BRIGHTENING UP THE LIVES OF SENIORS

- Lighting as medium when designing wellbeing supporting environment

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ABSTRACT

Lighting is evidently an important element of built environment. Due to financial constrains uniform standard design solutions are often applied in the construction industry which may not serve all the user groups. This applies also in lighting solutions. The user experience of built environment is not similar for every user group. Among other special groups, seniors have special needs related to accessible built environment in which lighting can play supporting or limiting role depending on the lighting design and its implementation.

A lighting study, exploring wellbeing supportive lighting, was conducted as part of “MONA”, a multidisciplinary project, aiming at promoting social and physical accessibility in built environment concentrating on public and semi-public spaces. The goal of the study was to explore the possibilities of supporting the wellbeing of seniors when the medium is light; how can lighting eliminate daily challenges seniors face, how can lighting enhance positive spatial experience or as an ultimate goal increase happiness?

A lighting design concept proposal was created based on the results of user studies and findings from literature related to multisensory environment, lighting and wellbeing, vision and ageing. User-centeredness and empathic design were the main approaches applied in the process while prototyping-driven attitude was the leading method for proceeding from conceptual ideas to an implementation plan to be applied when piloting the ideas in real assisted living building site.

Evidently, lighting affects the accessibility of built environment even though as being rather an intangible element its effects cannot be easily indicated. However, lighting as a mean can be utilized in order to enhance intangible accessibility e.g. in the form of assisting spatial perception and orientation in space, atmosphere of safety as well as emphasizing mental and social accessibility e.g. including interactive elements in the lighting installation in order to prompt space users’ feelings, possibly even enhancing the feeling of happiness.
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INTRODUCTION
INTRODUCTION
This architectural lighting design thesis project, completing master program studies at KTH Royal Institute of Technology, is part of larger scale research project called MONA conducted in Aalto University, Finland. I got involved in the project while working in MIND Research Group of Aalto University. A couple years history of working as part of a multidisciplinary team concentrated on strategic innovation, in particular experimentation and service development, affected also how this thesis project was approached, mostly influencing the theoretical framework and the driving attitude of the project. MONA is a multidisciplinary project concentrating on wellbeing supporting built environment. In addition to lighting design study also other individual studies were conducted during the project in the fields of cognitive science focusing on cognitive maps, user research based on methods drawn from art therapy, usability research about database for architects and designers as well as an automated system development for measuring user behavior in spaces. The studies were run parallel; some of them complementing each other and therefore the findings were utilized and applied across the different studies. In the lighting study the focus was on the user experience of seniors in residential environment in order to develop lighting in semi-public and public spaces to support wellbeing.

THE CONTEXT OF LIGHTING STUDY - MONA RESEARCH PROJECT
The main goal of the project “MONA - multisensory experience of living environment” was to multidisciplinary examine and develop a social, stimulating and multisensory environment for seniors. The research and piloting objects were public spaces of existing residential environments for seniors in Helsinki.

BACKGROUND OF MONA
“Due to financial constraints in the building industry, uniform design solutions and building materials are being used. The originality, cultural and historical stratifications of the environment disappear and way-finding is becoming difficult. In this multidisciplinary study, individual, effective and memorable experiences in residential environments are developed by means of architecture, the arts, and cognitive and usability research.

The user experience of the built environment is not the same for all user groups; in particular, elderly and disabled people. Good design promotes social wellbeing and the notion of “ageing in place”. Beneficial spatial design will help in way-finding and will also increase safety. The goal of this research is to develop user-centric, multisensory residential environments that promote social and physical accessibility.

This study is a multidisciplinary opening in the Finnish research area related to common spaces of residential environment, focusing on the possibilities of connecting science, technology, the arts and new practices in order to develop the versatility of the semi-public and public spaces. The experience is attained by means of acoustics and lighting as well as through spatial, urban and landscape planning. The study focuses on indoor and outdoor spaces in residential environments, including staircases, common spaces, entrances and courtyards.” (MONA research plan, 2010)

OTHER STUDIES OF MONA PROJECT UTILIZED IN THE LIGHTING STUDY
User study of Sara Ikaävalko concentrated on how users’ desires and needs can be researched by applying methods from art therapy in interactive user interviews within the MONA project as an individual master’s thesis project. The collected user data e.g. desires, dreams, experiences, needs as well as fears of seniors were considered as an important source of user knowledge when designing the lighting concept for piloting. Also findings from a cognitive science study conducted by Christian Sanne-mann were utilized when defining the lighting pilot proposal. User information drawn during conducting cognitive walkthroughs provided also useful information applicable to lighting concept proposal.
MONA CO-OPERATORS
A variety of stakeholders were involved in MONA project. In addition to researchers and research assistants the project was supported by several experts from different disciplines, organizations and companies related to the context of multisensory built environment for seniors. The project started in the autumn 2010 and finished in summer 2012. The main financier of project was Tekes - the Finnish Funding Agency for Technology and Innovation.

