STRATEGY FOR THE DEVELOPMENT OF ASSISTIVE ENVIRONMENTS BASED ON GERIATRIC ASSESSMENT

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ABSTRACT: In this paper we present a systematic method for the development of assistive environments based on geriatric assessment. The method is based on the assumption, that geriatric assessment can be used to describe scenarios and peoples individual skills and disabilities. To counterbalance disabilities and disorders and to bring people back to a state of skills which allows them to live self-sustained at home, sets of assistance methods and assistance technologies are bundled to form a distinctively planned living environment. In a first step a typology is defined, which is assumed to suit best for ascertain use case, secondly the typology is upgraded with useful functionalities from other typologies. In a third step the thus defined basic system is customized further through the integration of various active and passive subsystems.

***Keywords**: Demografic Change, Geriatric Assessment, Service Robotics*

1. INTRODUCTION

Based on the fact that the society is exposed to a demographic change, long-term changes of the surroundings become unavoidable. These concern, above all, the adaptation to the everyday courses of action. Every person depends on food supply and spends nearly 30% of his day in the kitchen. On this occasion, the preparation of food in the kitchen plays an important role. The rhythm of eating (morning, noon, evening) divides the daily routine into single areas (sleep, work, spare time). Since the kitchen belongs to the most complicated systems in the household and plays a high-priority role in the everyday life of a person, it is analyzed and stereotyped in the following chapters.

2. APPROACH

The health restrictions of older growing people can be divided into the following groups:

1. Sensorial restrictions: - Lack of eyesight - Lack of hearing ability - Limited olfactory organ	*2. Motoric restrictions:* - Lack of body mobility - Lack of skill - Lack of coordination
3. Social restrictions: - Lack of communication ability - Lack of motivation - Lack of personal hygiene	*4. Cognitive restrictions:* - Losses of memory - Problems with speaking and concentration
5. Mental restrictions: - Timidity - Depressions	*6. Somatic restrictions:* - Physical and organic complaints

For each of the problems there are several solution approaches or at least possibilities to ease the everyday courses of action. The everyday life can be simplified, for example, for a person with a visual impairment (sensorial restriction) by an easy route guidance, stepless accessibility, high-contrast composition etc., also for a person with concentration and commemorative loss (cognitive restriction). Additionally, one can help people with cognitive restrictions in everyday life by a good sign-posting. The single architectural actions to be taken are proving advantageous to different groups of persons.

2.1 Linking of Use Cases and Assistive Systems

Particularly older people often become not only affected by one “disturbance“ or illness, but often several “disturbances“ occur at the same time. This consilience is also called multimorbidity [2]. A concurrent consilience of different disturbances can strengthen single clinical pictures or/and generate completely new ones. Most assistance systems with AAL-relevant technologies are able to counteract one or two of the abovementioned disturbances. Therefore, residential surroundings must be constructed for encouraging a flexible integrating and

cooperation of different assistive systems and of architectural, constructional actions to be taken, services and relatives/assistants. To be able to make the planning of comprehensively built up AAL-surroundings more efficiently, a system with the AAL-technology was analyzed and built up by the authors in order to be able to counteract certain restrictions. Thus it should become possible for planners of AAL-surroundings to receive proposals for assistive systems or sets of assistive systems by a database, which can be integrated as subsystem into residential surroundings in order to support certain cases of need.

2.2 Description of Use Cases by Geriatric Assessment

To diagnose the abovementioned health restrictions, there are different possibilities. The medical study group for the support of the geriatrics in Bavaria e. V. (AFGiB), for instance, worked out proposals and test procedures to win new hints for the further therapy-, theory- and care planning. But other experts and authors are also already dealing intensely with the description of cases of need by geriatric assessment [3]. Organ-medical, cognitive mental, psychic, social and surroundings-related dimensions in the works of old and multimorbid patients belong, among other things, to the described restrictions on this occasion. Immobility, incontinence, nutrition problems, confusion, decubitus, social problems and care problems are standing in the center of the therapy. The following procedures, for instance, were compiled by the AFGiB [4] with different degrees of difficulty for testing purposes:

