

Aiding Self-reliance of the Elderly and the Disabled - Modular Cupboard with Mobile Internal Units

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Abstract. Changes in the age structure of societies, development of medical care and, even more importantly, the drive of the elderly and the disabled towards self-reliant and satisfactory lives make the creation of space devoid of any barriers a fundamental goal of the architectural design. The subject of the study presented in this paper is the design of the modular cupboard with mobile internal units. The purpose of such a unique construction of this piece of furniture is to make the users able to optimally use the space available in the upper parts of the room. The paper consists of the three main elements: description of the inventive design, analysis of the customization options for the modular cupboard frame, and the research including the assessment of the modular cupboard frame according to the *kansei* method.

Keywords: Designing for the disabled and the elderly · *Kansei* method · Customization

1 Introduction

In the face of the demographic and social phenomena of the 21st century, related to the changes in the age structure of societies, the development of medical care and, even more importantly, the drive of the elderly and the disabled towards self-reliant and satisfactory lives, the creation of space devoid of any barriers has become an imperative of the modern architectural design. Adaptation of the surroundings to the needs of the users, who have diversified mobility impairments and high expectations related to their old age, is an important element of the therapy of accident victims and the disabled as well as the prolongation of self-reliance of the elderly.

The above-mentioned assumptions are viable thanks to the new inventive design of a modular cupboard with mobile internal units. The purpose of such a unique construction of this piece of furniture is to make the users able to optimally use the space available in the upper parts of the room. The aim of the project is to facilitate the kitchen work for the disabled, performing everyday tasks, and developing interest in cooking. The project meets the European principles of universal and inclusive design (Branowski and Zabłocki 2006).

2 Structure of the Study and Research Methods

The design of the modular cupboard allows for the most important achievements and stylistic trends in the modern architectural design and the public utility design, which include:

- popularization of electric drives that support the mobility of the pieces of furniture,
- employment of the remotely-controlled mechanisms,
- discrete interior design that employs the unobtrusive spatial solutions related to the physical impairment of the user,
- following the modern stylistic patterns and the universally accepted trends of the furniture design.

The above-mentioned achievements and stylistic trends have been defined through the literature research and the analysis of model solutions offered by the leading manufacturers of the kitchen furniture.

The paper consists of the three main elements:

- description of the inventive design, prepared on the ground of the literature research and the analysis of model solutions,
- analysis of the customization options of the modular cupboard frame,
- research including the assessment of the modular cupboard frame according to the *kansei* method.

3 Core of the Modular Cupboard Concept

Solutions employed in kitchens that are designed solely for the purpose of serving people without any disabilities significantly differ from those dedicated to the users with limited mobility, chiefly in the aspect of ergonomics related to the vertical accessibility zones. In case of the kitchens used by the elderly and the disabled, the vertical dimensions of the basic kitchen planes, that is the height of worktops and the height of wall cabinets, are designed individually.

The modular cupboard is aimed at enabling persons using a wheelchair or persons with a limited scope of manipulation movements convenient access and use of storage space located at higher levels of rooms which are usually inaccessible to them (Bonenberg A. 2013).

The invention solves the problems of storage space availability and it relates to persons with near-ground reach and manipulation zone resulting from anthropometric characteristics (e.g. low height of a person), the musculoskeletal system mobility (e.g. at older age) or motor disability (e.g. persons using a wheelchair). At the same time the piece of furniture enables traditional manner of use by persons with full motor skills.

The comfort of use both by disabled persons and able-bodied persons makes the piece of furniture meet the European standards of universal design (Figs. 1 and 2).

