

CONCEPT AND EVALUATION METHODOLOGY OF ADJUSTABLE TOILETS FOR OLD PERSONS AND PEOPLE WITH DISABILITIES

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Abstract: This paper describes research activities carried out while developing innovative toilet systems which are able to adjust themselves according to the individual needs of disabled and older people. The EU funded Friendly Rest Room (FRR) project has followed a user centred and a user driven research approach in order to develop and evaluate several toilet prototypes which support disabled persons and older people with functional limitations during toileting. This paper focuses on the concept development and on the evaluation methodology. Beside laboratory tests a field trial with one of the height and tilt adjustable toilet systems was carried out in day care centre. It resulted in a satisfaction rate of 82.3% (N=20). The paper also gives an outlook to the commercialisation of the prototypes and further research activities to improve quality of life.

Introduction and Aim

Despite the fact that most of us are using toilet facilities several times a day most of today's toilets in Europe do not meet the actual needs of users, especially of those with functional impairments. A study [3] has outlined the severe limitations in old persons' life due to current lack of toilets which satisfy the needs of old persons and disabled persons (see Fig.1). The aim of this paper is twofold: (a) to outline a concept for new adjustable toilets using state of the art technology and (b) to describe a methodology how to carry out its evaluation in a user centred way.

High Needs from Users

As part of the user needs research design, a quantitative study was conducted in several European countries. More than 320 persons answered a questionnaire that combined questions on problems with technical equipment with questions concerned with the social and societal consequences of these problems. So far, no comparable study has been conducted [3].

Amongst others, one objective of this study was to assess the extent to which the lack of adequate toilet facilities influences the quality of life of the target population. As displayed in Fig.1, the results speak a clear language: 36.1% of the respondents cannot

(12.7%) or hardly can (23.4%) leave home due to the fact that adequate toilet facilities simply are not available in the public or semi-public area. This fact forces them to stay at home instead of participating in societal life, and thus affects their quality of life in a massively negative manner. In a sociological perspective, these individuals are in risk of marginalization.

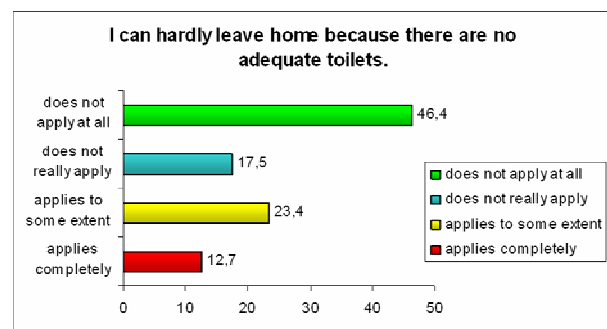


Figure 1: Results from FRR questionnaires (N=323) [3]

Consequently, the approval towards new solutions is rather high: About 60% stated that having user-friendly toilets installed in public areas would very much improve their every day life.

Concept

In the framework of the EU funded Friendly Rest Room (FRR) project [24, 10, 8, 23] a user driven approach was followed. After establishment of user boards [11] focus groups, expert interviews and computer based interviews [18] were organised and case studies [28] were carried out. During concept development different areas inside the toilet room were identified: (a) access area, (b) transfer area and (c) toilet area [10]. Analysing the activities carried out during toileting several issues where improvements are needed were found [10]: Transferring including standing up and sitting down, supports, balance, dressing and undressing, hygiene, danger of falls [27], support for visually impaired users [9], reaching [17] etc.

Five iterative toilet prototypes were built and intensively evaluated in the framework of the Friendly Rest Room project. Based on the results the following

main parts of a concept for a new type of adjustable toilet are proposed:

Control Unit: For monitoring user's activities and for controlling the interaction between the different toilet sub modules. Currently it is based on a PC platform running Microsoft WindowsXP as operating system and dedicated steering hardware and software [22]. For a commercial product an embedded system will be used instead of the standard PC. The control unit is also connected to various sensors which are integrated in the toilet system.

Toilet seat, bowl and grab bars which can be adjusted in height and tilt via actuators controlled by the control unit and/or manually according to the users' individual preferences. Adjustability of the geometric properties allows meeting the different anthropometric needs and preferences of the user [17, 4].

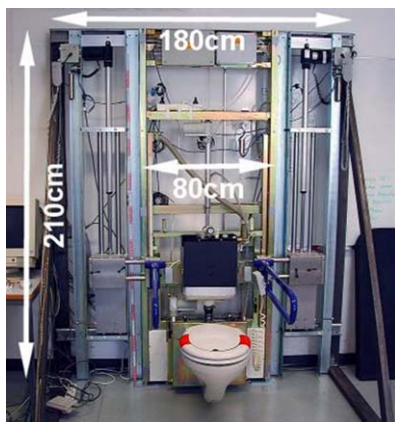


Figure 2: Early prototype tested in laboratory setting

Sensors for measuring positions, to recognise falls, to estimate intention of the user (e.g. his / her intention to stand up - in this case the toilet can assist if wished by the user by moving into a higher position). Sensors for fall recognition (e.g. work reported by Sixsmith et al. [2]) are of high importance but should be seen as a tool complementary to a design which implicitly is aiming at *prevention of falls* (e.g. work of Buzink et al. reported in [27]).