OUTLINES AND GOALS OF THE LIGHTING STUDY
The importance of lighting as a part of the built environment is significant and lighting also had a central role in the research project. In MONA research project wellbeing supporting environment was defined as an environment that promotes social and physical accessibility therefore lighting qualities related to enhancing sociality and physical accessibility in senior environments was studied. The focus of the lighting design research part was to create a concept of wellbeing supporting lighting installation based on findings from literature, user studies conducted in MONA project and knowledge from previous research projects I have been involved related to product and service development for improving seniors life. User-centeredness was naturally the main approach when concentrating on the specific user group. Therefore the concentration during each different stage of the process was on the seniors and their needs, challenges, dreams and desires. All the lighting design decisions and judgments when designing the lighting concept for piloting were made based on the knowledge of and from the users:
- user comments captured during observation, informal discussions, interviewing
- results of other studies conducted during MONA project e.g. cognitive walkthroughs and dreams and challenges defined in workshops and diaries related to a focus group study in a sheltered home

RUNNING PILOTING
The findings and knowledge were transformed to a lighting installation concept piloted in the environment of the target user group to test if lighting hypotheses behind the lighting concept were meaningful and enhanced the feeling of wellbeing as well as aiming at increasing the understanding of how lighting as a medium can support seniors’ well-being in general – what are the special needs and possible preferences (if generalizable) of seniors related to lighting. Prototyping-driven attitude played a central role of the process; small scale rough prototyping with real users in senior housing environment was run before the actual pilots to collect feedback and have a possibility to iterate and redefine lighting concepts to meet user desires better before the larger scale testing. The pilots were realized together with Fagerhult Finland.

As an ultimate goal of the piloting, was to test if the new lighting installation affected seniors’ behavior. This is why senior’s behavior was monitored before and after the lighting piloting was mounted. The senior inhabitants were also interviewed to be able to understand how they felt about the change and how did they perceive the new lighting setting.
SENIORS - POSSIBLE LEAD USERS
Seniors as a user group with special needs can be regarded as lead users when developing environments which promote well-being. Would not multisensory environments that reinforce wellbeing and minimize challenges of aging e.g. memory loss, subsidence or disability of senses or movability issues, be better environments for any kind of user and usage? Therefore the results of this lighting study are meant to be relevant and applicable for a variety of users and usage environments depending on the function of the space, not only recommended to be applied to senior or hospital environments but also other type of public spaces.

THE CHALLENGES OF DESIGNING FOR SENIORS
Issues and challenges can be identified that many seniors will face sooner or later in their life as well as common dreams and preferences of what is important or meaningful in order to live happily. The number of senior citizens in relation other age groups is increasing remarkably in the near future. According to Hynynen (seminar speech 2012), Housing Counselor of Finland’s environmental administration, in the year of 2030 the number of over 55-year-old citizens will reach 2.2 million while the total population of Finland is only 5 million. Considering this fact good multisensory environmental design should be paid more attention to in order to support this vast group of seniors to live longer happily and healthy and faring better independently.

The challenge of creating wellbeing supporting environments for seniors is its complexity and fragmentation into different fields and specialists without common approach or knowledge to apply. In Finland the senior care services are very much concentrated on medical care, aiming at maintaining physical condition instead of concentrating on people holistically paying also attention to “happiness dimension”. Without denying the importance of nutrition, medicines, housekeeping help and hygiene as wellbeing supportive I would like to emphasize the importance of supporting other type wellbeing than “functional wellbeing”. When concentrating on services that increase wellbeing and happiness related to their intangible forms e.g. as structures or elements of built environment we can more likely succeed in creating and providing solutions that rather improves life quality than maintains it or supports only surviving.

USER-CENTERENESS
Very often when designing environments for seniors the actual users of the spaces are neither involved in the design process nor listened to what they have to say, even though undeniably they are the best experts of their own life. This is what should be changed, the ones designing for seniors should preferably involve the users in the process or if not possible to have an understanding of the specific user group. Studying the users to understand their life and what creates happiness for them helps designers to focus on real needs and desires instead of relying only on personal insights and stereotypic assumptions of the users.

HAPPINESS AS A FUNDAMENTAL DESIGN GOAL
Food, drugs and shelter only fulfill the lowest level needs as well as helping aids, equipment and other functional gadgets assist in the situations of disability. Both categories are separated from the most desired element of life – happiness! Even though the focus of the MONA project was on social and physical accessibility of built environment, one of the fundamental dream goals of the lighting research study was to understand in bigger scale, if and how possibly lighting could be utilized as a mean when enhancing feeling of happiness. Isn’t it so that happiness is always the ultimate goal of life for people? Therefore happiness cannot either be forgotten when designing built environment. As designers we can make a choice and strive for designing objects, environments or services to fulfill higher level needs than basic ones. Therefore interesting research question to carry with through the research was: What could be the ingredients that make people happy, healthy and active and embody the elements in the form of lighting design proposal as an attempt to impact on the happiness of the inhabitants living in senior housing in addition to providing sufficient lighting levels and creating certain type of atmosphere through lighting? Keeping the dimension of
happiness in mind also when designing for a user group that I as designer find challenging to relate to, it is more likely possible to be able create a proposal that at least could end up being meaningful and create value for the user.

FOR THE READER
This thesis presents a point of view on how to tackle lighting design challenge with user-centric approach processing with prototyping-driven attitude to outline a senior environment specific lighting concept and summarize the findings as practical tips for professionals designing built environment for seniors.

In the theory chapter is presented theoretical background that opens up the background points affecting the lighting design proposal. Theoretical sources are an input collection of concepts from different fields because of the complexity of the context. The next chapter describes the methods applied in the concept developing process and the leading attitude during the process. That chapter describes how piloting, the leading research method of the lighting research, was supported with activity data recording and interviewing. After all background fundamentals are introduced follows process description pinpointing how the theory and user knowledge gained during the entire MONA project is transformed to a lighting design concept piloted in a real assisted living building site including an interpretive analysis of the practical implementation and its user feedback. As an utilizable result of the project, findings of the study might be translated to practical tips entered in Arvi assessment tool which is an open data base for professional practitioners designing built environments emphasizing accessibility administered by The Housing Finance and Development Center of Finland. In the end of the thesis the results of the project related to its wider context are discussed.
THEORETICAL FRAMEWORK

CENTRAL CONCEPTS
In this theory chapter is presented theoretical concepts that explains the background points affecting lighting design process of the project. As the project context is rather complex and there isn’t any comprehensive and obviously definable singular background theory, this chapter presents theoretical sources in the form of theory injections of the fundamentals supporting the wider context, its main concepts emphasized and chosen approaches to the topic as being leading fundamentals behind the whole process. First is presented a background theory for designing multisensory built environment emphasizing lighting perspective. After introducing the wider context background theory, theoretical injections of lighting and wellbeing as well as vision and ageing are presented. In the end are introduced theoretical ideas about user-centeredness and happiness as design fundamentals.

