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Universal Design or Modular-Based Design Solutions – A Society Concern

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1. Introduction

Universal Design (UD) is a concept with the aim of promoting the development of products or environments that can be used effectively by everybody without adaptation or stigmatization (Mace, 1985). Modular-based solutions on the other hand can provide the individual with optimum usability as the solutions can be adapted exactly to the needs and requirements of the individual. In this chapter UD product solutions will be discussed in relation to modular product solutions in the perspective of the developing/ manufacturing company and society's request for universal design solutions.

The Committee of Ministers of the European Union - decided to recommend the Governments of the EU member states to accept Universal Design as a philosophy and strategy supporting implementation of full citizenship and independent living for all people, including those with disabilities in the Resolution ResAP (2007)3. According to the resolution; "*Universal design is a strategy which aims to make the design and composition of different environments, products, communication, information technology and services accessible, usable and understandable to as many as possible in an independent and natural manner, preferably without the need for adaptation or specialized solutions.*"

Political ambitions and initiatives such as, for example, the EU Resolution are important and well known prerequisites for implementing a UD perspective into the development of a democratic and integrated society. In addition, activities and advocacy from users/user organizations and nongovernmental organization (NJO´s) also contribute to create a society accessible to "all", and usable by as many people as possible. However, the business sector – the third stakeholder – is involved in the technical and market/sales-oriented development of solutions of various kinds and thereby an important partner when society invest in modern and sustainable public arenas.

Thus, there are three parties forming the BUS triangle - Business, User and Society, which is shown in figure 1 on page 2.

It is in the interest of individual users and the whole of society to have products and environments designed so that they can be used by as many people as possible without having special solutions for every single deflection from the existing norm. Previous studies have identified barriers for increased uptake of UD in companies such as government regulation, training, market data, consumer demand, technical complexity but also lack of

knowledge interest and techniques. A study performed in Great Britain concluded that only one third of one hundred companies investigated were aware of the term Universal Design (Goodman et al., 2006). There is a misconception that design for universal accessibility means designing for the elderly and disabled. It has been shown that increased usability and accessibility for older and disabled people benefits users in general because where some are excluded from using a product or service many more are likely to find it difficult or frustrating to use. UD does not eliminate the need for assistive technology (AT). People with disabilities (permanent or occasional) will continue to need AT solutions such as communication aids, visual aids, wheelchairs, orthoses and adapted toys in order to interact more fully with their environment. AT will also be required when UD solutions are lacking due to cost or difficulties in creating good solutions. However, building accessibility into new technologies and curricular materials as they are developed will help to ensure maximal inclusion into the full array of opportunities that are available to all people.

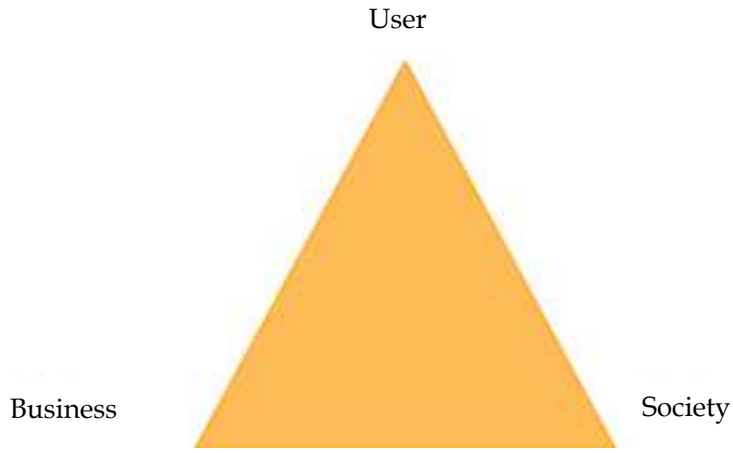


Fig. 1. The BUS triangle illustrates three important stakeholders for the creation of UD solutions (Ottosson, 2004).

By incorporating an attitude of designing products and environments that are universal in use, companies can benefit greatly as markets are expanded and it allows them to identify niche market opportunities. To increase the interest for UD in companies, knowledge and techniques must however be invested in what is in the interest of society due to both legislative and financial reasons.

Disability is not a simple consequence of an individual's impaired capability, but results from a failure to take proper account of the needs, capabilities and preferences of all potential users when designing products, services and facilities aimed towards the public. Elderly people are becoming a demanding wealthy group of customers who want to participate in society, use facilities and services, and who also demand good usability and pleasure in the products they buy. People who suffer from some kind of disability have the same requirements as the population as a whole for accessible environments, usable public transport systems and good usability in products and systems. Legislations, regulations and changing attitudes around the world are generating increasing pressure for a more usable and accessible design. The Norwegian Action Plan for universal design and increased accessibility 2009-2013 is one of several examples (www.regjeringen.no).

The Universal Design concept does not just focus on the user's physical abilities. More attention is on cognitive and communicative abilities, which are sometimes complicated and demanding for designers/product developers to handle. These abilities not readily visible, are difficult to grasp without knowledge within the areas of psychology and sociology and additionally also requires observation of behaviour in performing activities in certain environments over time in order to comprehend. There is more to functionality and task performance than bodily access, and in order to be able to design products and environments supporting behaviour, information on person/environment fit is not enough.

2. Aim

The aim of this chapter is to discuss UD product solutions versus modular product solutions in the perspective of needed technical, financial and other resources for the developing companies. The different conditions will be discussed from the request of society for more universal solutions

3. Modular product design

The basic idea underlying modular design is to organize a complex system (such as a large program, an electronic circuit, or a mechanical device) as a set of distinct components that can be developed independently and then plugged together. In systems engineering, modular design — or "modularity in design" — is an approach that subdivides a system into smaller parts (modules) that can be independently created and then used in different systems to drive multiple functionalities. In a production context modular design in addition to reduction in cost (due to lesser customization, and less learning time) also offers flexibility in design. Modular design is an attempt to combine the advantages of standardization (high volume normally equals low manufacturing costs) with those of customization. Another aspect with modularity is the possibility of adding a new solution by merely plugging in a new module. Computers use modularity to overcome changing customer demands and to make the manufacturing process more adaptive to change. A downside to modularity is that modular systems have a tendency to expand in number of modules which to the customer and user can be at the expense of good usability and for the manufacturer a larger number of parts meaning logistic expansion.

