1 INTRODUCTION

We are in times of a dramatic demographic change in western cultures (Walla et al, 2006). Visible in Japan and elsewhere, this is really nothing new to product design considerations. For decades, product developers have been taking some kind of user-centred design into account, whereas other parameters such as 'design for manufacture', 'design for costing' or, more recently, 'design for recyclability' or 'design for sustainability' (also known as 'design for X') were superficial (Steinfeld & Smith, 2012). Acting in those areas, we often tend to forget for whom we are really creating products. However, within the shift of dominant generations, the elderly show us that the user's demands have to be our overall, primary goal.

As the living standards of our societies are constantly improving, equally the demand for independent living and individuality is rising across all generations. It is no longer an individual's quest to be able to take part in everyday living and be integrated into society, but rather the other way around. Our living environment is obliged to allow us to be different. Whereas at first glance most of us are thinking of healthy people striving for self-fulfilment, those of us who unwillingly have different abilities and needs due to competence shifts are even more affected. In the field of product development, it is not all about product design in the narrow sense any more. On the contrary, it is an understanding of how products serve people of any generation and ability in the same manner. Products shall be created to fulfil their individual needs and wishes and to be able to choose their own lifestyle.

In dealing with the claim for a stronger integration of people with all their kinds of abilities and needs, user-centred approaches in product development need to be better established. User-centred methodologies are often still rejected in practice as they implicate big changes in current design routines. Furthermore, they are often left unused due to time and money constraints (Goodman-Deane et al, 2009).

Thus, the present work proposes a framework of reliable user-centred design integration into popular product development practice. This discourse focuses on universal design (UD). UD strategy attempts to meet the needs of all kinds of users with all their manifold needs in a 'one for all' product design. Figure 1 shows the overall research work plan that will be processed in this field to better perceive UD in design practice.

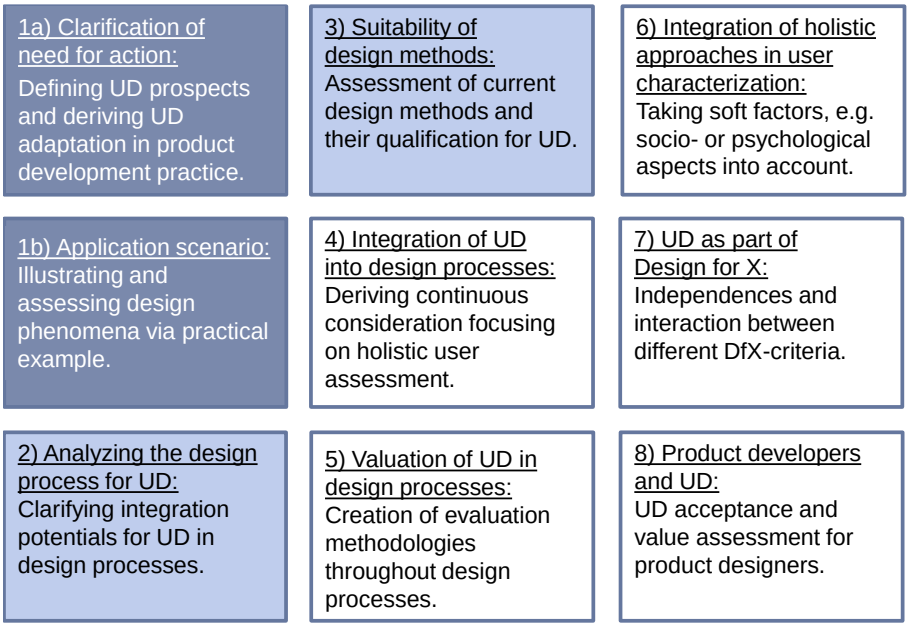


Figure 1: Fields of activity for UD integration in product development

Within this paper, we are mainly focusing on the upper left corner of the landscape for a first assessment (see coloured boxes). A closer look shows that UD needs more shaping to be truly adaptable for the development process in an ex-ante and accompanying way. The core question is how to overcome and how to assess the combination of both design methodology and user-centred

strategies. In particular, the continuous consideration of different users throughout the whole process has to be met. Until now, common development practice promotes user consideration once in the requirements list. This normally happens at the very beginning of the product development process, and then the developer sticks to this information. Additionally, there is hardly any product developer's integration in the user characterization process which is commonly carried out by third parties (e.g. marketing). Facing this, it seems to be quite obvious that this does not always lead to an adequate result. It becomes even more challenging to introduce UD when the user's needs cannot always be defined precisely. To support an improved UD integration, product development processes need elements for regular check-ups (see Figure 2). Within this paper, suggestions for how to realize the robust control circuits illustrated will be given conceptually. Therefore, selected creativity methods from the early stages of the product development process and their respective adaptations will be exemplarily treated. To have an appropriate application scenario from the very first moment, an example is proposed. Thus this paper contributes to an improved practicability of UD throughout established product development processes.