MULTISENSORY ENVIRONMENT
Jokiniemi (2007) provides an interesting approach in his doctoral thesis related to environmental design. As being actually visually impaired himself in addition to his professional knowledge about lighting and built environment in general, he has the firsthand experience as a support when pointing out how important paying attention to all elements of built environment affecting sensory perception.

All the multisensory ideas presented in this chapter are based on Jokiniemi’s PhD dissertation (2007) about multisensory environment. According to him good environmental design considers all the senses both singly and jointly. Spaces cannot be experienced only through vision but the spatial dimensions are perceived simultaneously with all the body and its senses. Related to how people perceive world around them Gibson (1966/1983, cited in Jokiniemi 2007) presents a categorization of senses as perceptual systems as 1) the basic orientating system, 2) the haptic system, 3) the auditory system, 4) tasting and smelling as perceptual system and 5) visual system. All these system are utilized while experiencing world whether we are acting in familiar space or orientating in new environment. However, Jokiniemi (2007) states if there is a contradiction between different sensorial messages interpreting those perceptual messages becomes challenging. When an environment contains rich and versatile stimuli e.g. visually impaired people have to use maximum capacity of their attention to be able to orientate and survive.

Nevertheless, Jokiniemi also states that environment has to be challenging enough in order to provide stimuli. Multisensory environment rich of stimuli, offers versatile sensory experiences which makes it easier for the user to form a pleasurable cognitive map of the space. However, stimuli cannot be based on neglecting accessibility. Stimuli-crowded spaces strain the power of observation, e.g. shopping malls. The same information can be messaged to the user through all different senses. A good multisensory experience requires a balanced combination of different sensory prompts e.g. when emphasizing visuality over other sensory stimuli of a space the same benefit cannot be obtained than when designing a space that stimulates all the senses delivering the same messages.

However Bertelson & de Gelder (2004, cited in Jokiniemi 2007) have stated that vision dominates over other senses, therefore lighting plays an important part when perceiving built environment and it should emphasize the most important elements of the space supporting accessibility and orientation as well as consort with other sensory stimuli the space. According to Jokiniemi multisensory stimuli are in balance in nature and because of that often the feeling of being disabled (related to senses) disappears. Creating similar effect should be also the aim when designing built environments. Because acting in built environment is a challenge for people with weakened or disables senses, this should be considered also when designing lighting for public spaces. In addition to avoiding or communicating about upcoming physical barriers accessibility also includes rather intangible accessibility avoiding e.g. creating optical illusion with lighting and confusing perception.
Jokiniemi (2007) addresses that visually impaired are actually even more demanding user group than seniors when it comes to lighting design even though it is not rare that a senior belongs sooner or later to both of these reference groups. Therefore the special needs of visually impaired are applicable also when designing lighting for seniors. There are some exemplary guidelines to be considered when designing lighting for public spaces:

- Visually impaired people can be considered as even more demanding user group than seniors when it comes to lighting design. In general light levels below K4 (5lx) are not sufficient for seniors and visually impaired people. When lighting is limited to that level the possibilities of utilizing tactical sense have to be considered when designing built environment. (Jokiniemi 2007)

- Level changes are a big safety risk particularly for seniors because of risk of heavy injuries in case of falling down. Therefore when walking in the stairs the co-operation between senses is emphasized. Poor vision is one cause and when a step is not perceived or when a floor material change is mistakenly seen as change of level accidents can occur. Visual messages can support keeping balance in the stairs. To avoid that and enhance moving with confidence of visually impaired people the directionality of lighting must enhance the view of floor plane emphasizing continuity and indicating changes of level (Jokiniemi, Torrington & Tregenza 2007).

**LIGHTING AND WELLBEING**

Boyce (2007) addresses that knowledge about light and wellbeing is still rather discursive and therefore further research is needed to be conducted in the area. Veitch (2005) states that there are many open research questions related to the discourse of light and health to be answered with sufficient clarity and certainty to support lighting practice recommendations. She states that ‘fundamental research about the effects of light on biology, behavior, and health is a rapidly-advancing field’. In the discourse of light and wellbeing there are e.g. discussions about the benefits of daylight, lighting affecting circadian rhythm as well as discussion of the effects of lighting in working environments. All these discussions are cut out from the scope of this thesis while the concentration is more on individual wellbeing (see figure below), and how to support or stimulate it utilizing lighting as a medium. Ideas related visibility, activity, socializing and safety were created during the design process while ideating the lighting concept to be piloted.

**VISION AND AGEING**

Physical changes are part of ageing e.g. often all senses weaken and movability reduces. Nevertheless, there is a great variation in the vision of seniors (Torrington & Tregenza 2007) because a number of changes in the structure and capabilities of visual system occurs while ageing.

[Diagram: Lighting quality model (Veitch 1998 presented in Veitch 2006).]
(Boyce 2003). Physical changes in eyes affect vision in many ways; dark-to-light and light-to-dark adaptation slowers gradually, accommodation reduces, and reduction of both contrast and illuminance of the image projected onto the retina as well as raised sensitivity to glare (Boyce 2003, Halonen & Lehtovaara 1992, Liljefors 1999, Torrington & Tregenza 2007). Also increased prevalence of retinal dysfunction induces an increased need for light, very high levels of illuminance can compensate deterioration of vision (Torrington & Tregenza 2007).