Modular design in an assistive technology context has traditionally been a way to handle the individual needs and demands of people with disabilities. To be able to supply people with individually designed products new modules have been added to already existing product solutions. This has been an unfavourable situation for many children with reduced body function, receiving a smaller copy of equipment aimed and developed for adults. Fortunately today, knowledge about children's needs for good design in assistive devices has resulted in a much better situation. There are however still products on the market that are based on the same idea with the argument that it satisfies the individual need; an argument which is sometimes true but at the same time an argument for not considering a new design solution that perhaps covers the needs of several more users. However, one outstanding argument for modular-based design is the flexibility to change parts in the solution when broken or when user needs change.

From a market perspective it can be argued that a modular-based solution can be more difficult to communicate as it consists of several parts (if not pre-mounted by the manufacturer). As the amount of time companies have to communicate a message to customers is decreasing the message must be easy and intuitive in order to be successful. Simple illustrations can replace long and often difficult written explanations used in user manuals and product instructions and are beneficial as they can be communicated in several markets in multiple countries. Web-based customer/user information is of course the most global and economically most efficient way of presenting information; however, not all households own computers and have an Internet connection. An additional factor is also that the personal computer which was initially considered as a new possibility for accessing information, in fact needed adaptations to be accessible to most users and often people with disabilities have to "wait for the technology"(Emiliani 2009). Supplying companies argue that modular-based products are fully adaptable to individual needs and abilities but the rehabilitation engineers are often forced to rebuild in order to achieve the individual support required. Technical details also in today's solutions are sometimes dimensioned without the important holistic design perspective, e.g. screws, nuts are too big to fit into the product design, there is a lack of user-friendliness to the human hand when a change needs to be accomplished, or a different materials change in colour with time and thereby making the assistive device look old-fashioned. The saying "the devil is in the detail" is indeed true in the assistive technology field as people with disabilities have a reduced ability to adapt themselves to poor product design.

Products communicate with its users through different channels. Interest in the perceptual and image values also in the field of assistive technology products can be seen as a sign of product designers having become aware of that both primary and secondary users of assistive technology constitute demanding and often well-educated customers. It is an expanding, growing market where users also become buyers to a greater extent than previously, which increases the interest of companies for additional product values.

The personal perception of a product is affected by function, perceptual values such as colour, weight, design etc. but also by the image value with its identification attributes. Assistive technology devices have for a long time focused on the technical functions, underestimating other product values.

- *Functional product values* are dependent on the technical solutions often hidden inside the product. When the user can perform the intended activity for which the technical solution was developed, it is a good functionality.
- *Perceptional/sensorial product values* are based on what we experience with our senses (sight/hearing/taste/touch/smell) from outside and/or in contact with a product. The product name's semantics are an important contributor to these values.
- *Image values* are based on the "feeling" the user gets of the product. Brand names, patents, the image given on web pages, stories and the expressed experiences of the product by other users (Ottosson 2004).

4. Universal design

The one running theme in the demographic context is that Universal Design not only provides a framework for action but is an approach that values and celebrates human

diversity. Further, as a product of social policy Universal Design can restore equity and enhance citizenship. This can be called the politics of sustainability and civic rights.

4.1 Universal design principles

It can be stated that establishment of the seven Universal Design principles which were initiated by R. Mace and his team at North Carolina State University in beginning of the 1980 was a step towards a human perspective on how products and environments should be designed to be usable and understandable by as many as possible (Connel et al., 1997). The seven principles listed below, (table 1) with the guidelines added to it, gives a slight view of what problems designers and product developers might have had when trying to transform the principles to technical terms, specifications and measures.

Principle	Explanation
1. Equitable in use	The design is useful and marketable to people with diverse abilities *Guidelines* a) Provide the same means of use for all users: identical whenever possible; equivalent when not b) Avoid segregating or stigmatizing any users c) Provisions for privacy, security, and safety should be equally available to all users d) Make the design appealing to all users
2. Flexibility in use	The design accommodates a wide range of individual preferences and abilities *Guidelines* a) Provide choice in methods of use b) Accommodate right- or left-handed access and use c) Facilitate the user's accuracy and precision d) Provide adaptability to the user's pace
3. Simple and intuitive use	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level *Guidelines* a) Eliminate unnecessary complexity b) Be consistent with user expectations and intuition c) Accommodate a wide range of literacy and language skills d) Arrange information consistent with its importance e) Provide effective prompting and feedback during and after task completion
4. Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities *Guidelines* a) Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information b) Provide adequate contrast between essential information and its surroundings c) Maximize "legibility" of essential information

		d) Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions) e) Provide compatibility with a variety of techniques or devices used by people with sensory limitations
5. Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions	*Guidelines* a) Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded b) Provide warnings of hazards and errors c) Provide fail-safe features d) Discourage unconscious action in tasks that require vigilance
6. Low physical effort	The design can be used efficiently and comfortably and with a minimum of fatigue	*Guidelines* a) Allow user to maintain a neutral body position b) Use reasonable operating forces c) Minimize repetitive actions d) Minimize sustained physical effort
7. Size/space approach/use	Appropriate size and space is provided for approach, reach, manipulation, regardless of user's body size, posture, or mobility	*Guidelines* a) Provide a clear line of sight to important elements for any seated or standing user b) Make reach to all components comfortable for any seated or standing user c) Accommodate variations in hand and grip size d) Provide adequate space for the use of assistive devices or personal assistance

Table 1. The seven Universal Design Principles (Story et al., 2001).