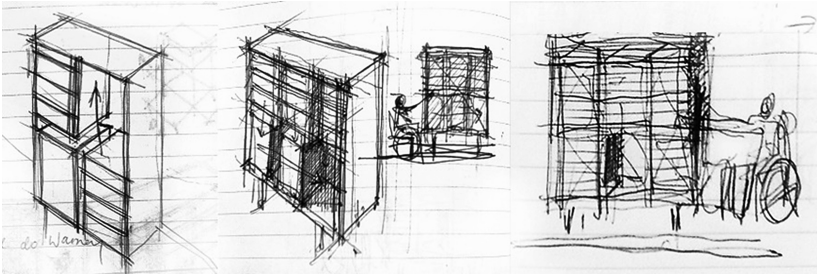


Fig. 1. Drawings presenting the preliminary concept of the modular cupboard [A. Bonenberg]

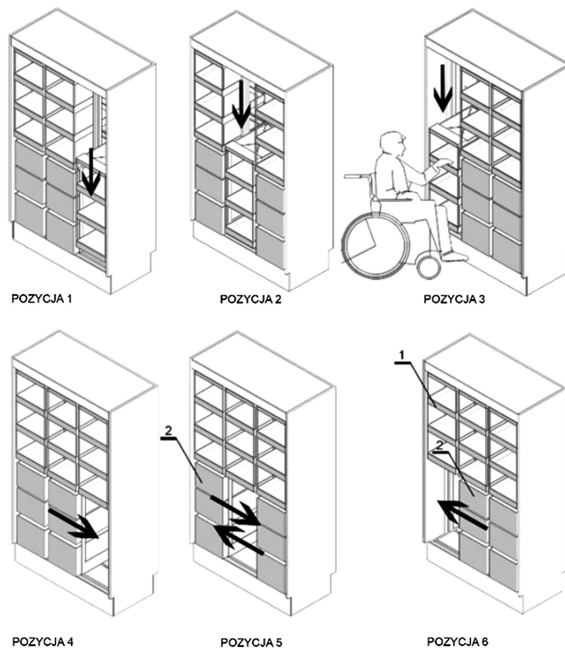


Fig. 2. Principles of operation for the modular cupboard. Six possible positions of the internal baskets. Positions 1, 2, 3 – upper baskets have been pulled down. [by A. Bonenberg]

4 Structure of the Modular Cupboard

In terms of its structure, the cupboard is comprised of two systems: the support-and-drive system and the protective system. The protective system is designed in accordance with the stylistic concept of the remaining furniture in the room and as a self-supporting element that remains independent from the support-and-drive system.

The design solution of the modular cupboard combines the technologies of the furniture industry (in terms of the protective system) and the technologies employed in the construction of machines with mechatronic drives (in the support-and-drive system). This provides comfort within the design and production. Separation of the protective system and the support-and-drive system is simultaneously the separation of the aesthetics, which is consistent with the remaining furniture in the room, and the functionality. This way it is possible to apply the universal support-and-drive system in a number of external structures of the kitchen furniture.

The modular cupboard contains two levels of storage modules where the availability of upper modules is ensured owing to the possibility of sliding them to the lower level. The movement is supported with the electric drive and mechatronic control. Modules may be equipped with shelves, drawers, cabinets or pull-out cargo type elements.

Modules are placed in skew drive system socket at two levels and the total number of skew drive sockets is even $n > 2$. In the upper level $n/2$ modules are placed and in the lower level the number of modules amounts to $(n/2)-1$. Whereas the upper level modules slide vertically, lower level modules slide horizontally. Along with the increase in the n number, the degree of the use of the cupboard usable area is increasing. Lower level storage modules may only move horizontally, to strictly defined positions, leaving one socket space free. The upper level storage module can easily move into this space (Figs. 3 and 4).

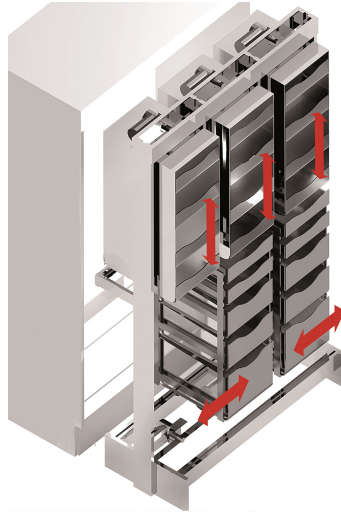


Fig. 3. Support-and-drive system of the modular cupboard. [by A. Bonenberg]