Eye diseases become general when ageing e.g. cataract is a common illness which typically progress slowly and causes loss of vision. All the eye diseases affect vision differently and therefore the special needs of visually impaired might vary considerably considering lighting.

According to Figueiro (2011) ‘the visual system plays an important role in addition to perception and orientation in maintaining balance when moving. As a person ages, usually gait becomes slower and stride becomes shorter, especially in dimly lighted environments. Risk of falling has been associated with reduced speed and increased gait variability’.

In addition to low vision and eye diseases there are several ageing related conditions that also set special requirements for lighting. Dementia is one of them and according to Utton (2007) a demented person might perceive a sharp shadow or strong contrast as an obstacle or gap. These kind of false interpretations are not only result of impaired vision even though low vision can worsen the situation.

Liljefors (1999) states that “freedom of glare” is a primary condition when regarding lighting requirements for seniors. Related to this Torrington & Tregenza (2007) suggest that glare from light sources within fields of view should be low in luminance or indirect and the light sources should be positioned away from sight directions of users.

According to ageing related special needs for lighting some guidelines can be drawn e.g.:
- Higher lighting levels
- Emphasizing main structures of the room to support perception and orientation
- Minimizing glare
- Avoiding uniformity of lighting
- Avoiding sharp shadows and very strong contrasts

USER-CENTEREDNESS & EMPATHIC DESIGN

Usability Professionals’ Association [UPA] (2012) defines user-centered design (UCD) as “an approach to design that grounds the process in information about the people who will use the product. UCD processes focus on users through the planning, design and development of a product.” UCD is often applied in software design particularly when designing interfaces as well as in the field of product design when concentrating on usability of some specific product. ‘UCD is a term describing design processes in which end-users involve and influence on how design takes shape’ (Abras & al. 2004). Actually today the importance of usability is widely recognized as critical to the success of products or interactive systems (Shackel 1981, 1984; Eason 1984; Whiteside, Bennett & Holtzblatt 1988; Fowler 1991; Shackel 1991; Nielsen 1994; ISO 1997b; cited in Maguire 2001). Maguire (2001) states that often poorly designed systems and objects exist which users find difficult to understand and complicated to operate. These products and systems are often likely to be under used or misused frustrating their users. When users are not considered when designing lighting of a space its lighting conditions can be perceived e.g. uncomfortable because of unsuitable qualities of light which can lead to lower usage levels of that space.

Empathy can be considered as a fundamental element of UCD. It is a human-centered design approach which typically envisions a close, constant dialogue with users (Steen & al. 2007). Empathic research provides user representations that reveal unmet needs, raise the users’ perspective, provide insight, inspiration and set a collaborative mindset.
(Mattelmäki et al. 2011). All these elements are particularly needed when developing built environments for specified user groups: knowledge needs to be shared across the borders of different stakeholders involved in the design and implementation process, and “experts” need to understand and listen to the users to be able to facilitate them in finding their own voice.

According to Mattelmäki & Battarbee (2002) design empathy means that users are understood as persons with feelings, rather than laboratory subjects. They also state that design empathy requires a twofold personal connection: the dialogue with participants has to be empathic and respectful, while the participants need to support the designers’ empathic understanding. Researchers and designers move as close to the end-user as possible to connect with them at the level of experience and emotion (Steen & al. 2007). In empathic design the main focus is not task-focused usability, but rather context understanding, actions, feelings, attitudes and expectations related to future user experiences (Mattelmäki & Battarbee 2002, Pine & Gilmore 1998, Thackara 2000). Accordingly, observation is conducted around users concentrated in everyday routines, in their own environment to access information otherwise ungraspable (Leonard & Rayport 1997).

User-centeredness and empathy should be considered also as a critical approach when designing built environment; not only paying attention to physical accessibility but also in order to provide solutions that serve the needs of the space users and create positive usage experiment avoiding frustration. The future users of the space should not be an additional and inconvenience element not to be considered during design process. Instead they are the reason for creating or developing a space and therefore they deserve to be studied and understood in their natural context to deliver them a solution that provides them positive usage experiences. Aesthetics or eye-catchiness should not be the ruling approach of a design process. This is particularly important when designing environments for people who spend every single day most of their time in that specific environment which actually is the case of most of the seniors living in sheltered homes.

**HAPPINESS**

Positive psychology is a study of the conditions and processes that contribute to the flourishing or optimal functioning of people, groups, and institutions (Gable & Haidt 2005). Happiness can mean different things to different people. However Seligman (2011) has defined in the discourse of positive psychology five central elements of flourishing, good life and happiness: positive emotion, engagement (being in the flow), relationships, meaning (purpose in life), and accomplishment (PERMA). PERMA is relevant also for designers in order set up high level goals when outlining a designing proposal. It can be utilized as framework for studying users. E.g. Desmet (2011) states that design often base on problem solving and minimizing threats to make safer circumstances. Instead we can design artifacts to stimulate people to perform activities that opens up possibilities enabling something new content to life; ingredients of meaningful activities. An interesting question is how built environments can be designed to stimulate or activate people in order to provide positive experiences to the space users? And how that could be accomplished if the only parameter is lighting?