The seven principles define the degree of fit between individuals or groups and their environments, but they also refer to the attributes of products and environments that are perceived to support or impede human activity. They also imply the objective minimizing the adverse effects environments may have on their users such as stress, distraction, inefficiency and sickness. However, the principles require perspective and reflection. Some have criticized their orientation toward products (e.g. Paulson et al., 2005), and others have criticized them as vague, incomplete, and difficult to understand (e.g. Steinfeld, 2002). Although little re-evaluation, reconsideration, or questioning of the principles has occurred since their introduction in 1997, Duncan (2007) suggested adding new principles that relate to affordability and sustainability. He also requested guidance in weighting the principles. Nevertheless, the idea behind the principles remains – to create products and applications that can be used by all customers, independent of their age or physical and mental conditions.

Several studies have shown different barriers and drivers for UD. For instance, a US telephone interview was conducted on 26 consumer product manufacturers and a similar survey on 307 Japanese companies in five different industrial categories (Helen Hamlyn Research Centre, 2000) pointed at government regulations, training, market data, consumer

demand, technical complexity and the lack of interest, knowledge and techniques as main barriers.

Goodman (2006) has identified some main causes for the companies lack in acceptance:

- Lack of knowledge
- Lack of business case
- Lack of time and budget

The misconception, that designing for universal usage means only designing for elderly and disabled (Keates et al., 2000) has also been noticed. A UK survey of 29 design professionals stated that "Design for all" was widely known and understood but not widely practiced within the design community (Simms, 2003). Reasons given included lack of time, client backing, money and awareness of the possible market.

Bellerby and Davis (2003) interviewed six product developers and market specialists. They suggested that standards and guidelines could be important drivers but were mostly not presented in an appropriate format. Dong et al (2004) found in a survey of 38 manufacturers in small- and middle-sized companies in the UK that key barriers were based on assumptions such as UD is more expensive, and that there are practical and implementation difficulties.

Goodman et al (2006) presented other drivers for UD; demographic, consumer trends, social responsibility and brand enhancement. Key consumer benefits were increasing customer satisfaction and producing innovation and differentiation.

Most manufacturing companies are using product development models in their design work which has an impact on their ability to adapt to UD principles. Many manufacturers require a UD concept which can be integrated into the Product Development (PD) models they use. Additionally, they require that it can be evaluated towards ordinary quality systems and standards used, otherwise it becomes an additional activity that most manufacturers do not know about or lack knowledge about how to handle or benefit from, or even neglect based on economic or organizational reasons. Blessing (2003) argues that "… *most product development models are static description and to identify whether a method or a tool indeed contributes to success is far more difficult and the results are not easy to generalize. The success of a method or tool depends on the context in which it is being used. This context is different for every design process, because every design project is unique*."

5. Prerequisites for integration of UD perspective in product development

From reading the literature, scientific publications and based on the author's own experience (Björk, 2003), four main prerequisites that need to be integrated into the PD methodology can be indentified in order to qualify it to act as a guide for a design process applying a Universal Design perspective. The four prerequisites identified are presented and discussed below.

5.1 User intervention with user trials

When referring to user involvement in the implementation of functionality and usability aspects in product design, many authors have reported positive results. E.g. McClelland

stated as early as 1995 that user trials are the most valuable source of information about a product's performance. In 1998 Eric von Hippeln discovered that many products and services were developed by users, who then successfully transferred their products to manufacturing in their own enterprises or in other companies. When individual users face problems that the majority of user's and customers do not, they have no choice but to develop their own modifications to existing products, or entirely new products, to solve their issues. Often, user innovators will share their ideas with manufacturers in hopes of having them produce the product. In 1986 von Hippeln introduced the *lead user* concept and argued for the benefits of involving lead users into the development process. He stated that lead users are familiar with actual contexts and have a pre-understanding for special environments which makes them better qualified to identify new products and new solutions (von Hippeln, 2005).

Who then are the users? What kind of different users do we have to consider to cover the range of today's and tomorrow's users? Normally "the user" is seen as just one of the product- or environmental stakeholders but – except from end-users – several others are involved in the usage, such as clients, producers, owners, and decision makers (Nelson & Stolterman, 2003).

However, the individual user perspective has sometimes been shown to be too unilateral and primarily reflecting the person's own situation (Jensen, 2001). The process of user-centered design described at an early stage by Buurman (1997) also argues for user involvement and to assess the performance of users when using products (Jordan et al., 1998; Björk, 2003). Through observation of the user and participation in the usage situation product developers/designers can through their own experiences, knowledge and reflections (the famous reflection in action described by Schön, 1983) achieve a holistic understanding for the actual situation. Studying usage in a real environment by participating as an insider (Coghlan, 2001) allows the product developer/designer access to a great amount of information that is of another character than that which can be obtained via common data collection methods (Ottosson & Björk, 2002). By using all human senses, information input is increased and a holistic view of the situation can be attained.

Improved product usability for those with reduced capability and for disabled people also makes life easier for fully capable individuals (Fig 2). By increasing the uptake of Universal design in companies' development philosophy, the need for assistive devices used by people with disabilities will decrease, which in turn is valuable for all in the perspective of democracy, human rights and equity. One early example is the bus manufacturer Optare which teamed up with the Royal College of Art in the UK to create more interesting bus interiors that can also cater for less able persons (Shahmanesh, 2003). Another company, Gowrings Mobility, is one of the UK´s leading manufacturers and suppliers of wheelchair passenger vehicles. The managing director of the company explained that a design engineer should have a more realistic understanding of who is actually using the car. Where "no cost choices" can be made at the design stage, this can benefit a whole range of drivers and passengers of all ages, abilities and sizes (Shahmanesh, 2003).

Another valuable tool for obtaining user involvement grasping information is focus groups, but they are rarely used in isolation. Marketing researchers employ a variety of tools, including one-on-one interviews, written surveys and polling to track consumer opinion. Used together with all of the above, a focus group is an integral part of gauging public

perceptions. Focus groups have some obvious benefits: The product developer can interact with the participants, pose follow-up questions or ask questions that probe more deeply. Results can be easier to understand than complicated statistical data and the product developer can get information from non-verbal responses, such as facial expressions or body language.Information is provided more quickly than if people were interviewed separately.