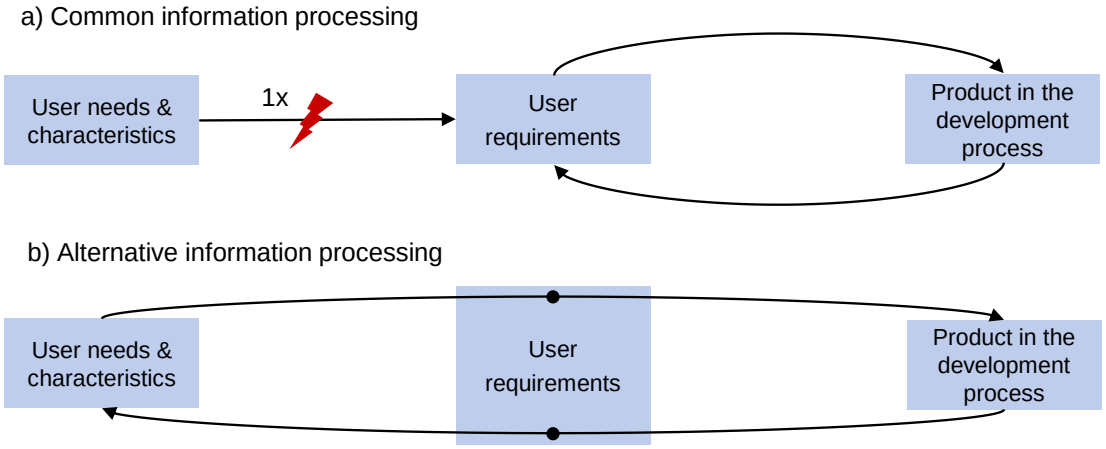


Figure 2: Common (a) and improved continuous Information processing (b) throughout product development processes

2 THE STRATEGY OF UNIVERSAL DESIGN, ITS OPPORTUNITIES AND LIMITATIONS

UD initially occurred more than a century ago. Even though it was not yet called UD (or design for all, inclusive design, lifespan design or human-centred design), the first thoughts arose (Catanese, 2009). As our healthcare system has been improving and life expectancy has mainly been increasing since the early 20th century, more than 17% of Europeans are now at least 65 years old (Stula, 2012). One hundred years ago, living with chronic disease was much harder and often entailed living and ending up in special institutions. On the contrary now it is estimated that, for instance, almost every tenth European citizen has a status of severe disability, but still remains widely self-independent in daily life (Eurostat, 2013). So the demographic change, increasing aid for living with disability and even more circumstances such as several equal rights movements led to a better acceptance of diversity in the population. The demand for equal rights in all areas of life and integral accessibility arose. Hence a strategy was born to respect all different kinds of needs. Mainly dealing with physical barriers in the first instance, the approach nowadays is to try to compensate or provide support for all kinds of first-degree disabilities (e.g. sensory, motor and cognitive). Instead of differentiating people due to their abilities, a holistic approach is envisaged, trying to meet the needs of people of all ages and abilities in one design (Catanese, 2009).

Seven principles describing UD strategy were formulated by a working group of architects, product designers, engineers and environmental design researchers led by the late Ronald Mace at North Carolina State University. Those principles, including guiding phrases like 'Equitable Use' (Principle One) or 'Simple and Intuitive Use' (Principle Three), are meant to be set as guidelines for a wide range of design disciplines. Hence UD is not initially treated to be a rule-based design process (Steinfeld & Smith, 2012). In the field of product design, its very open and broad guidelines for products being

adaptive to every different assistance expectation are not yet sufficient to support the product developer's work due to its generic character.

2.1 Current works on universal design

Nowadays, scientific findings on UD are basically focused on physiological and cognitive inclusion. Therefore, 'the weakest' of our society are still often the decisive objects of UD theories (e.g. Raviselvam et al, 2014). As one of the most important drivers in methodological use is perceptible benefit, many researchers already focus on design practicability. As stated by Vanderheiden and Tobias (2000), a major step is how to find and use key internal and external factors to increase UD usage in industrial environments. Still the amount of benefit for the company itself in introducing UD is not sufficiently communicated.

During the last few decades, there has been work on ease of use in UD evaluation. To value design exclusion, for instance, the 'exclusion calculator' by Clarkson (2007) proposes a first assessment for a product's inclusivity based on statistical data. In addition, many guidelines such as Biermann and Weissmantel (1995) or ISO-Standards like ISO 941-210 (2010) address product usability and thus UD strategy in product usage related decision making.

Work on this field has already improved design practicability and its value perception in many areas. But much work is still needed to prove its value to decision makers (e.g. treated in Mieczakowski et al, 2013) and to capture the universality of products in a more holistic way. As current principles have mainly focused on physical and cognitive impairments until now, there is a demand for an enhanced picture of the user including social, cultural or personal characteristics. Some studies have already been carried out in this field (e.g. Bichard et al, 2007).

2.2 Challenges of universal design arising in product development processes

As explained before, UD is a strategic approach to integrate people with all kinds of abilities and backgrounds. It promotes the creation of an environment that minimizes and eliminates barriers and stigmatization in everyday life, be it from an architectural, a product engineer's or anyone else's perspective. It is meant to inspire and to serve as many experts from all kinds of professions as possible. Due to the holistic approach of UD, detailed guidance for each special discipline is rather difficult to derive. Focusing on product design, so far there is not sufficient integration into the systematic product development process (Steinfeld & Smith, 2012; Scheuer, 2011).

In most of the literature dealing with UD approaches in product design, strategy is more based on best practice cases such as the example of German public transport illustrated in Figure 3. In this case, easy train access allows wheelchair users to stay independently mobile when taking local traffic services. Over and above this, it also serves others like people with pushchairs or cyclists; even regular passengers without any luggage benefit from the convenient train entrances in the same manner.