**APPLYING THEORIES**

Lighting is an important part of a multisensory environment. It affects how all the visual stimuli of a space are perceived e.g. colors, shapes and contrasts. Lighting can be considered as the most intangible element of a built environment because it is not that simple to recognize and indicate all the effects of lighting of a space. When designing lighting for any kind of built environment it should not be considered as an independent element but as one sensory stimulus of an entity of different sensory stimuli to succeed in complementing in the creation of a balanced multisensory space providing compatible information for the user of the space. This would enable all kind of users to orientate better as well as more confidently and independently to move in public spaces.
This thesis concentrated on some particular wellbeing supporting point of views: How lighting can emphasize safety, help orientating and invite people to enter and stay in a space providing an opportunity for socializing. Literature findings about vision and ageing were taken into account as inspirational starting points for concept design to be paid attention all the way during the design process from the conceptual level to practical implementation plan.

The user-centric approach was applied in the process emphasizing empathy during studying the users aiming at understanding their needs and desires beneath the surface. The approach was applied following iterative ways:

- considering user group specific needs based on literature findings
- observing users in their natural context
- considering all the findings from art therapy based user research and cognitive walkthroughs conducted in the other master thesis studies of MONA
- involving users in evaluating a test setting and the final piloting

The knowledge gained while studying the users was utilized during all the stages of the design and prototyping processes; conceptual design and implementation design as well as to improve communication while involving user in prototyping.

As already reasoned in the intro chapter the concept of happiness was set in the role of a fundamental design goal of the project, like “a beacon in the horizon”, emphasizing the ultimate goal to be reached for during the design process to more likely succeed in designing a proposal fulfilling also higher level needs in addition to support functional accessibility.

In general, all the theoretical concepts defined in this chapter guided the design and research process of the project described in detail in the following chapters. The theoretical concepts and findings influenced on what issues to concentrate on and how to approach the design challenge both in conceptual and very practical level when designing the lighting concept and its practical implementation.
METHODS
METHODS
In this chapter is briefly described and reasoned the methods applied in the project.

USER STUDY METHODS
To be able to understand the target user group and their life, the seniors were studied applying different methods to conduct qualitative research. First they were observed in their daily environments, and then users were studied while taking part to an art therapy based user workshop and a cognitive walkthrough. Overlapping with these activities was also conducted prototyping to involve the target users in the lighting concept development process.

Observing on site
The very first thing to be done in order to connect with users and collect first insights related to their daily life was to go where the users are. Target users were observed in their daily routines in common spaces of an assisted living building where later were run the first mock up testing. Observing was both passive and active; first following activities happening in the building to learn what the spaces are used for and later discussing informally with random inhabitants met in the common spaces to understand how the users see their life in that specific assisted living building.

Taking part to a user workshop and a cognitive walkthrough
In order to be able better utilize the results of the other master thesis studies of MONA I was taking part to a user workshop in which were utilized methods drawn from art therapy to better communicate with the users who might have challenges in communicating and expressing their opinions. I was observing and assisting one of the workshops in which a focus group was ideating dream solutions to improve the assisted living building they were living in. I was also assisting a cognitive walkthrough in which seniors were interviewed during a walk in order to understand their cognitive maps; how they perceive their daily surroundings e.g. distances and locations of specific spots. Participating in these both user studies provided user knowledge from different point of views.

Prototyping
Prototyping played an important role in the lighting project. It enabled involving users in the design process providing opportunities for the users to express their opinions and give feedback of prototyped solutions. On the other hand I as a designer had opportunities to study the users better during the testing in their natural context with personal contact.

PROTOTYPING-DRIVEN ATTITUDE
Prototyping was the driving attitude of the lighting study. Prototyping enables learning from failures and iterating implementation ideas before final implementation. Prototyping offers an opportunity to rapidly execute ideas and involve users in the development already in the early stages of innovation process (Tuulenmäki & Välikangas 2011). In the lighting study prototyping was not utilized in order to approve that an idea works in practice but it was rather used as a method for indicating failures when exploring if a specific implementation of an idea creates any value for the user to either reject the idea or develop it further based on learnings remarked during prototyping.

PROTOTYPING METHODS
Prototyping was applied in the project in the form of mock up testing and piloting. The pilot and mock up tests were run in two existing assisted living buildings for seniors located in Helsinki, Finland. The two separate piloting rounds were conducted in two different locations during the project. Mock up testing was run in the early stage of the project and actual piloting in the last stage of the project. Both the tests were run in real living environments of the subjects.
Mock up testing
The mock up tests in three different common use spaces of an assisted living building. The goal of the tests was to collect user feedback by asking the test subjects to compare and describe two different lighting settings simulated one after each other. One setting was the original one and the other one was simulated with a rough temporary mock up setting. This testing was run in order to involve the target users in the process already in very early stage to be able to communicate with the real users in the right context and test few initial lighting improvement ideas in the users’ daily surroundings.

Piloting the developed lighting design concept
The actual piloting was run in two almost identical spaces of an assisted living building. The spaces were common living rooms in the middle of the residential wing of the building on two different levels. The idea of the piloting was to follow the usage of the living rooms for two four-week periods, before and after installing new lighting, to compare if there was any change in the usage levels of the living rooms. Inhabitant’s living in the two floors, in which piloting took place, were also interviewed to understand how they felt about the new lighting compared to the original one.

METHODS FOR COLLECTING FEEDBACK
During the project user feedback was collected in the form of an interview while facilitating the mock up testing walkthroughs. During the actual piloting interviews were conducted to find out how the users felt about the change and how did they feel about the new lighting. Activity data was collected in the two piloting spaces to be able to follow the activities in the spaces before and after the change on daily basis.

Interviews
In the mock up testing round the test subjects were interviewed while the walkthrough. In the actual piloting in addition to senior inhabitants of the assisted living building also personnel were interviewed. Struc-
This chapter presents the design process of defining a lighting concept to be applied in piloting and activities related to it. In the piloting was examined the concept implementation and the results were reflected related to the hypotheses behind the lighting concept.