Fig. 2. The user pyramid (Ginnerup, 2010).

While all of these are valid points and give more information than a survey or questionnaire, they do not always give as much as is needed to succeed. The small sample size means the groups might not be a good representation of the larger population and the group discussions can be difficult to steer and control, so time can be lost to irrelevant topics. Additionally respondents can feel peer pressure to give similar answers to the moderator's questions, the moderator's skill in phrasing questions along with the setting can affect responses and skew results (Edmonds, 2000).

5.2 Focus on user's desires

It is meaningful to distinguish between a present user need, a want or a more distant desire. Incremental innovations are often based on satisfying a present *need*. Radical innovations on the other hand are often based on satisfying a *desire* – or *wish* as it has originally been termed (Ottosson, 2006). The conditions for *want*- and *desire*-based Product Development methodology differ much from *need*-based PD for which the well-known PD models were initially designed. Some differences between the three PD driving forces mentioned are shown in Table 2.

Driving PD force	**Characteristics**	**PD Target**	**Planning**	**Stable conditions**	**Unstable conditions**
Need	Knowledge and solutions exist to re-use for an existing need	Fixed	Fulfil plan	Yes	No
Want	Knowledge and solutions are incomplete to solve a new want	Moving	Adopt to the situation	Partly	Partly
Desire (Wish)	Important knowledge and solutions do not exist	Vision	Create, make and test	No	Yes

Table 2. Three types of backgrounds for product development causing different circumstances for PD work (based on Holmdahl 2007).

Generally, a need-based PD project has stable conditions, a want-based PD project experience more partly unstable conditions while a desire-driven project represents totally

unstable conditions. Two philosophically different views exist on how to best perform need-based PD development, leading to a categorization of PD methods as either classic or dynamic depending on their ability to handle stable/unstable conditions.

For a company performing PD projects based on a market *need,* the time factor is crucial from a market perspective as the need/problem already exists and the risk for competitive solutions to occur is great. The price is the second most important variable as many similar solutions can appear on the market, meaning a price competition. In turn that means a demand for low PD and production costs as well as effective logistics. User intervention is a valuable resource in need-based development projects and focus group can be one alternative to consider. A need-based PD project will from a company perspective therefore benefit from modular-based product design.

For the development of products or other solutions that are based on a *want,* the time factor does not have the same importance as for *need*-based development. The long-term planning in these projects is not possible to maintain as so many variables are unknown when the project starts; planning can only be successful for short periods of time. The market price is not at all an issue initially in the desire-driven development projects (often innovation projects). Especially lead users (von Hippeln, 2005) can initially make important contributions for products or solutions that are based on a *desire,* where the time and price factors are less important. From a company perspective, a desire-based PD project would likely benefit from a UD solution. To find out *wants* for a near future – or *a desire* for a more distant future – lead users and dialogues with professionals in certain fields can be of good value. End-users, rather than manufacturers, are responsible for a large amount of new innovation (von Hippeln, 2005).

To be able to create solutions which are inventive and attractive and which go beyond today's user needs and functionality the focus should be on users' desires. Edefors (2004) discussed the problems with focusing on the actual local user and argued for a wider perspective. The presumptive users of tomorrow are interesting to investigate as they have the arguments and motives for **not using** an actual product or environment today. Their motives for being no users put demands for new inventive solutions. This approach is similar to Jordan (2002), he argues for fitting products to people in a holistic manner where the relationship between people and products depends on more than just usability, it is about perceptual and image values. People have hopes, fears, dreams, aspirations testes which influence their choice and experience of product and environments (Björk, 2003).

5.3 The product development methodology should be able to deal with complexity

Manufacturing industries are under tremendous pressure to reduce cost and time-to-market and yet offer a large variety of products. Consequently, the companies are compelled to operate at the lowest profit margin and shift manufacturing operations to developing countries for cost savings. Current PD methodology is not adequately upgraded nor equipped with efficient design tools and techniques to meet the challenges of the Universal Design concept on a global market, as mentioned earlier.

Complex systems consist of a large number of dynamically (and usually non-linearly) interacting non-decomposable elements (McKelvey, 2004). Because of high interconnectivity between elements, it can often be difficult to associate effect with cause (Holmdahl, 2007).

One is confronted with incredible intricate interacting parts and not relatively easily identifiable chains of cause and effect apparent in linear processes. The world is experienced as being increasingly complex, unordered and non-linear which becomes obvious in innovation projects. The complexity comes from the fact that such projects build on limited number of pre-known solutions.

To be able to manage innovative product development projects which are unique and difficult to plan beforehand, a dynamic and flexible philosophy is needed. Most product development methodologies of today are created with big- or middle-sized firms in mind where certain rules and hierarchies are established and where the company system rules all activities. The Stage Gate system philosophy (Cooper, 1986) is well known but cannot offer flexibility, short planning periods or uncertainty as it is a static method.

The world is changing faster than ever before. Market dynamics increase, changes in fashion with different trends shift rapidly and product life is reduced. If companies do not get their product on the market at the right time, it flops. Laws which regulate the conditions for product design, sales, production and destruction change frequently.

If, in such a situation, one starts product development with a detailed specification and a detailed schedule and sees product development as a matter of delivering specifications and follow the plan, several problems will occur. Things are even worse if a serial/sequential development strategy (baton method) with different phases that traversed sequentially is selected. If the project also slows down by using different gates (toll gates), the situation can go really crazy in a changing market.