- Screening by Lachs
- Barthel Index
- Timed Up and Go
- Geriatric Depression Scale
- MMSE
- Demtect
- Clock Sign Test
- MNA (Mini Nutritional Assessment)

The first serves almost solely for the identification of geriatric patients. It offers the basis for the choice of other assessment procedures. The second procedure concerns an already widespread standard procedure for the appraisal of everyday activities and for the assessment of rehabilitation processes. The third procedure assesses the mobility of the patients. The Geriatric Depression Scale concerns the emotional needs and tests the level of contentment of the patients with possible hints of depressions. The further tests MMSE and the DemTect procedure check the patients for their powers of recollection and demand the memory with tricky brainteasers. The Clocks Sign Test gives information about the stage of the dementia. The last procedure tests the patients for right nutrition and the food admission without any help (MNA). [3]

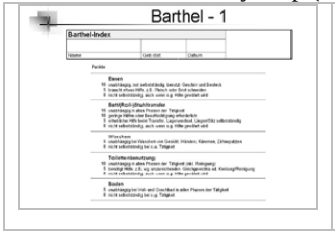


Fig. 1 Assessment process: Barthel Index.

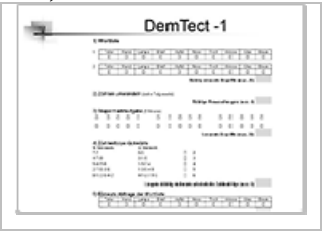


Fig. 2 Assessment process: DemTect.

2.3 Logistics Strategy

An analogy exists between the processes in the kitchen and in the industrial logistic systems. Every logistic system is marked by the teamwork of movement- and memory processes. It is divided into performance phases, which are reflected in different subsystems: The first serves almost solely for the identification of geriatric patients. It offers the basis for the choice of other assessment procedures. The second procedure concerns an already widespread standard procedure for the appraisal of everyday activities and for the assessment of rehabilitation processes. The third procedure assesses the mobility of the patients. The Geriatric Depression Scale concerns the emotional needs and tests the level of contentment of the patients with possible hints of depressions. The further tests MMSE and the DemTect procedure check the patients for their powers of recollection and demand the memory with tricky brainteasers. The Clocks Sign Test gives information about the stage of the dementia. The last procedure tests the patients for right nu-trition and the food admission without any help (MNA). [3]

- Purveyance logistics
- Production logistics
- Distribution logistics
- Disposal logistics

The single subsystems or phases are related to each other. Each of the subsystems is subordinated to the overall system, but is also an independent logistic system at the same time. In many approaches this cycle can be taken over in the processes of a kitchen. A comprehensive consideration of the single steps or phases is necessary for achieving a good “overall result“, which is, in this case, the food supply.

2.4 Process Strategy

A good example of logistically mature work routines is the fast food chain Mc Donalds: Only one single supplier's company - namely Havi Logistics - supplies Mc Donalds with all required products and utensils. For instance, Havi Logistics sources the chips of the company Mc Cain and various drinks of Coca Cola and then supplies the several fast food chains. Therefore not only Mc Donalds profits from the logistically easy distribution. Mc Donalds makes all orders at Havi Logistics, what is even more simplified by a direct order proposal with precast invoice. Actions of the fast food chain are even being made by automatic assignment of the product. This means money and above all time saving. In future it shall be worked on the idea with which the supplier's company buys the warehouse and takes therefore fast food chain’s work, which has to do with food purveyance and storage. Besides everything is organized so that the food, drinks, packaging and all other required utensils are provided completely for the final processing or directly for the use. This simplifies the staff’s work considerably. The Mc Donalds kitchen is split in two areas, the grill-direct-side and the made-for-you-side. On that grill-direct-side the standard products are prepared on stock. Besides the meat is grilled ready for other dishes and it is provided for the subsequent treatment in the heated store cupboard. This cupboard can also be accesses by the made-for-you-side. As with an assembly-line manufacture, the kitchen is adapted to the respective work routines. These processes are taking place one after the other, timewise as well as spatially. An in-house technician provides the constant service of the machines. These optimized processes can be used as a role model for the new development of a culinary type.