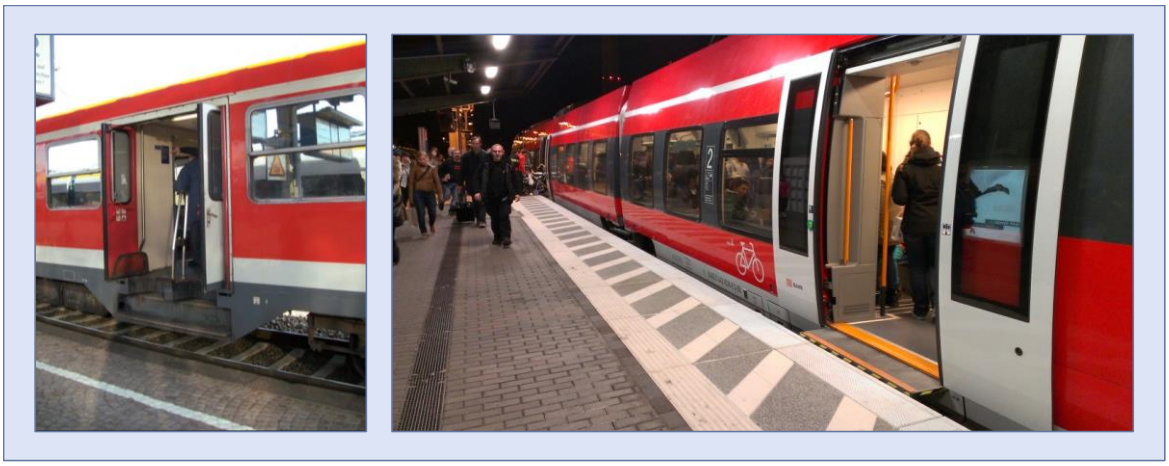


Figure 3: Train boarding – accessibility without (left) or with (right) UD content

Looking at this example, it is mainly a post perspective view issuing successful realization of UD in product design. Without explanations of how to achieve UD in a systematic way from the very first moment of the design process, designers still seem to inadvertently meet UD principles (see recent

example) in some cases whereas in other cases, not. Though there are several guidelines for design strategies taking particular users into account (e.g. the SENSI-catalogue, a guideline for designing products for seniors, Biermann & Weissmantel, 1995), there is hardly any instruction given on how to integrate general UD into the product development process in an ex-ante and accompanying way. Highlighting this lack of methodology, we aim to link UD from the generic point of view with common product design systematics. Within this paper, first investigations are carried out by finding a significant field of application as well as assessing different design methodologies for their qualification for UD integration.

3 ASSESSING UNIVERSAL DESIGN POTENTIAL: THE DESIGN PROCESS AND ITS DIFFERENT METHODOLOGIES

It is recorded that time and experience were the main constraints that led to methodology aversions (Goodman-Deane, 2009). So the forthcoming work is to keep it as simple and as familiar as possible to higher UD adaptation in current development processes.
Instead of shaping the general principles of UD for product development usage, our research work aims to immediately integrate UD into common product design methodologies. Therefore, the aspect emphasized in this paper is to identify different strategies in the concept stage and their individual potential for UD. As examples, we use morphologic techniques and the TRIZ (or TIPS: theory of inventive problem solving) methodology as tools. Both methodologies are embedded in the first phases of the design framework. The framework structures the product development process into the general stages of task definition, conceptualizing, embodiment and detailing (see Figure 4; Feldhusen & Grote, 2013).
As the challenge is thus to integrate UD also in the early stages of the product design process, we are now mainly focusing on the first half of the framework. Two different strategies serve as examples as they represent both a product-centred and a user-centred tool. In the following, we propose their simple but effective UD implementation potential.

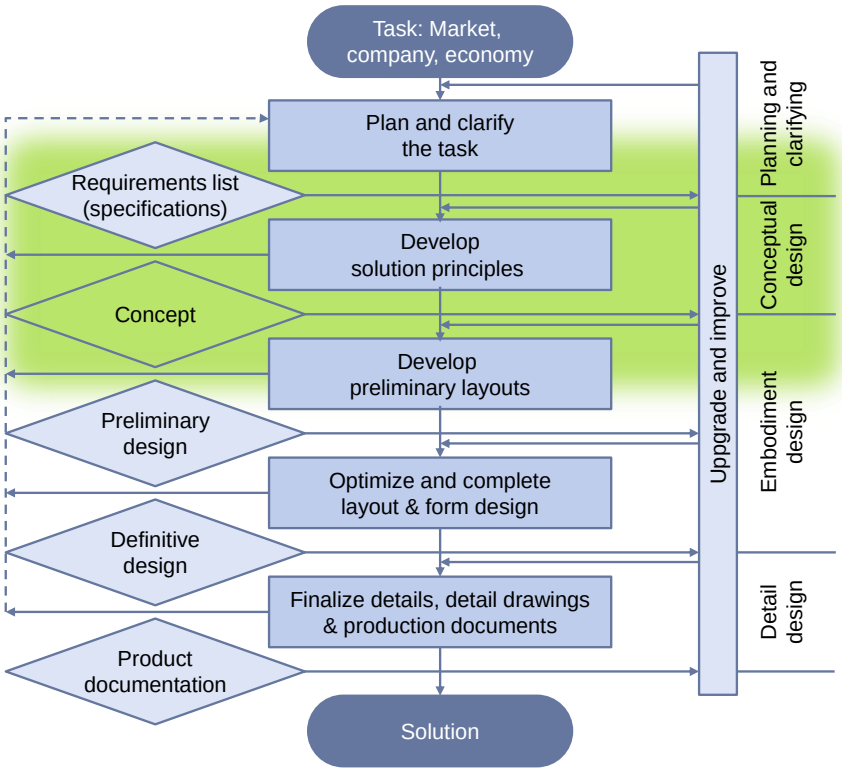


Figure 4: Design methodology by Pahl and Beitz (Feldhusen & Grote, 2013)