**DESIGNING LIGHTING CONCEPT**

This chapter describes the design process of the lighting concept proposal later implemented in the piloting stage. The design process was started by dreaming of what could be ultimate benefits of wellbeing supportive lighting. After defining these dream goals the aim was to progress step by step towards a realizable lighting plan of its practical implementation in order to conduct piloting and collect feedback of the realized lighting concept and hypotheses behind it.

In the beginning of the project when defining the main questions related to lighting the following ideas arose: What are the possibilities of utilizing light to increase senior wellbeing? How can lighting be part of a built multisensory environment as a complementary element supporting and enhancing wellbeing? These questions where explored and examined during the design process.

**STARTING POINT, FRAMEWORK FOR DREAMING**

Knowledge from the theories and the concepts presented earlier in this thesis as well as learnings from user studies were the input source for ideating how to fulfill dreams, desires and needs of seniors avoiding negative lighting qualities aiming at transforming the spatial experience to more positive one. A framework was defined based on central learnings and findings of the challenges that seniors often face to guide the design process:

**PHYSICAL AND PSYCHOLOGICAL CHALLENGES:**

- **Low vision** – sets requirements e.g. for higher lighting levels and light quality as well as paying attention to contrasts, glare elimination, emphasizing main structures of the room to support perception and orientation, avoiding uniformity of lighting as well as sharp shadows and too strong contrast, lighting in balance with other multisensory messages

- **Mobility challenges** – supporting orientation with lighting, stimulating people to be active and be able to improve or maintain their mobility

- **Memory problems** – guiding with lighting, emphasizing identification of spaces with the help of lighting

**SOCIAL CHALLENGES:**

- **Shrinking personal network, loneliness** – emphasizing coziness and inviting atmosphere, creating meeting spots, inviting people to gather together, encouraging in socializing, influencing on mood through lighting

In order to set the level of lighting ideas as high as possible without being too realistic or critical from the very beginning of the process the ideation was started by dreaming. Ideas related to the dream effects of lighting for seniors in semi-public and public spaces in assisted building were brainstormed. The most interesting conceptual ideas were: light medicine, laugh prompting light, campfire and light providing company decreasing loneliness. Although these ideas and measuring their possible effects on people are rather challenging topics they were taken to the next ideation round.
DEVELOPING CONCEPTUAL IDEAS

Here are shortly presented some conceptual ideas of the earlier defined challenges transformed to dreams related to lighting. Ideas are described on conceptual level. Therefore examples of how the very intangible ideas could be transformed to rather tangible lighting ideas are included in the short descriptions.

1. INVITING LIGHTING?
   LIGHTING ENHANCING LOCAL IDENTITY?
   - Inviting people to gather together, inspiring and activating
   - Proving an opportunity for interacting e.g. in the form of a meeting point or by offering "experience landscapes"

An implementation idea:
   - A strong lighting element in the entrance area of the space welcoming people and inviting to enter the space.
   - A strong element would strength the identity of the place and could be even a small attraction itself
   - Also an informative element could be added e.g. informing which weekday it is with different colors of light

Fig. 2 Strong identification  Fig. 3 Poetic atmosphere  Fig. 4 Landmark of Paris
2. SOCIALITY ENHANCING LIGHTING?
- Encouraging people in socializing and providing a reason or permission to approach other people and spent time with them

Fig. 5 Happy together

An implementation idea:
- Creating separate meeting spots "inside" common spaces
- A meeting spot inviting residents of an assisted living building to gather together to different spots with varying atmospheres

Fig. 6 cosy meeting spot

Fig. 7 Attractive atmosphere
3. RECOVERY AND HEALTH SUPPORTING LIGHTING
- Refreshing and vitalizing light, eliminating aches and illnesses ("light painkiller")
- Providing consolation and company

An implementation idea:
- A lighting treatment spot with energy light treatment or calming light therapy while enjoying other treatments such as pedicure or hairdressing
- On the other hand lighting treatment spot could be situated in a gym which could be divided in two lighting areas: one with interactive lighting and energy lighting and another one with calming lighting e.g. lit landscape or light and color therapy
4. ACTIVATING LIGHTING?
- Lighting that prompts people and engages them in an activity or enables interactive communication with lighting as “the language”

An implementation idea:
- A light game as an interactive element
- Light could react when detecting touching or movement
- The interactive element could also be in connection with another similar element located in another place enabling interactive messaging between two rooms or buildings

5. INFORMATION DELIVERING LIGHTING?
- Inhabitants of senior housing could be provided e.g. information from outside. Very many living in sheltered homes spend most of the time indoors almost never leaving the building and getting in connection with outside world.

Implementation ideas:
- Indoor lighting could be reacting to changes of weather and conform with outdoor daylighting
- The indoor lighting could be automated to also conform to seasons and enhance the atmosphere of the season also indoors
- Lighting could be also harnessed to inform inhabitants in real time when activities are organized inside the community -> lighting could function as an element pulling seniors out from their rooms to take part in social activities

- 3 different lighting settings related to outdoor lighting changes:
HAPPINESS ENHANCING LIGHTING?

All these conceptual ideas might be the seeds for enhancing happy and joyful feelings by stimulating people to smile or even laugh.
FINAL CONCEPT FOR LIGHTING PILOTING

After dreaming and exploring ideas in intangible level a tailor-made lighting concept for chosen spaces was defined in order to run piloting. In this chapter the piloting spots are presented first and then the evolving of the lighting concept and implementation plan.

