually uses especially for disabled people in wheelchairs, because of reduced range of vision in seated position.

Wall ovens set into the high kitchen cabinet at a height of 59 cm in the range height of the vertical reach of arm in a seated position from 125- 130 cm and height of eye seated 80- 87 cm suitable for reach and door opening around vertical axis, thus allow easier access to the stove and reduces reach required to remove hot items from the ovens to wheelchair users and those with limited lifting force.



Fig. 6. Pull- out worktop shelves with full extension under wall ovens.

The pull- out worktop shelves under the cook top and wall ovens provide landing pads for hot food that has been moved from the cook top or the ovens and facilitates the access of seated users including people in wheelchairs. Advantage is their manufacture of fireproof material.

6) “Food consuming” zone:

The dining table is easily moved and provides wheelchair- accessible knee and toe clearance. When designing the round table is taken into account the space of 61 cm which allows enough space for the maximum width of the body in a sitting position with widen elbows, while the common area in the center is limited. The round table is designed with diameter of 121.9 cm, on which are sitting four people in wheelchairs, with enough space for maneuvering around the table. Space from the floor to the lower surface of the table is a critical distance which provides enough room to approach a man in a wheelchair and is with installed height adjustment mechanism in height range of 65-95 cm, measured from the floor to the upper surface of the table.

Full- extension of the pull-out drawers and worktop shelves base cabinets achieve easy access to storage space without bending.

Front- mounted controls on all appliances allow person to work while seated and are easier to reach without bending from seated position.

The oversized push- button controls are on the cabinets’ fronts and are mounted at a height that allows hand- eye coordination from a seated position.

Circulation in space:

Provided parallel approach to the dishwasher combined with a front approach to the counter with sink, serves wheelchair users and those who use rolling walkers.

Edge of the round table from the edges of the kitchen work surfaces is presented with width of 106.7 cm to 137.2 cm, which represent horizontal path circulation, access to work areas and maneuvering space for wheelchairs in the kitchen. In front of the balcony door is provided pure spatial dimension of 137.2 x 137, 7 cm for "T" maneuvering of the wheelchair.

In the presented kitchen model is used one winged door with clear width of 82 cm, which corresponds to the minimum acceptable width for wheelchair circulation.

Windows with dimensions of 90 x 110 cm, allow natural room lighting on the kitchen workspace. They are set at 100 cm in height from floor, with the position of the handle which allows acceptable reach opening, closing and locking the window from seated position.

Interior lighting and interior colors:

The ceiling of the kitchen is designed with sunroof, which allows natural light in the room.

Distinctive and contrasting colors between the working surfaces and front surfaces (faces) of the kitchen elements, clearly define the separate working zones of the kitchen.

The floor is visually contrasting with the kitchen elements colors, without shiny surface made from no slide materials.

5.2. Critical points in the universal kitchen model

Opening knee- spaces as well as lowering counters reduce the shortage of storage space, as well as, for tall people may appear not to be convenient.

The smooth surface induction cook- top has the disadvantage of having less capacity to catch spilled liquids, which may increase the risk of burns for someone sitting near it, this problem should be solved.

While placing a pull-out table under the cook top appears to be useful, more study should be done to find out its best location to maximize its usability. As suggested in the evaluation process, placing it to the right or left side of the present location should be considered.

In conclusion universal kitchens should be designed in accordance with the following questions:

- Whether the product can be used from a sitting position?
- Can the product be used without leaning over half?
- Whether the product requires reaching above the shoulders or below the waist?

However, it should be accent that objects designed as a universally accessible for persons with disabilities can exhibit many features of universal design, but often specifically designed to address specific disabilities or abilities this way not "universal." features "available items" should be critically evaluated to determine that the subject is useful to a wide range of people for which it is intended.

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