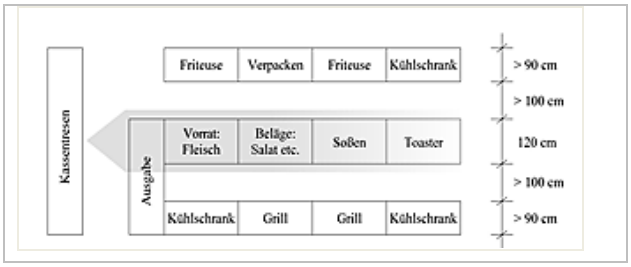


Fig. 3 Mc-Donalds kitchen: functional system for efficient processes.

3. PLANNING METHODOLOGY

Kitchens and the processes taking place in them play a central role concerning the maintenance of independence in an older age. With the help of the example kitchen, a planning method for AAL-surroundings was experimentally developed by the authors. The basic principles of this planning method are demonstrated in the following. By the consilience of different courses of action a complicated socio-technical system is created, in which functionality, logistics and process planning are playing a central role.

3.1 Description Levels

In the context of the development of a solution attempt for a kitchen, which reacts on these new, functional requirements of the today's aging society, a comprehensive analysis of culinary types was accomplished. During this analysis, in which the basic qualities of the kitchens were looked within the context of Ambient Assisted Living, seven basic types emerged. In the next step the single culinary types were compared to each other and valued due to their relevance in relation to cases of need. To be able to conduct the comparison of the single culinary typologies objectively, an assessment system was developed, which could be applied to each of the identified culinary types. The assessment system is divided into 4 levels:

Level 1

The first level concerns an arrangement of seven signs by which every kitchen is valued. The maximum score is 10 points. These are the signs, which have the following meaning:

- *Flexibility:* describes the changeable character of the kitchen; extensibility, variability, accessibility, approachability, interchangeability
- *Compactness:* describes whether the kitchen is space-saving and consistent
- *Clarity:* describes how fast and intuitive one can find his way in the kitchen
- *Use:* describes the possibility of the concurrent use of several features

- *Ergonomics:* describes the ergonomic adaptability of the kitchen to its operator
- *Logistics:* describes the interaction and organization of time and accessibility
- *Installation Procedure:* describes the degree of integrated technology and / or the made-to-measure

Level 2

The single kitchens are examined in relation of their possible user's groups. These are the following:

- *Junior:* youthful people
- *Adult:* adult people
- *Senior:* older people (not nursing-needy)
- *Spiritually Nursing-needy:* mentally restricted people
- *Physically Nursing-needy:* physically restricted people
- *Chronic Symptoms:* People suffering from a lasting illness

Level 3

The restrictions one tries to compensate with help of the kitchen.

- *Socially*
- *Physically*
- *Cognitive*
- *Psychically*

Level 4

A scale concerns the character of the kitchen:

- *Free Form:* describes the degree of the design claim of the kitchen
- *Function Form:* describes the degree of functionality of the kitchen

3.2 Definition of AAL-typologies

In the following the seven identified and within the context of Ambient Assisted Living usable culinary types will be described and explained by sketches.

3.2.1 Frankfurter Küche

„Frankfurter Küche“ counts as a foundation-stone of the development of the today's line kitchen. For the first time the run ways and work routines concerning the cooking were taken into consideration. It accommodates all features on minimum space. The main signs are clarity and thereby easy and intuitive use.

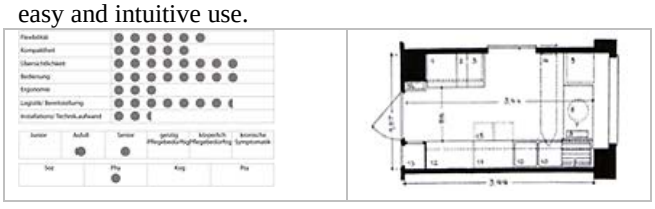


Fig. 4 „Frankfurter Küche“, [5]

3.2.2 High-Tech Kitchen

The working surroundings are made of a huge number of highly mechanized electronic machines. One assistance systems, for example, gives information about where which grocery and kitchen item is to find. Information is also given by the lighting. The high-tech kitchen has got a high technology- and installation effort, which leads to a high maintenance.