Piloting spots, background information
- living rooms and their original conditions

The two living rooms in which the concept proposal was decided to be run as a pilot situated along corridors in a residential swing of an assisted living building. The living rooms were almost identical spaces on two different levels located on the top of each other. Those living rooms were the largest common spaces of the wing furnished with sofas and coffee tables, tables with chairs, rocking chairs and a TV. The only difference between the spaces was that in the second floor there was a large table used for hand craft club in addition to sofas while in the third floor there were two sofa areas instead (see figures on the right). There was also a rather small window in the corner of the room which did not provide any special view but enabled daylight entering the space.

The lighting of the living rooms was almost identical; the only exception was in the second floor where a fluorescent lamp was mounted on the top of a large table (see figures in next page). Otherwise the lighting was realized in both spaces with only one type of luminary. The luminaries were mounted mainly to the walls and couple of them to the ceiling, all on the same height. There was no relation between the lighting installation and the furniture defining the functions of the room. The fixtures were mounted on rather low level and directed light mainly downwards. The impression of the lighting was relatively dim. The usage of the space was rather low and related to its usage levels it was rather a dead spot than a lively plaza.
THE LIGHTING CONCEPT

The aim of the lighting concept was to improve the spatial experience of the living rooms with light as the only parameter changed in the spaces in order to enhance orientation, create pleasant and inviting atmosphere and as an ultimate goal influence on the behavior of the inhabitants inviting them to enter the space and encourage them in socializing by supporting such conditions with lighting. The practical installation was aimed to be an embedded as a natural element of the space supporting the functions already defined for the rooms. Lighting was designed to be in balance with other multisensory messages without standing out over other sensory stimuli.

CONCEPTUAL IDEAS TRANSFORMED TO LIGHTING EFFECTS

The lighting concept proposal was designed to result as an embedded part of the built environment that:

- emphasizes perceiving the main structures of the space to help the users with low sight to orientate in the space as well as feel more secure (wall washing)
- invites inhabitants of the senior house to gather together and inspires and stimulates them in socializing (dynamic lighting, lighting “wakes alive” when movement sensors are detecting person approaching the space)
- focusing lighting according to functions of the space particularly lighting up the tables and seats around them to invite people to sit down
- avoiding uniformity in the lighting levels to give privacy to each separate function spot aiming at glare free installation
- Accentuating warm atmosphere aiming at creating cozy and home-liked feeling (Nordic people usually prefers warm color temperatures in lighting)
DRAWING THE SPACE WITH LIGHT
Lighting the main structures of the spaces gently by washing the walls with low lighting levels in order to ease in perceiving the space which is particularly important for users with low vision.

GUIDING PEOPLE
Guiding people to enter and stay in certain spots of the room by emphasizing the functions of the space. As the main goal to invite people to spend time in the sitting areas and offering a social meeting point. Directing the light emphasizing the sitting area without placing the sofas in spotlight because people prefer to sit eyes facing light without being lit up themselves (Flynn & al 1973).

ADDING DYNAMICITY TO LIGHTING
Integrating sensors reacting to movement to lighting system -> The space "wakes up" when a person is approaching it e.g. from dim to lighter or from white to colorful.

...OR PROVIDING A MEAN FOR INTERACTIVITY
By embedding an interactive element to the space enabling gaming with light. Often the atmosphere of assisted living buildings is stagnant and therefore some movement and interactivity might invigorate the atmosphere (McClannahan & Risley 1975).
FINAL LIGHTING PLAN FOR PILOTING

After the lighting concept was designed it was transformed to a practical lighting implementation plan. Because the aim of the project was not to develop proposals of new luminaries the concept realization was limited to existing lighting fixtures from the product portfolio of Fagerhult Lighting who was the co-operator when running the piloting. The selection of fixtures to be utilized in the piloting were chosen based on judging the lighting effects – which fixtures would provide best solution to imitate the wanted effects described in earlier chapter.

The color temperature of all the luminaries was chosen to be 2700 kelvin in order to create a warm and homelike atmosphere. To integrate a slight element of dynamicity and interaction also controlling system was needed to be programmed to control the luminaries. All the luminaries were chosen and mounted considering glare elimination; seeing directly to any of the light sources of the mounted luminaries was almost impossible. Apart from the wall washers the other fixtures were directing light both to down and upwards that also the ceiling would be lit in order to show the ceiling as one of the main structures of the room as well as emphasize spaciousness and welcoming atmosphere.
Luminaries and controlling systems applied in realizing the develop lighting concept

1) Pendants: effectiveness 1x40W
The pendants were mounted to the height of 150 cm to light up the sitting area as an individual space and avoiding glare.

Functioning: When a sensor detects movement the luminaries are controlled to turn to full power (100%). The time delay before starting to dim back to the sleeping mode when no more movements are detected is 12 minutes. The dimming takes 32 seconds to get to the sleeping mode of 5%. They never switch off automatically.

2) Wallwashers: effectiveness 1x35W
Washing the walls gently and rather uniformly in order to show the main structures of the rooms without emphasizing them too much or distorting perception of the perspective with e.g. spotlights.

Functioning: When a sensor detects movement the luminaries are controlled to turn to 16%. The time delay before starting to dim back to the sleeping mode when no more movements are detected is 12 minutes. The dimming takes 32 seconds to get to the sleeping mode of 5%. They never switch off automatically.

3) Wallwashing the pillar: effectiveness 1x26W

Functioning: When a sensor detects movement the luminaries are controlled to turn to 16%. The time delay before starting to dim back to the sleeping mode when no more movements are detected is 12 minutes. The dimming takes 32 seconds to get to the sleeping mode of 5%. They never switch off automatically.

4) Desktop pendant: effectiveness 2x35W
Functioning: The luminary is controllable with manual switch enabling choosing from three different lighting levels. Pulling one switch turns the luminary on to 50% for general lighting. When more light for working, reading or handcrafts is needed by pulling also the other switch turns the power to 100%.