3.1 Application scenario

To assess the potential of UD integration in design approaches, an appropriate application scenario is introduced. The practicability and the effects of the suggested proceedings can thus be immediately

applied. Passing through all upcoming considerations, it has always to be taken into account that the general statements of the findings have not been proven yet, so that further investigation will be needed.
Instead of product adaptation we aim for new product development. Firstly, the basic requirements of an exemplary idea to be developed have to be pointed out. To assess UD potential, the idea of a technical product of appropriate significance for everyday life is obligatory. When analysing quality of life indicators, mobility is one of the most influential parameters of human wellbeing in society especially for the elderly (Farquhar, 1995). Thus the preservation of independence in mobility is an essential challenge when dealing with upcoming societal changes (Guralnik et al, 1993) and therefore affects a wide range of people. Focusing on that wide range of users, one has to identify a mobility activity that every generation has in common and which does not differ significantly across generations.
Splitting up the obligatory tasks of everyday activities, going shopping is a task that causes difficulties since it requires the ability to lift and to carry a load of more than five kilos, for example when carrying drinking water (Ayis et al, 2006). Currently, customers are offered shopping carts with wire baskets to carry their goods. These carts require frequent load lifting and lowering which may lead to health problems. However, lifting and carrying heavy loads frequently does not only affect special focus groups like the elderly or disabled people. This problem thus appears to be a good example for possible UD optimization as it also contains potential for all kinds of users. Our main question for an appropriate application scenario can thereupon be formulated as follows: How can a technical product be designed to minimize the everyday load lifting and carrying in shopping activities without significantly changing the user's routines?

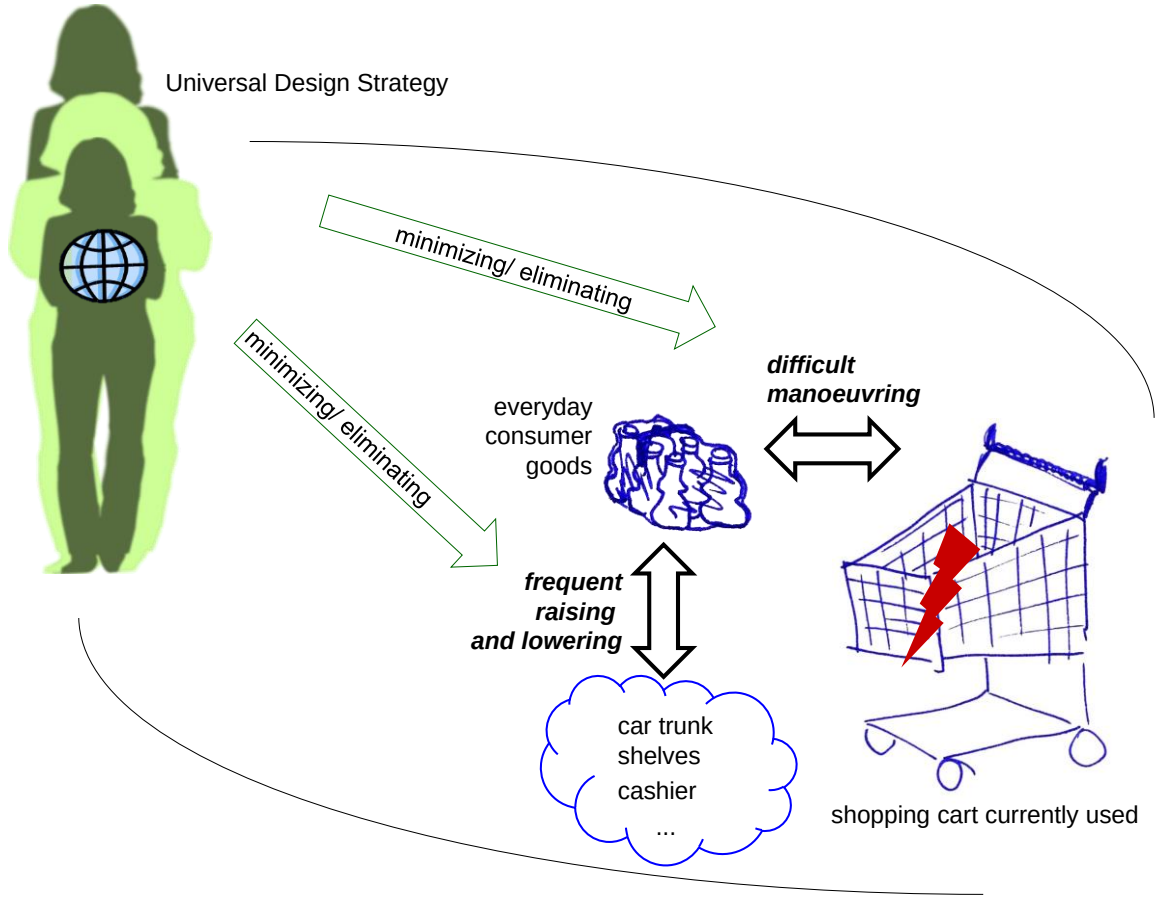


Figure 5: Illustration of the problem field – reduce frequent physical movements in the shopping process

The vast majority use a car to get their weekly groceries, and we have to consider that elderly people especially hold on to their habits so that changes are only made unwillingly or even rejected. Private transport, using a car, will thus still remain attractive (Eurostat, 2014). Figure 5 illustrates general assumptions. After parking the car in the adjacent parking-lot, a supermarket trolley has to be found.