A dynamic strategy is required to meet the ongoing changes and no one can in advance know exactly how the product should be wired to best suit a universal market. *Dynamic Product Development (DPD™) method* (Ottosson, 2004) argues that flexibility and easy adaptation to changing circumstances must be built into the system. The organization must be competitive in order to quickly respond to new impulses and new insights. Only an expert-led self-organizing organization has these characteristics. *Dynamic Product Development (DPD™) method* is based on a usability philosophy; good usability is based on knowledge about human performance and of the environment where the performance takes place. To cope with complexity and unstable situations, DPD™ argues for the presence and participation of the Designer/PD developer in the project mentally and physically. By being present in the centre of the development immediate feedback from the development activities can be gained.

Usage involves human behaviour which is strongly linked to context, environment and time and is a good example of a complex relation. The study of usage in actual environments as has been focused on in this chapter is one important tool to find out about what tricky situations there are to be handled.

5.4 Interdisciplinary teams

To be able to effectively deal with Universal Design-based development, a lot of knowledge and experience from separate fields is needed, which is why various professions should be represented in the teams. This prerequisite is almost adopted in all development processes in society today. Team composition has proven to be of extreme importance for outcome.

How one design the team is said to affect the performance 40 times more than coaching a team (Hackman, 2002). There is a risk of achieving too little cohesion in a group of disparate talents, and if there are personality differences, communication within the team is hampered. A heterogeneous group performs better than a homogeneous (Pech, 2001) as most decisions taken are intensively motivated, the group represents a holistic view and different perspectives are represented. Respect for other knowledge than that which you yourself have is important in all forms of team work. Team leaders' job is often a balancing act between achieving goals, deadlines and cost limits, which is why important communication within the team and with other stakeholders might sometimes be less than required.

Several of the projects initiated by municipalities or regions and relating to the design or equipment in the public domain are purchased through so-called public procurement. Companies are asked to give a quote for the product or services requested based on a list of demands put together by the purchaser. Low price is the most valued variable when the offers are examined and variables like accessibility, usability, etc. are not addressed at all as knowledge is lacking among the purchasers on how those demands could be addressed in the list of demands. Interdisciplinary teams are needed at different levels in the system to prevent that disabled and other groups become excluded and discriminated, ultimately prevented from using the public domains.

Understanding user requirements on a holistic basis requires a focus and attention to the roles that products play in people's lives. Ethnographic methods may be particularly useful in this context as their use may give rich insight into the roles that people have in different situations in life. Such methods tend to be qualitative in nature.

6. Some examples of UD visions in companies today

6.1 Toshiba

Toshiba America, Inc. (TAI) is the holding company for one of the leading groups of high technology companies, with a combined total of approximately 8,000 employees in the U.S. Together, the U.S.-based companies under TAI's umbrella manufacture and market represent a widely diversified range of modern electronics, each conducting research and development, manufacturing, sales and service in its field of expertise.

Toshiba Group is collaborating with internal and external specialists on product development in various fields, including home appliances, housing facilities, information equipment, and public facilities. By applying a human-centered design process emphasizing the users' perspectives and incorporating customer requirements, the Toshiba Group believes they contribute to realization of a society where everyone can live at ease and in comfort regardless of age, gender and abilities"(www.toshiba.com).

On their website an ambition has been formulated which tells about a new way forward "Transforming "can't use" to "able to use", "hard to use" to "easy to use", Toshiba's universal design aims to create products accessible and safe to use for everyone. With the perpetual drive for innovation, Toshiba continues to explore ways to create more convenient and easier to use products which, will meet even greater number of peoples' standard for "want to use"(www.toshiba.com).

The Universal Design (UD) Promotion Working Group (WG) established in 2005 is striving to incorporate the universal design concept in development steps and is promoting dissemination of information on Toshiba's universal design internally and externally. The triangle in fig 3 constitutes of the three main and important parts which Toshiba argue are the most important for creating products accessible and safe to use for everyone. Some of the seven UD principles have been adopted as specially important.



Fig. 3. Toshiba Group Universal Design Guidelines.

- Intuitive use
- Simple use
- Low physical effort
- Equitable use
- Safety and minimal anxiety

6.2 Omron

Omron Corporation was founded in 1933 in Kyoto, Japan, and Omron Healthcare is a subsidiary of that company. Omron is one of the leading distributors of medical, home health care, and wellness products worldwide.

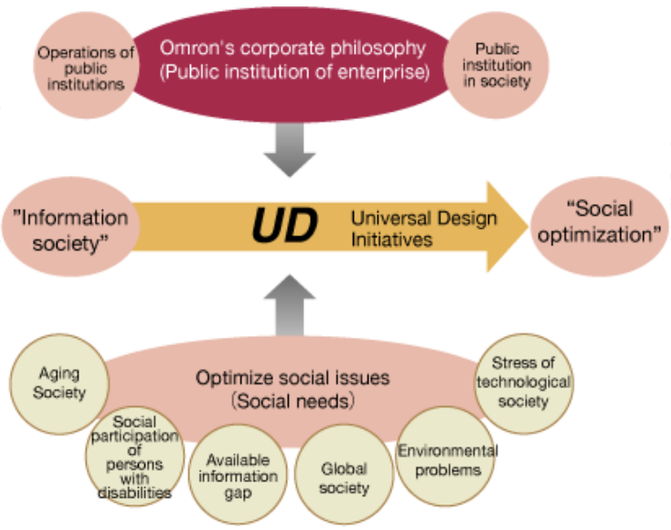


Fig. 4. Omron's idea of Universal Design.

Omron has a vision and a philosophy which is "Sensing tomorrow"(www.omron.com). That vision is from a demographic perspective a very good one and as customer satisfaction is in focus the promotion of Universal design to make products easy to use by a broad range of people it fits in to the companies idea of Universal design.

6.3 The Careva systems AB

Careva Systems AB is a small-sized Swedish enterprise started in 1998. It specializes in positioning equipment for safe and comfortable transportation of persons with disabilities in vehicles cars, vans and buses. The vision behind the development of the company's existing product range is that "everyone should have the right to travel in vehicles in a safe and comfortable way. To be able to realize the vision two product lines have been developed" (www.careva.se). Careva's idea of UD is that all kinds of users should be able to use all kinds of transport systems



Fig. 5. The idea behind the Company´s product line.