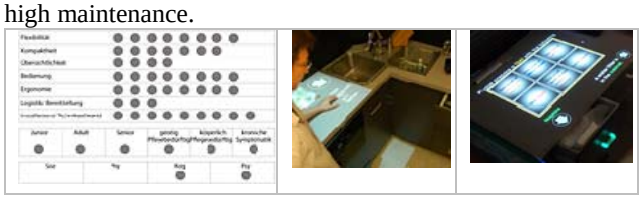


Fig. 5 Augmented Reality Kitchen, [6].

3.2.3 The Wall-Integrated Modular Kitchen

It is characterized by a very high compactness as well as a good clarity. Thus it is possible to freely put together the single elements, like with the module principle. Another advantage is that one can exchange single machines in time – due to the needs of the respective user.

Fig. 6 Wall-integrated Modular Kitchen, [18].

3.2.4 Culinary Cupboard

These kitchens are mobile and flexible, they are not stuck to its location. Thus it adapts to every surroundings. Besides, the order of the single machines is very compact and they can be exchanged and arranged individually. Furthermore, elements can be added beyond the firmly given frame, so that the kitchen is arbitrarily extendable.

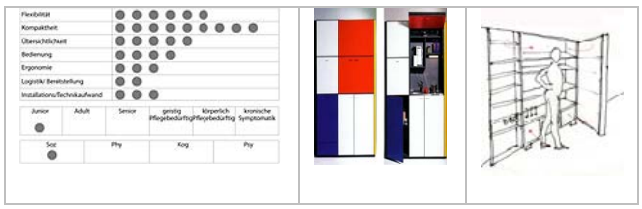


Fig. 7 “Culinary Cupboard”, [8].

3.2.5 Rotating Kitchen

With the rotating kitchen the whole working surface is swiveling around a concentric axis, so that the user can reach all features comfortably from a standing position or from a sitting position. The positioning of the kitchen is flexible; it can stand in the middle of space as well as in a corner or be integrated into a wall breakthrough. The base

of a round kitchen is substantially lower in comparison to a square one, but it is also reflected in the technology effort.

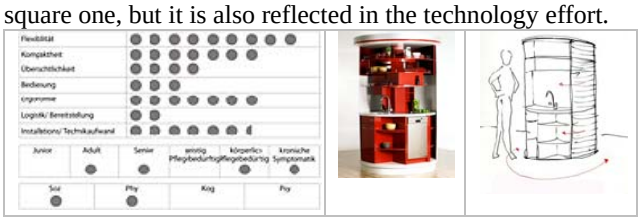


Fig. 8 “Rotating kitchen”, [19].

3.2.6 Elevator-like Kitchen

Elevator-like kitchens have all features, which are important for the culinary work, on a uniform and for the respective user pleasant height. Thus the single machines can be shifted and adapted to the needed height. This flexibility is very helpful especially for motorically limited persons.

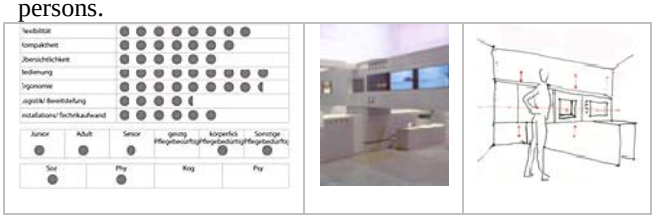


Fig. 9 “Elevator-like kitchen”, [20].

3.2.7 Cockpit Kitchen

“Cockpit kitchen” can be compared to the cockpit of an airplane regarding the order of the elements. All features and machines can be comfortably reached from a central position. This leads to a huge relief concerning the work routines. Besides the kitchen can be accessed from all sides, so that several users could work there at the same time.

Fig. 10 “Cockpit-kitchen”, [21].

3.3 Optimization by Combination of Qualities

According to the analysis and the assessment of the single kitchens it becomes clear that there is a relatively big range of features and possibilities, which ease the work routines in the kitchen. Through the combination of the single kitchens with each other, one can see whether the single culinary types are completing or hindering each other.