With that trolley, one starts walking through the supermarket aisles and picks up the desired consumer products, lifting them into the trolley. After carrying everything to the cashier, all the products have to be lifted onto the conveyor belt and soon back again into the trolley after scanning. Back at the car, again every purchased product has to be lifted now into the car trunk. Back home, the lifting and carrying task again needs physical effort. Analysing this shopping process, it is obvious that the main lifting movements are in connection to the supermarket trolley that belongs to the supermarket operator. So many lifting movements may be avoided by developing an adaptive personal trolley that fits into the car trunk and thus minimizes lifting and carrying activities effectively. Moreover, the design is also transformable for using public transport. Using this application scenario, both exemplary design methodologies of the early phases in the product development process will now be treated.

3.2 Morphologic methodologies

Morphologic methodologies basically consist of a stepwise process of abstraction and concretization. By identifying a certain development task, initially, it has to be described as a main specific function (e.g. 'providing human mobility'), containing input, output, restrictions and possible disturbance. This part is also known as 'black box thinking'. In the next step, this main task description may be split into a hierarchical function tree stripping the task down to basic, abstract problems (e.g. 'moving'). Thus, an abstract problem formulation is achieved, and several general solution strategies can be listed equally avoiding hasty, pre-shaped decisions. These lists lead to an overview matrix, forming a morphological box (also called a Zwicky box). By combining basic solutions to the specific generic solution, a number of different conclusive concepts can be systematically generated. (Feldhusen & Grote, 2013)

UD considerations can now be integrated into the methodology as an additional feature. Starting from the black box thinking, the function structure may already be augmented by respective aspects, taking different user types into account. Then, this variability can be transferred into the morphological box, adding further functions to the list. UD aspects are thus translated into generic problem formulations and provide an implicit description of UD requirements. Using Figure 6, an exemplary sketch of a black box, a function tree and a morphological box for our application scenario will be illustrated.

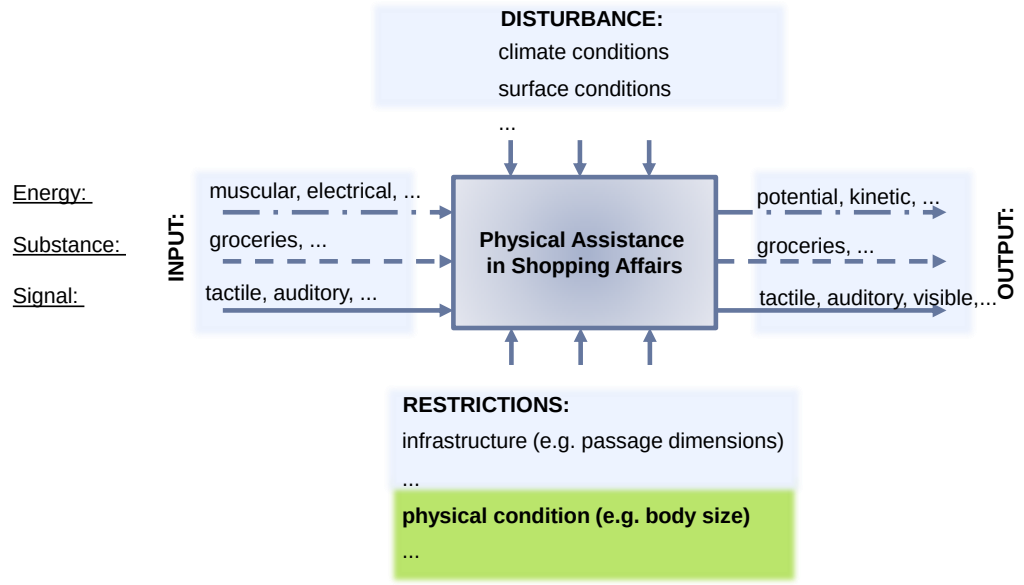
The black box description as the first step of the process supports the product developer by providing a structure for a 360° view of the main task that is to be identified in the respective problem field. In our current example, the avoidance of hindering activities in shopping processes (e.g. lifting and carrying) can be named as 'Physical Assistance in Shopping Affairs'. Now, a generic formulation of the interaction system has to be sketched by using open phrases for each direction. The in- and output of the technical system remains the same as it describes the transformation of environmental factors via product functionalities. In contrast to this, the user dependencies exist in disturbance and restriction considerations. For example, one possible restriction may be the physical condition of any user (see Figure 6 (a), green). Therein, the UD demand for product accessibility for a wide range of users can be taken into account. Other factors such as culture, social environment, communication skills etc. also have to be listed, ensuring a generic formulation of user determinants and the usage context.