1. *Careva belt – a modular based system* for optimization of the individuals requirements, differently designed parts can be mounted together to meet the personal requirements of the individual, a traditional assistive technology device.
2. *Crossit belt – a universal design solution* meaning that the same solution can be used by most users who requires a positioning support in vehicles without individual adaptation and additional items.

The company´s strategy to offer both modular and UD solutions is interesting. As the modular based system were introduced to market several year ahead of the UD solution which was introduced to market less than a year ago. Perhaps the company discovered the new trends and a market request for UD solutions.

6.4 Society concern

In Figure 6 below the relation between the "Private room" and the "Public room" is illustrated with the aim of putting focus on the increasing need for intervention but also on the difference in requirements for how environments and products are designed dependent on the individuals performing activities there.

First, in the "Private room" (here understood as the home), the focus is on the individuals living there and the environment and products are created towards their requirements (often in the family context), an individual design. The persons act as users but also as customers, meaning they use their own judgment choosing the products they buy and the environment becomes a result of their choices and creativity. However, today many of the people who live with a mental or physical disability reside in group homes, institutions, nursing homes or at home with their parents. This means that somebody else is in control and setting the rules. Even if a person may be in need of assistance it is also important that he or she have a measure of autonomy. Most people experience the advantage of living in their own home as it means one can be in control.

The private room must fit on a detail level to promote the independence and empowerment of the individual without being an institutional setting which could have negative effects for other family members. Home modification and Assistive Technology make it safer and easier for people with disabilities to live independently Assistive technology is in this context defined as; technology used by individuals with disabilities in order to perform functions that might otherwise be difficult or impossible. If Universal Design solutions could enter also into the private room it would facilitate intervention and reduce the number of special solutions in the field of AT.

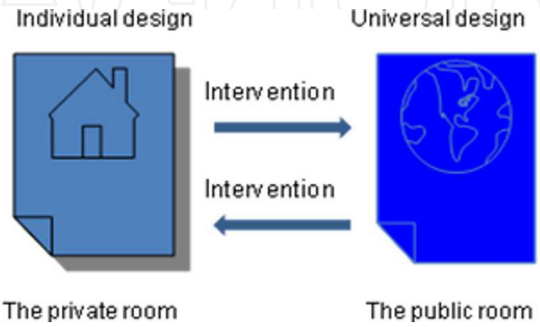


Fig. 6. The relation between the "Private room" and the "Public room".

In the "Public room" on the other hand, solely Universal Design solutions are required to optimize usage by as many people as possible; a true demand for professionals designing buildings, outdoor environments and services. How to design an entrance in a public building? How to design the information system in the public transportation system to be accessible and understandable to as many as possible? What is to consider when purchasing benches for use in a public park? How to create a playground with accessibility for children with different abilities? Professionals compete to offer "the best solution" for the city or the municipality after considering all the demands that have been sat up by the purchasing representatives. The competence and experience among the purchasing representatives is of outmost importance as the public procurement establishes the rules for what solution should be accepted. Unfortunately the purchasers are not familiar with the Universal Design concept but consider cost as the most important variable. Knowledge about UD in Public procurement processes have a huge impact on how fast the UD concept can be accepted and implemented in public arenas in society.

Laws and regulations have been established in several countries to safeguard to democratic rights and to prevent segregation due to ability, age, gender or ethnicity. They are meaningless, however, unless wedded to policies and practices that challenge the realities of property development and design dynamics. Economic and cultural rationales and values drive these realities and, in doing so the needs of diverse users of the built environment are often overlooked (Imre & Hall, 2001).

One area obviously not prioritized at design/engineering schools is learning about the Universal Design concept and how to perform real UD solutions. Companies and consultancy firms need guidance to be able to fulfil the intentions of an inclusive society. Except from implementing laws and regulations, society should take responsibility for the change towards UD solutions in the public room getting the right prerequisites otherwise it will be a flop.

The intervention becomes more intense the number of elderly become more mobile and require public services. Physical accessibility has also improved during recent years, which offers new opportunities for groups of users who were previously locked out. The private room has furthermore become a working place where home services of different kinds need to be carried out and where demands for a good and safe working environment for staff is present. All aspects together make Universal Design a socioeconomic factor, a human/quality of life factor as well as a market/business factor.

6.5 The demographics

The number of individuals with some form of disability has, in Europe, been estimated to be between 12 and 15% of the population, a figure which is increasing due to a growing number of elderly but also the fact that disability statistics tend to count those individuals who are registered as permanently disabled, occasional disabled who would benefit from a more accessible environment or increased usability in products is not included in the figures. The consequence is that disability statistics almost certainly underestimate the number of individuals who experience limitations in activities due to reduced body function.

Demographics require companies to abandon the concept of targeting only young and fully capable customers (Grassman & Reepmeyer, 2008). They need to create new products that are attractive to a broader customer group. Products that follow the principles of Universal Design do not separate but integrate customer groups, and they can also substantially increase a company´s targets.

The 50+ generation turns out to be one of the most attractive target groups. The "new" elderly generation is much more vital and has a higher purchasing power compared to the "older" generation. Research on the economic potential of demographic change is fairly limited. Most studies relate to customer segmentation approaches and defining the needs and special demands of older customers (Grassman & Reepmeyer, 2008). Considering the future, companies have no other choice than developing products independent of customer´s age and ability to be successful. The concept of Universal Design represents a standard, not an exception, and Universal Design intentionally avoids highlighting the users' and the customers' different capabilities.

In order to identify and define processes that allow implementing Universal Design strategies, a closer look at the older customers' specific capabilities and abilities has proven to be a very effective first step. Physical and mental capabilities usually worsen with old age. Many age-related medical conditions lead to the fact that sensory capabilities and velocity-related activities decline. Vision usually starts to deteriorate at an age of around 40. The eye's abilities relating to contrast and colours are usually impaired by then. Starting at around 60 years of age, more severe constraints frequently occur. Hearing impairment usually starts at an age of around 60, the same age where the muscular strength usually starts declining as well. For example, a 60-year-old has on average 15–35% less muscular strength than a 20-year-old (Grassman & Reepmeyer, 2008).