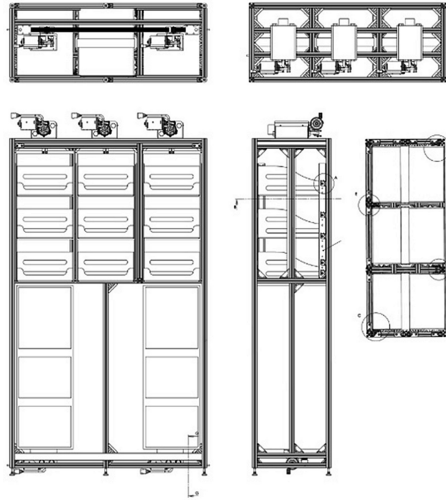


Fig. 4. Support-and-drive system of the modular cupboard. [by S. Głowała]

The construction of the modular cupboard has been awarded with prestigious prizes: the gold medal at the INPEX exposition in the USA (Pittsburgh) and the gold medal at the European EUROINVENT exposition. The question of further development of the product has been brought into the spotlight. The patented system of mobile units constitutes the ground for further development while the next step should be the decision concerning the frame of the cupboard that would exhibit its values and render it attractive for its future users. The decisions taken in terms of the industrial design were based on two research methods:

- analysis of the mass customization options of the modular cupboard frame,
- assessment of the proposed visualizations of the modular cupboard frame according to the *kansei* method.

5 Analysis of the Mass Customization Options of the Modular Cupboard Frame

The separation of the support-and-drive system and the protective system enables the designers to match the frame of the cupboard to any existing set of furniture. The popular strategy of adapting the product to the individual user's needs is customization, which has become a standard feature of the industrial production (Bonenberg W. 2013). According to the studies¹, as many as 30 % of consumers would like to receive the

¹ The study has been conducted on a sample of 1000 customers who make their purchases online. Source: Forbes, access on 06.11.2013. (<http://www.forbes.com/sites/baininsights/2013/11/05>).

individually prepared offers that reflect their own needs. The process of co-designing is the attractive element of this phenomenon: the development of modular solutions, flexible technologies and production methods. The author’s systematics showing the stages of customizing the product to the needs of the user has been based on the functional customization, size and measures customization, and the aesthetical customization (Fig. 5). The diagram distinguishes the product customization at the stage of the industrial production and the changes applied to the product directly by the user.

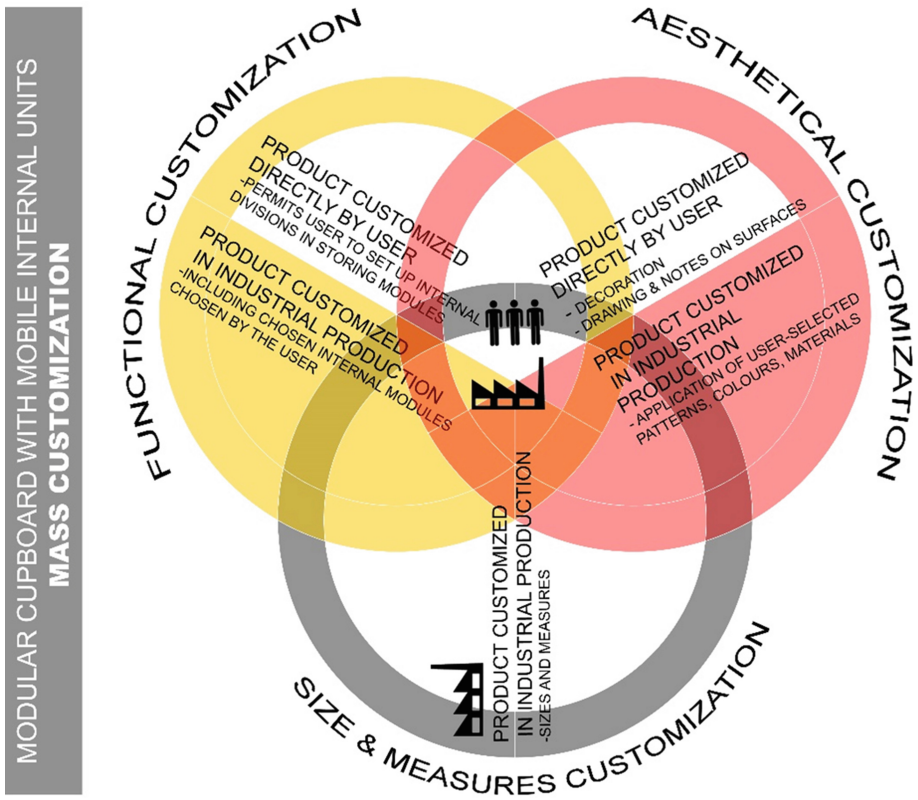


Fig. 5. The diagram showing the author’s systematics of the mass customization processes in designing the modular cupboard. [by A. Bonenberg].