Voice control: e.g. acting as "third" hand of carer. This part of the concept allows to steer the toilet via voice of the user or voice of the care person which is of particular usefulness when all hands are busy (e.g. during transfer process).

Voice output: This feature enables the toilet to inform the user about current status of system, about activities which will just start or which have been completed. This part of the concept allows a very basic way of prompting which might be useful as part of a cognitive orthosis; see e.g. [15].

Smart cards based on RFID (Radio Frequency identification) technology for saving and recalling personal preferences – e.g. the toilet is able to move into the preferred position automatically while the persons is entering the toilet room [22]. This is a major part of the toilet concept as it allows an automatic adaptation of the toilet system, including activation or deactivation of

optional features (voice control on/off, alarm sensor on/off, native language to control the voice input and for voice output, etc.). The smart card also can be used as entrance key as e.g. the traditional European key [6]. An important advantage is the contact-less way the RFID technology is working. The user does not need to manipulate the smart card; he / she just need to have it in the purse or pocket.



Figure 3: Transfer procedure during a lab test



Figure 4: Prototype with extended seat, grab bars and ultra sonic distance sensor behind the user's back.

Additional Assistive Features: are covering issues like: support for visually impaired users (contrast of colours, level of illumination [9]), hygiene / cleaning of toilet and of user (e.g. hand washing when sitting on the toilet [4]), dressing / undressing, space for storing personal belongings.

Evaluation

The FRR project applied a cyclic approach to development. Five prototype generations were tested in different settings. As it was the case with the user needs research design, the FRR project applied a multi-methodical approach in the evaluation phases [11]. Based on the principles of triangulation [5], several methods and data sources were combined in order to investigate the phenomenon from different perspectives and thus get a global and comprehensive picture of it. Beneath methods of qualitative research like participant observation and open interviews, quantifying methods concerned with the usability of proposed solutions and established tools of assistive technology outcome measurement were applied. Together with an ethical review team [12, 13], the project partners invested considerable effort in establishing a research setting that combines ethical and methodological concerns in a way

that is not intrusive and meets ethical conditions as well as scientific requirements. Especially in the context of toileting, privacy issues and the related ethical concerns build a framework crucial for the success of the research activity.



Figure 5: Final prototypes in laboratory (left) and in real life evaluation in a day care centre (right)

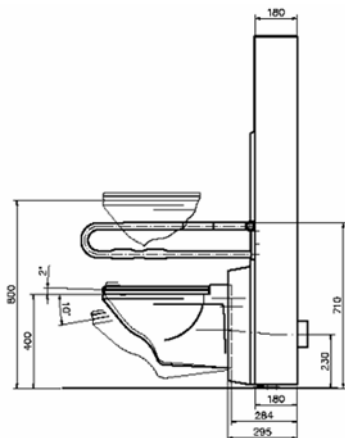


Figure 6: Base module of the toilet system; provides adjustability of height and tilt of bowl [1]

In the final stage of the development process, a prototype was installed in a day centre for patients with multiple sclerosis in Vienna. There, the system was tested in a setting as close to real life as possible (Fig.5). After seven weeks of evaluation, the guests of the day centre evaluated the prototype very positive [16, 19, 25]. A questionnaire based on the known outcome measurement tool QUEST 2.0 [29] resulted in an overall satisfaction rate of 82.3% (N=20).

Discussion and Outlook

Based on the successful completion of the user evaluation phase in laboratory and in real life setting a basic commercial version is being developed by Clean Solution Kft. [14]. A modular approach envisages a base module which provides the tilt and height adjustability of the toilet bowl (Fig.6) and several additional modules which can be added optional. Examples of the optional modules are an extended seat (Fig.7, Fig.8), user identification module, voice control module, etc.

Further research is proposed to be done particular in areas like e.g. fall prevention [27] and fall recognition [2], cognitive support for persons with dementia [15], embedding the user interface of the toilet into the environment.



Figure 7: Computer drawing of upcoming product version

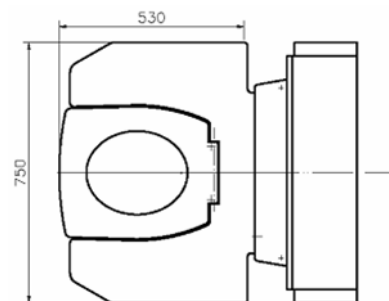


Figure 8: Extended seat for providing support for transfer and increasing stability

Conclusions

Work until now has shown the high need for toilets which are better suited for meeting the needs of old persons and disabled persons. Toilet facilities in private and public places presently do not fit for the specific needs of many old persons with physical and cognitive limitations. Many European citizens currently do have to cope with toilet facilities in their environment which are clearly not meeting their individual needs.

It could be shown that innovative toilet concepts can deliver technically feasible and well accepted prototypes of more user friendly toilets. This new type of toilet is able to adjust itself to the individual needs of older persons with functional limitations and to the needs of people with disabilities, allowing them to gain greater autonomy, independence, self-esteem, dignity, safety, improved self-care and therefore enable them to enjoy a better quality of life. A first product version comprising of the base toilet module is being produced by Clean Solution Kft. to enter European market by end of year 2005. The successful user driven research approach needs to be continued to cover some of the questions still open, e.g. the provision of cognitive support to users with dementia.

More information: <http://www.frr-consortium.org> and <http://www.fortec.tuwien.ac.at/frr>

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