Taking all these factors into account, adding also the changes in mental capability researchers in gerontology have come to the general belief that people beyond their mid-60s

face considerable multi-morbidity issues (Grassman & Reepmayer, 2008). However, studies have shown that substantial losses of physical fitness only correlate for people with an average age of over 85. Figure 7 illustrates the increasing need for assistive technology in older age.

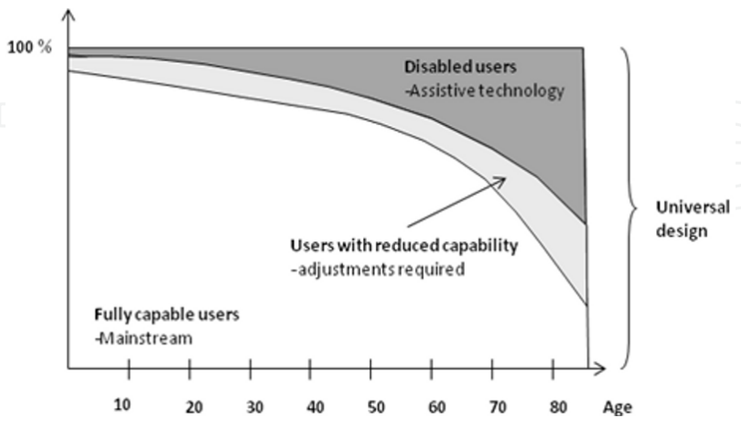


Fig. 7. An illustration of how different groups of users are represented in relation to age (Ottosson, 2009).

Users with severe mobility problems (in black, in Figure 7) require assistive technology, often individually developed solutions. Mainstream products and modular based systems can also be adjusted to fulfil their requirements. Users with reduced capability (in grey, in Figure 7) represent those who require smaller adjustments of mainstream products to maintain independence. Often modular-based systems can be used without adjustments.

Figure 7 also illustrates that below the age of 50, about 80-85% of all users are fully capable and use mainstream technology products. Over the age of 50 the number of users who require assistive devices or adaptations increases. Users with disabilities increase nearly linear from the age of 60 up to 80 years of age.

7. Conclusion

The discussion in this chapter has focused on the prerequisites companies require to be able to be an active part in the BUS triangle for an inclusive society. Without the physical solutions products and systems supplied by the business sector the argumentation becomes more of a vision than a reachable realistic goal. In the argumentation for a Universal Design perspective to the benefit of a democratic and inclusive society, more is required to make the companies invest in UD solutions.

What is too little discussed is the complexity connected to the development of UD solutions and the fact that when innovations and new products are required, modular design is often inappropriate. As time-to-market is longer and project costs are often higher for universally designed products in a short perspective compared to modular systems, there can be limited commercial reasons to invest in universally designed solutions in a short-time perspective (Björk 2010). Some benefits have been argued for companies to invest in UD solutions:

- Can be quickly communicated to customers/users.
- Covers a bigger market.

- Requires less logistics in production and marketing compared to modular-based design products.
- Contributes to savings in marketing.
- Contributes to innovation and future expansion toward a sustainable society.

Of the three main parts comprising the BUS triangle, society and the user clearly benefits from UD concept. However, the business sector, supplying with the physical solutions have to calculate costs with higher margins than for modular-based or mainstream technology products. The time to break-even in these projects is many times longer due to the unstable and complex development circumstances. Nevertheless, within a longer time perspective UD solutions might contribute to success. Consequently, support from society, both in financial terms and in improving competence in industry, is essential to ensure that new methods for product development become known and practised for guiding the creation of UD solutions.

8. References

Bellerby, F.,Davis, G. (2003). *Defining the limits of Inclusive Design,* Proceedings of Include 2003. London Royal College of Art pp 1:00-1:17

Björk, E. (2003). *Insider Action Research Applied on Development of Assistive Products,* PhD Thesis, Otto-von-Guericke University, Magdeburg, Germany.

Björk, E., Ottosson, S. (2007). *Aspects of Consideration in Product Development Research,* Journal of Engineering Design, 18(3): 195–207.

Björk, E. (2010). *Why did it take four times longer to create the Universal Design Solution?,* International Journal of Technology and Disability, 21(4): 159-170.

Blessing, L. (2003). *Future issues in Design Research* in Lindemann, U. (ed) *Human behaviour in Design,* Springer Verlag ISBN 3-540-40632-8, Germany, pp 298-303

Buurman, R.D. (1997). *User-Centered Design of Smart Products,* Ergonomics, 40(10): 1159–1169.

Coghland, D. (2001). *Insider Action Research: Implications for Practising Managers,* Management Learning, Vol. 32, No 1, pp 49-60

Connell, B.R., Jones, M., Mueller, J., Mullick, A., Ostroff, E., Sanford, J. Steinfeld, E., Story, M. & Vanderheiden, G. (1997). *The Principles of Universal Design,* Version 2.0, North Carolina State University, Raleigh, North Carolina. *http://www.design.ncsu.edu/cud/about_ud/udprincipleshtmlformat.html*

Cooper, R. (1986). *Incorporating Human Needs into Assistive Technology Design*, in Gray. David B. et al., *Designing and Using Assistive Technology,* Brookes Publishing Co, Baltimore, Maryland, pp 151-170

Council of Europe (2007). *Achieving full participation through universal design*. Committee of Ministers Resolution ResAP (2007)3.

Dong, H., Keates, S., Clarkson, PJ. (2004) *Inclusive Design in Industry, barriers, drivers and business case.* Proceedings of ERCIM Workshop "User interface for all", Austria

Duncan, R. (2007). *Universal Design Clarification and Development,* Internal report for the Norwegian *Ministry* of Environment, Government of Norway.