The next step is to break down the main task into certain very low level sub-functions, so that the sub-functions at the lowest level are basic abstract terms with several generic operating principles. Following up the UD integration strategy, the previous considerations of user implementation in disturbance and restrictions are transformed into a new dimension of sub-functions in the function tree (see Figure 6 (b), green). One must point out that not only static attributes may be suggested, but also an allowance made for variability in certain functions (e.g. body size adaptability).

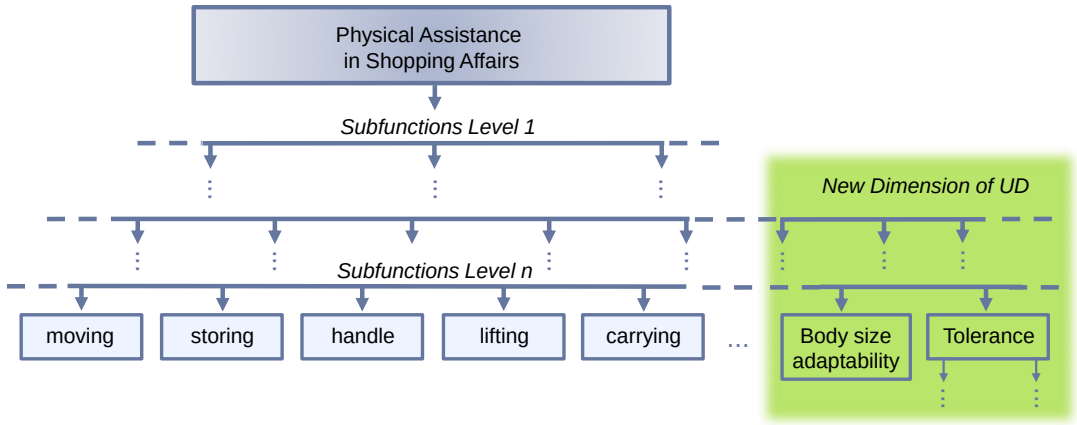
The last step illustrated here is the deduced morphological box. Therein, the strategy of a systematic UD consideration is pursued due to the previous sub-function-modelling. Having the additional sub-functions, principal solutions for them can be suggested without intellectual barriers (see Figure 6 (c), green). Without the abstraction level attained at this stage of the process, the original problems may urge creativity into specific ways. In our example, the demand for a body size adjustment of the shopping gadget may be narrowed to scissor elements from the outset as it is commonly used in other products.

Following up the discursive process, the whole solution space can be illustrated and included. As this three stage procedure represents an iterative process, every abstraction level of UD strategy can be examined, from the capture of system variables into black box terminology, down to abstract problem-solution constellations and back up. The robust UD integration is thus be ensured.

(a) Black box



(b) Function tree



(c) Morphological box

principal solution / function	①	②	③	...
moving	rolling	sliding	caterpillar	...
storing	wire basket	bag/sack	platform	...
handle	pipe bend	joystick	two handles	...
presenting	flap	window	drawer	...
minimizing/maximizing	scissor elements	air cushion	folding	...
...				
body size adaptability	scissor elements	expansion	air cushion	...
...				

Figure 6: Morphological methodology for a shopping gadget, integrating UD dimensions

The outlined extension of UD criteria in the given morphologic process illustrates approaches of consecutive user factor integration. The detection of required variability in certain product properties has to be assessed in previous stages (e.g. market analysis). Instead of asking for static, clearly formulated functions, the focus is set on adaptation and preservation of product functionality for a huge variability of possible users as UD proposes. As the process of a morphologic methodology is only one of several possible solutions, another concept using TRIZ approaches will now be shortly illustrated.

3.3 TRIZ

The acronym TRIZ, mainly created by G. S. Altschuller in the 1950s, is based on the idea, that every innovative process can be operated systematically without taking any coincidence into account. The theory is based on four main principles (Klein, 2002), so that parallels to UD can already be identified at first view. Analogous to the generic formulation of UD principles, TRIZ works with very high level propositions. In the following, we focus on a specific tool named trenDNA to assess UD potential exemplarily.

TrenDNA is a tool to predict and to use forthcoming trends to position innovations in early product development phases. Given the basic assumption that trends are mainly caused by people and their behaviour, the trenDNA roadmap starts from a customer's point of view and tries to link it with trends using hierarchical levels. Moreover, a consistent user-centred process involving several kinds of user archetypes is intended. Archetypes are different classes of generation patterns that can be extracted throughout our societies. The findings of Strauss and Howe (1998) define that there are four basic archetypes named Heroes, Artists, Prophets and Nomads. Although the descriptions of these archetypes differ slightly from nation to nation, they are adaptable to any culture. Those archetypes grow with the ageing of their representatives and alter over time. Every archetype is therefore always represented in a focused time but differs due to the specific conditions. This leads to a two dimensional overview of occurring archetypes in our society over time, illustrated in Figure 7. Therein, the archetypes in relation to the time line are named by their main characteristics (Mann & Ozozer, 2009).