Combination of Rotating Kitchen and Elevator-like Kitchen	*Combination of Modular Kitchen Inte-grated and Wall and Kitchen Cupboard*
Flexibility ++ Compactness ++ Clarity ++ Use ++ Ergonomics ++ Logistics/Provision ++ Installation/Technology Effort ++	- Flexibility – - Compactness ++ - Clarity 0 - Use 0 - Ergonomics 0 - Logistics/Provision – - Installation-/Technology Effort ++
These two culinary systems can be brought together to a performance-stronger overall system.	By combining of these two culinary types a substantially worse system is created.

Cate-gory	Sub-Systems	Sub-Components
“Passive” Subsystems	*Building system*	Carrying structure
	Home automation	Water lines, Cables, Airing, …
	Fitting systems	Walls, Doors, Windows
	Surfaces	material, Color
“Aktive Subsystems”	*Mechatronics and Gerontological*	Lift systems etc.
	Microsystems technology	Sensor systems, Activity detection
	Portable and implantable systems	Sensors implanted in a T-shirt, the teeth etc.
	Smart home appliances	Refrigerator, Rotoflex-beds etc.
	User interfaces *Service Robotics*	Touchscreen, voice control etc. For example Robotic Bed Panasonic
	Mobility	Toyota i-swing, Toyota I-Unit, HAL Cyberdyne
	Platforms	IT platforms, monitoring/tracking systems, ambient Intelligence, proactivity
	Services	Care service, Home service, Supply with goods and information, Emergency call

Tab. 1: overview of different active and passive subsystems

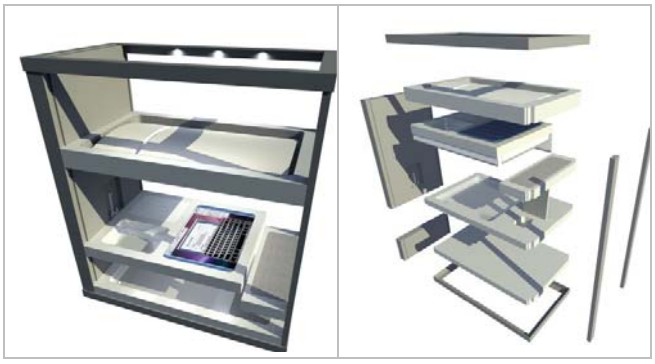
This knowledge is very important for the development of a kitchen, which contains all important systems and therefore simplifies the working surrounding of the person. Two possible combinations are shown in the table above (Assessment to explain how the single systems act in case of a combination: ++ = qualities are complementary, 0 = neither negative nor positive consequences, — = features of two kitchens are not compatible with each other).

3.4 Further Adaption by Integration of well-chosen Subsystems

After a culinary type was identified for certain cases of need and an optimization of this typology by the combination of qualities was conducted, the optimized type can be equipped with other subsystems in detail in the next step. Through this a specifically adaptation of the type to certain cases of need can be made. With a modular construction of the by the type given basic scaffold, it would be even possible to dynamically integrate subsystems over time or to extend again in order to react with the AAL-residential surroundings to changes of demand. Tab. 1 gives an overview of different subsystems.

4. CONCLUSION

To verify the suggested planning method, a kitchen was developed exemplarily for a given residential scenario and was simulated with the help of 3D CAD programs (Figs. 11). Firstly residential surrounding and case of need were described concerning the 4 consideration levels and identified due to the results of a geriatric assessment of the inhabitant. Afterwards the type „elevator-like kitchen“ was identified as suitable and extended by features of the „kitchen cupboard“ and of the „modular kitchen“. To guarantee high flexibility, the kitchen was made transportable. This way, additional subsystems and features can be integrated according to the demand of adaption. The idea of the type is an adaptable arrangement of the kitchen. Due to the modular system, subsystems can be put together. Therefore a vertical movement allows an uncomplicated use on arm height. The purpose of this concept was also to develop a culinary system with the possibility of serial manufacture.



Figs. 11 Optimization of a type of kitchen. Left: Total system. Right: modular, division into modules.

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