In case of the modular cupboard, the customization is carried out at the functional level which can be personalized on the user’s request both at the stage of the industrial production and personally by the user (secondary partition of the space available in drawers and cabinets, which determines the position of tools and products stored inside the cupboard). The customization of the size and measures can be undertaken only at the stage of the industrial production whereas the aesthetical customization of the

modular cupboard is possible both during the industrial production and directly by the user. Two solutions in terms of the modular cupboard frame has been suggested: a high-tech solution with the front made of the polycarbonate resin and aluminum and a traditional one that employs a bended and lacquered MDF (Fig. 6).

6 *Kansei* Method in the Selection of the Modular Cupboard Frame

In case of the mass customization in the furniture industry, the manufacturer is required to offer a large number of available finishes, functional solutions, and sizes while the customer often faces a difficult decision in terms of choosing the optimal solution.

Thanks to the *kansei* method (Nagamachi 2011; Mori 2002), it is possible to examine the feelings of potential users towards the studied object. This method allows for a human factor in the assessment of a given project, that is the emotions and feelings which usually slip out from the fully measurable assessments, e.g. functioning of the device. The basic purpose of employing the *kansei* method is to limit the number of design variants of the furniture without the risk of reducing the attractiveness of the offer. It is possible to predict the decision of the customer. Therefore, it is crucial to maintain proper balance between the diversification of the offer and the number of options available to the customer. *Kansei* is the method of creating the product value and consists in the statistical examination of the interrelation between the customer's feelings and the product's measurable features. The reduction of the number of available variants of the product constitutes the reason for which the manufacturers attempt to understand the stimulus responsible for the customer's satisfaction.

The applied research method is based on seven consecutive stages:

1. Defining the scope and aim of the research.
2. Appointing 20 competent judges (the expert method).
3. Determining the criteria to describe the product (in form of a semantic differential).
4. Determining the criteria weight by comparison in pairs and standardizing the extreme values (the expert method).
5. Conducting surveys.
6. Averaging out the expert assessments of the furniture and hierarchizing the results.
7. Conclusions.

The purpose of the research is the selection of a final solution from among a high-tech solution with the front made of the polycarbonate resin and aluminum and a traditional one that employs a bended and lacquered MDF. Thus, the scope of the research embraces two suggested design proposals.

20 competent judges, aged 41–68, were appointed and then the criteria describing the product were formulated in the form of a semantic differential. The concepts included in the table are related to the reception and associations evoked in the judges by the presented modular cupboard frames. The assessment was based on a five-point grading scale (Table 1).

Then, the criteria weight was determined by comparison in pairs and the extreme values were standardized (Tables 2 and 3).