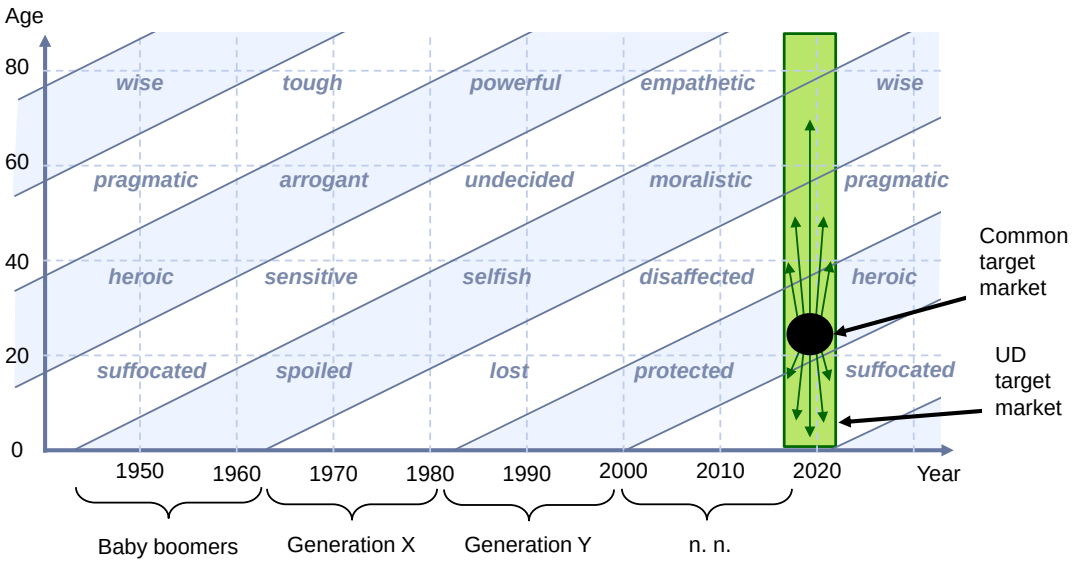


Figure 7: Customer archetypes in different life phases and generations based on Strauss and Howe (Mann et al, 2009)

TrenDNA uses those archetypes to position and to describe the new product's target market. In doing so, an implicit understanding of the users within this target market can be envisaged. As shown in Figure 7, this target market needs extension across all the generations to achieve UD. This procedure narrows the affected users down to four main parties, the occurring archetypes. It is both ensured that UD is systematically introduced but also manageable for further processing. In addition, this approach can be used to gain an alternative description of the targeted users as it is not only limited to physical and cognitive factors. Further steps of the trenDNA method specify the target market in a deeper manner. This includes the course of time and advising how to specify first product concepts.

The trenDNA archetypes should both reassure the reflection of our society and in the same way minimize the effort for creating a whole UD intended view. The customer definition (and hence also the user) can be widened to a holistic description of the different needs of users, leading to a UD guided product concept. It already shows high potential for further enlargement of the UD definition including soft factors such as social, cultural or motivational characteristics.

4 WORK PLAN AND PROSPECTS

Within this paper, we have addressed several research aims. So far, the initial role of UD in the societal and individual living environment has been clarified. We have outlined that the generic guidelines of UD, which are meant to be merely assistive in strategic considerations, need more concretization to be applicable in product development processes. In the two outlined examples, we demonstrated the potential of UD integration. The next step will be to generalize these first findings. Once we have overcome this challenge, we must further investigate and evaluate more design concepts to assess the highest potential for UD strategies. Striving for this, we have to set a valuation system and a definition of possible design criteria. UD might somehow become valuable for product development processes.
It is obvious that by only treating a single application scenario, the robustness of the findings is not proven yet. Nevertheless, this example provides a way to transfer theoretical thoughts into practical application. To improve the reliability and applicability, we need to raise the abstraction level. So besides further maturation and concretization of the illustrated scenario, we have to find ways to evaluate the findings. In future works, current findings need to be extended. We will integrate the UD into systematic product design and try to get its perception controllable both in an ex-ante and accompanying way. Within this process, we need to extend the holistic view of the user, taking soft factors such as sociological, psychological or cultural aspects into account. Those parameters are gaining increasing importance in user-centred research, as its importance is proven (e.g. Bichard et al, 2007). Some respective research activities have already been carried out, e.g. to assess cognitive aspects (Langdon et al, 2010). Considering trenDNA, there are already basic approaches that might be deepened. Moreover, thought should be given to using tools like trenDNA and their findings in the later stages, too. As the landscape of parameters in design considerations is nowadays rather extensive, the dependencies and effects among them must be clarified under user-centred aspects. Furthermore, the limitations of UD strategy itself have to be assessed, especially in regard to common product design practice.

5 CONCLUSION

Not only do the changes caused by the rapid ageing of our societies demand a reconsidering of the user's role in product development processes. Today, there are many approaches for implementing the user's perspective into product development processes (Keates et al, 2000). Yet, there is not sufficient integration in practice. So we suggest a strategy for its integration into popular product development process models instead of asking for completely new design processes, which may require unjustifiable effort for product developers. Focusing on UD as an inclusive user-centred strategy, we sketched the main features and current challenges. The continuous integration of UD into product development practice is outlined, aligned with applied product development frameworks. Within this paper, we prove that the established routines and methods can be efficiently extended. Initially illustrating the approach in early phases, we show the first steps towards a reasonable integration of UD aspects into popular product design practice.
We have proposed an appropriate application scenario for investigation. The treatment of a societally relevant topic, as mobility and independence are in everybody's life, has great value for upcoming challenges in our society. We have proven that the area 'mobility and daily needs' affects both average people and those with very different characteristics and thus has a relevant UD impact.
By stepping into design processes in early phases, we showed that different approaches in creativity can be used to systematically integrate UD. Some methodologies already contain high potential. In further activities, these findings have to be extended to all phases of the product development process. Hence our work contributes to an effective integration of UD strategy for user-centred products. Megatrends such as demographic change and rising diversification will extend. In the future UD will become more and more important, so product development practice needs to be prepared.