Edmonds, H. (2000) *Focus group Research Handbook,* ISBN ISBN-13: 978-0658002489 Mc Graw

Edefors, H. (2004). *Product development and design and other paradoxes*, PhD Thesis, Lund University, Dept. of Design and Art, Sweden.

Emiliano, L. (2009). Perspectives on Acessibility: From Assitive technologies to Universal Access and Design for All,(in the Universal Design Handbook, ed. Stephanidis.C., CRC Press, Taylor & Frances, pp.1:1 – 1:11

Mullick, A., Ostroff, E., Sanford, J. Steinfeld, E., Story, M. & Vanderheiden, G. (1997). *The Principles of Universal Design,* Version 2.0, North Carolina State University, Raleigh, North Carolina.

Ginnerup, S. (2010). *Achieving full participation through Universal Design*, ISBN-13-9789287164742, Ingram International

Goodman, J., Dong, H., Langdon, P. & Clarkson, P-J. (2006). Increasing the uptake of inclusive design in industry, *International Journal of Gerontology*, 6(3).

Grassman, O. & Reepmeyer, G. (2008). Universal design - Innovations for all ages, in Kohlbacher, F & Herstatt, C (eds.), *The Silver Market Phenomenon: Business Opportunities in an Era of Demographic Change*, ISBN 978-3-540-75330-8, Springer,Berlin.

Hackman, J.R. (2002). *Leading teams. Setting the stage for great performances,* Harvard Business School Press, Boston ISBN 1-57851-333-2.

Holmdahl, L. (2007). *Complexity Aspects of Product Development*, PhD thesis, Otto-von-Guericke University, Magdeburg, Germany.

Imrie, R. & Hall, P. (2001). *Inclusive Design: Designing and developing Accessible Environments,* Taylor & Frances, New York

Jensen, Lilly (2001). *User Involvement, in Development and Evaluation of Assistive Technology, Nordic Development Centre for Rehabilitation Technology,* NUH, Tammerfors Finland, Joma Tryck AB

Jordan, P.N. (1998). *Human Factors for Pleasure in Product Use,* Applied Ergonomics,29(18):99, 25.

Jordan, P. (2002). Designing pleasurable Products, Taylor&Frances ISBN-13: 978-0658002489

Keates, S. et al (2000). *Investigating industries attitudes to universal design,* proceedings of Rehabilitation Engineering and Assistive Technology Society of North America, RESNA, Orlando, USA

Mace, R.L. (1985). *Universal Design, Barrier-Free Environments for Everyone*, Designers West, Los Angeles.

McKelvey, B. (2004). Toward a complexity science of entrepreneurship, *Journal of Business Venturing*, 19: 313–341.

Nelson, H. & Stolterman, E. (2003). *The Design Way -- Intentional Change in an Unpredictable World,* Educational Technology Publications, New Jersey.

Ottosson, S. (2004). *Dynamic Product Development* - DPD™, Technovation - the International Journal of Technological Innovation and Entrepreneurship, 24: 179–186.

Ottosson, S. et al (2006). *Research Approaches on Product Development processes*, International Design Conference – Design 2006, Dubrovnik, Croatia

Ottosson, S. (2009). *Frontline Innovation Management – Dynamic Business & Product Development*, Ottosson & Partners AB, Sweden (ISBN 978-91-977947-7-0).

Paulsson, J. (2005). *Universal Design Education Project – Sweden*, School of Architecture, Chalmers University of Technology, Gothenburg, Sweden.

Pech, R. J. (2001). *Reflections: Termites, Group Behavior, and Loss of Innovation*: Conformity Rules!, Journal of Managerial Psychology, 16(7/8): 559.

Prakash Y., Bimal P., Rakesh J. (2007). *Managing product development process complexity and challenges: a state-of-the art review*, Journal of Design Research, 6(4): 487–508.

Schön, D.A. (1983): *The Reflective Practioneer*: How Professionals Think in Action, Basic books, New York

Shahmanesh, A. (2003). *Age Concern*, Automotive Engineer, January 34–36.

Sims, RE. 2003. *Design for all: Methods and Data for Support Designers*. PhD thesis, Loughborough University, Loughborough, United Kingdom

Steinfeld, E. (2002). *Universal Designing,* in Christoffersen, J. (ed.): *Universal Design,* ISBN 82-90122-05-5, pp. 165–189, PrePress ,Haslum Grafiske, Norway

Story, M.F., Mueller, J. & Mace. R. (2001). *The Universal Design File, Designing for People of all ages and Abilities.* North Carolina State University, Raleigh, North Carolina.

Barne-, likestillings- og inkluderingsdepartementet [Ministry of Children, Equality and Social Inclusion]. (2009). Norge universelt utformet innen 2025. Regjeringens handlingsplan for universell utforming og økt tilgjengelighet, Government of Norway. URL: *www.regjeringen.no.*

Wijk, M. (1997). *Differences we share*, Faculty of Architecture, Delft University of Technology, Netherlands.

von Hippel, E. (2005). *Democratizing Innovation,* The MIT Press, Cambridge, Massachusetts, London, England.

von Hippel, E. (1998). *The Sources of Innovation,* ISBN 0-19-509422-0, Oxford University Press, New York

von Hippeln , E. (1986). "Lead Users: A Source of Novel Product Concepts", *Management Science* 32(7): 791–806, http://www.jstor.org/stable/2631761

www.toshiba.com, http://www.toshiba.co.jp/design/pr/ud/intro.htm

www.omron.com, http://www.omron.com/media/press/2008/03/h0325.html

www.careva.se,http://www.google.com/search?hl=sv&q=careva+systems+Universal+design



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This book offers the reader new achievements within the Assistive Technology field made by worldwide experts, covering aspects such as assistive technology focused on teaching and education, mobility, communication and social interactivity, among others. Each chapter included in this book covers one particular aspect of Assistive Technology that invites the reader to know the recent advances made in order to bridge the gap in accessible technology for disabled or impaired individuals.

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