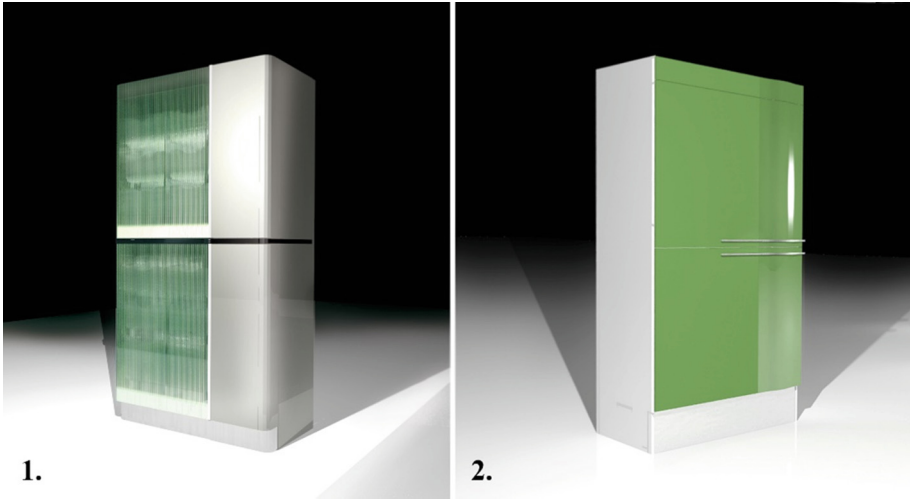


Fig. 6. Comparison of a high-tech solution with the front made of the polycarbonate resin and aluminum and a traditional one that employs a bended and lacquered MDF. [by A. Bonenberg].

Table 1. Semantic differential [by A. Bonenberg]

CRITERIA	CONCEPTS
K1 COMPLEXITY	(complex ↔ simple)
K2 MODERNITY	(modern ↔ traditional)
K3 UNIQUENESS	(original ↔ common)
K4 INNOVATIVENESS	(innovative ↔ imitative)
K5 INTEREST	(interesting ↔ boring)
K6 DANGER	(safe ↔ dangerous)
K7 USABILITY	(multi-functional ↔ mono-functional)
K8 INDUCTION OF EMOTIONS	(emotion-inducing ↔ neutral)

Table 2. Summary table of the averaged-out assessments of the furniture provided by 20 competent judges. [by A. Bonenberg].

CRITERIA and CONCEPTS	FRAME 1	FRAME 2
K1 COMPLEXITY (complex ↔ simple)	5.5	1.8
K2 MODERNITY (modern ↔ traditional)	6.7	4.5
K3 UNIQUENESS (original ↔ common)	3.4	3.3
K4 INNOVATIVENESS (innovative ↔ imitative)	5.6	3.8
K5 INTEREST (interesting ↔ boring)	7.5	6.9
K6 DANGER (safe ↔ dangerous)	3.9	6.8
K7 USABILITY (multi-functional ↔ mono-functional)	4.5	4.8
K8 INDUCTION OF EMOTIONS (emotion-inducing ↔ neutral)	8.2	6.7

Table 3. Summary table of the averaged-out and hierarchized assessments of the furniture provided by 20 competent judges. [by A. Bonenberg].

CRITERIA	FRAME 1		FRAME 2	
K1 COMPLEXITY	5.5×0	0.1	1.8×0.1	0.18
K2 MODERNITY	6.7×1	6.7	4.5×1	4.5
K3 UNIQUENESS	3.4×1	3.4	3.3×1	3.3
K4 INNOVATIVENESS	5.6×0.78	4.4	3.8×0.78	3.0
K5 INTEREST	7.5×0.71	5.3	6.9×0.71	4.9
K6 DANGER	3.9×0.14	0.5	6.8×0.14	1.0
K7 USABILITY	4.5×0.5	2.3	4.8×0.5	2.4
K8 INDUCTION OF EMOTIONS	8.2×0.07	0.6	6.7×0.07	0.5
		Σ 23.2		Σ 19.28

After summing up the score, it becomes noticeable that the first variant (FRAME 1) with a high-tech stylistic design is preferred among the group of 20 judges.

7 Summary

The design and aesthetics of the product constitute crucial elements of the adaptation of the surroundings to the needs of the elderly and the disabled. The furniture dedicated to this target group may be modeled in a futuristic pattern since this way it does not evoke associations with the restrictions caused by the disability and the old age. On the contrary, it remains attractive and draws attention. The frame of the modular cupboard that was chosen by the group of judges only confirms this thesis. Despite their advanced age, the group of 20 competent judges found the modern high-tech design more attractive. Such a result was unexpected since this age group is commonly considered to be strongly attached to the traditional design of the furniture.

Adaptation of the surroundings to the needs of the users with mobility impairments constitutes a crucial element of improving life quality for the accident victims and the disabled as well as of prolonging self-reliance of the elderly. In the face of the demographic and social phenomena of the 21st century, related to the changes in the age structure of societies and the development of medical care, seeking solutions that employ the principles of universal and inclusive design becomes the necessity. The proposed construction of the modular cupboard provides a step towards the available space.

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