REFERENCES

Ayis, S., Gooberman-Hill, R., Bowling, A. & Ebrahim, S. (2006) Predicting catastrophic decline in mobility among older people. Age and Ageing, 35 (4), 382–387.

Bichard, J-A., Coleman, R. & Langdon, P.M. (2007) Does my stigma look big in this? Considering acceptability and desirability in the inclusive design of technology products. In: Stephanidis, C. (ed.). Universal Access in HCI: Coping with Diversity, 4th International Conference on Universal Access in HCI. Beijing, 4554, 622–631.

Biermann, H. & Weissmantel, H. (1995) Seniorengerechtes Konstruieren SENSI: Das Design seniorengerechter Geräte. Düsseldorf, VDI-Verlag.

Catanese, L. (2009) Thomas Lamb, Marc Harrison, Richard Hollerith and the origins of universal design. Journal of Design History, 25 (2), 206–217.

Clarkson, J. (2007) Inclusive design toolkit. Engineering Design Centre University of Cambridge, Cambridge.

Eurostat (2014) Passenger transport statistics. [Online] Available from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Passenger_transport_statistics [Accessed 13th November 2014].

Eurostat (2013) Percentage distribution of severities of disability by sex and age. [Online] Available from: http://appsso.eurostat.ec.europa.eu/nui/show.do? dataset=hlth_db_emseag&lang=en [Accessed 13th November 2014].

Farquhar, M. (1995) Elderly people's definitions of quality of life. Social Science and Medicine, 41 (10), 1439–1446.

Feldhusen, J. & Grote, K.-H. (2013) Pahl/Beitz Konstruktionslehre: Methoden und Anwendung erfolgreicher Produktentwicklung. Berlin/Heidelberg, Springer Vieweg.

Goodman-Deane, J., Langdon, P. & Clarkson, J.P. (2009) Key influences on the user-centred design process. Journal of Engineering Design, 21 (2–3), 345–373.

Guralnik, J.M., LaCroix, A.Z., Abbott, R.D., Berkman, L.F., Satterfield, S., Evans, D.A. & Wallace, R.B. (1993) Maintaining mobility in late life. I. Demographic characteristics and chronic conditions. American Journal of Epidemiology, 137 (8), 845–857.

ISO 941-210 (2010) Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems. Geneve, International Organization for Standardization.

Keates, S., Clarkson, J.P., Harrison, L.-A. & Robinson, P. (2000) Towards a practical inclusive design approach. In: Scholz, J. & Thomas, J. (eds.). Conference on Universal Usability 2000, Arlington, VA, USA. New York, The Association for Computing Machinery, pp. 45–52.

Klein, B. (2002) TRIZ-TIPS - Methodik des erfinderischen Problemlösens. Munich, Oldenbourg.

Langdon, P., Persad, U. & Clarkson, P. J. (2010) Developing a model of cognitive interaction for analytical inclusive design evaluation. Interacting with Computers, 22 (6), 510–529.

Mann, D. & Ozozer, Y. (2009) TrenDNA - Understanding populations better than they understand themselves. Bideford, Lazarus Press.

Mieczakowski, A., Hessey, S. & Clarkson, P.J. (2013) Inclusive design and the bottom line: How can its value be proven to decision makers? In: Stephanidis, C. and Antona, M. (eds.) Universal access in human-computer interaction: Design methods, tools, and interaction techniques for eInclusion - 7th International Conference, UAHCI 2013, Proceedings, Vol. 8009. Berlin/New York, Springer.

Raviselvam, S., Noonan, M. & Höltta-Otto, K. (2014) Using elderly as lead users for universal engineering design. In: Universal design 2014: Three days of creativity and diversity. Lund, Ios Press Inc.

Steinfeld, E. & Smith, R.O. (2012) Universal design for quality of life technologies. In: Proceedings of the IEEE, 100 (8), pp. 2539–2554.

Story, M. F., Mueller, J. L. & Mace, R. L. (1998) The universal design file: designing for people of all ages and abilities. New York, The Center for Universal Design.

Strauss, W. & Howe, N. (1998), The fourth turning: An American prophecy. New York, Broadway Books.

Stula, S. (2012) Wohnen im Alter in Europa - Aktuelle Entwicklungen und Herausforderungen: Arbeitspapier Nr. 7 der Beobachtungsstelle für gesellschaftspolitische Entwicklungen in Europa. Berlin, Deutscher Verein für öffentliche und private Fürsorge e.V..

Vanderheiden, G. & Tobias, J. (2000) Universal design of consumer products: Current industry practice and perceptions. In: Proceedings of the IEA 2000/HFES 2000 Congress. Santa Monica, Human Factors and Ergonomics Society.

Walla, W., Eggen, B. & Lipinski, H. (2006) Der demographische Wandel. Stuttgart, Kohlhammer.

Scheuer S. (2011): Universal Design international - Perspectives for product development. In: Zec, P. (ed.). Universal design: Best practice. Essen, Red Dot Edition, pp. 42–49.