5) Desk luminaries: effectiveness 1x26W
Functioning: The lights are controllable with integrated switches (on/off).

Fig. 32 2nd floor (left) and 3rd floor (right) luminary maps
PILOTING

RUNNING PILOTS
In this chapter is further described how piloting was conducted during the project. Both the actual pilot and mock up testing were run in two existing assisted living buildings for seniors located in Helsinki, Finland. They both were individual studies involving users in the development and evaluation process of lighting ideas. Mock up testing was run in the early stage of the project and actual piloting in the last stage of the project. Both the tests were run in real living environments of the subjects.

MOCK UP TESTING
The goal of mock testing was to test few lighting ideas related to improving the present lighting and involve users in evaluating the difference. The test consisted of comparing the original lighting to a temporary mock up setting simulated one after each other in three different spots of the building. One test subject was involved in one test setting. The aim was to get feedback about light levels related to functionality as well as collect opinions about atmosphere. This testing was run in prior to concept design phase to explore lighting with target users.

The test subjects were 11 inhabitants of the assisted living building aged from 70 - 98. All of them had at least glasses for reading and 10 subjects out 11 did not have any problems with their sight. Only one test subject was visually impaired only being able to see weakly with one eye. The test spots were chosen according to negative feedback about lighting from the inhabitants of the building and personnel. The test was run in the most used common spaces of the building: 1) lobby, 2) activity room and 3) corridor (see figure below).

Fig. 33 1) lobby, 2) activity room and 3) corridor

SPOT 1
In the lobby the main sitting area and info board were lit up. The test subjects were asked to read the info board in both lightings and compare the experience.

Fig. 34 Spot 1: Original (left) and mock up lighting (right)
SPOT 2
In the activity room was explored lighting levels for reading in order to define sufficient and pleasurable lighting levels. The test subjects were asked to read text chapters in different font sizes and then choose a challenging font size to explore convenient lighting level with a continuously controllable luminary (0 – 1500 lx).

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SPOT 3
In the corridor was simulated the original direct lighting compared to indirect lighting which lit up also the walls. The test subjects were asked to walk in the corridor and evaluate the difference of the two lighting.
Additional feedback collection

After running the mock up tests the temporary lighting settings were left there for a couple of weeks and during that period feedback of the inhabitants were asked if they preferred the new lighting setting in the lobby over the old one. The feedback was collected with a Happy or Not machine.

![Happy or Not machine](image)

Fig. 39 With Happy or Not it is possible collect user feedback by placing a question on the top of the machine. The test subjects answer the question by pushing a button with face expressing their feeling.

RESULTS OF THE MOCK UP TESTING

All the eleven test subject were mainly happy with the original lighting of the building even though they described it as rather dim, the only exception was the visually impaired person according whom some fixtures were glary. It was challenging for the test subject to describe or comment the atmosphere of the lighting even though they were suggested certain adjectives to agree or disagree with. The intangibility of lighting might be challenging for people without any professional relation to it as well as some of the test subjects had weakened communication skills which resulted as scarce feedback. Also the changes in the simulated lightings were not dramatically different.

According to the test results opinions about lighting vary greatly depending on preferences and what type of lighting the person is accustomed to. Some of the test subject distinctly preferred very bright lighting while some others preferred soft and dim lighting. Nevertheless, all the test subjects preferred similar lighting when judging lighting from functional perspective e.g. reading the info board or when reading small text. To summary the results: Lighting the info board enabled noticing notes and reading the information from them easier (spot 1). The average of the most pleasant lux level for reading challenging small text was 1000 lux (spot 2). Half of the test subjects evaluated the indirect lighting which lit up also the corridors as better than the direct down light while the other half could not recognize any difference (spot 3). Utilizing Happy or Not feedback collecting appliance indicated that 97% of the evaluators preferred the lobby lighting when also info board was lit up.

Learnings applicable in the design process

When designing lighting for transit spaces people moving in different positions should be considered. Depending on if a person is walking independently with walking aids, in a wheel chair or pushed lying on a bed affects the direction of sight which influences e.g. on how light can be directed without causing glare.

- Controllable dynamic lighting is needed in multifunctional spaces to change the lighting setting according to the present activity
- Preferences according to lighting level vary and therefore common spaces should provide areas with different brightness and atmosphere in order to provide pleasant spots for sitting or socializing in common spaces.
- Aged test subjects were a challenging group for getting feedback because of their physical conditions or weakened social skills. Also “it takes time to build trust and therefore the first or second meeting do not provide circumstances for seniors to expose their deep feelings or opinions." (A comment from seniors’ activity tutor)
- Additionally some of the test subjects’ opinions were contradictory and inconsistent
ACTUAL PILOTING
The lighting design proposal designed to flourish the living rooms of an assisted living building was run in the last stages of the lighting study. Lighting ideas developed based on dreams, findings from theories and learned user knowledge was applied to a realizable lighting solution to be tested in order to understand if the concept implementation improved the space and created any value for the users.

Even though cognitive walkthroughs conducted in the same location revealed that the furniture in the living rooms was not appropriate for seniors they were not exchanged to more ergonomic ones because then lighting would not have been the only parameter changed during the piloting. Having light as the only parameter it was possible to study the effects of lighting as an independent element of a multisensory environment.

Lighting installation was mounted according to the lighting plan after monitoring the space with original lighting setting for a period of four weeks. Also the new lighting concept implementation was piloted and monitored for a four week period. After the monitoring periods residents living on the same levels as the pilot spots were located were interviewed as well as personnel of the building.

Residents of the building
The inhabitants of the assisted living building were in the condition that they would no longer survive at home by themselves. The inhabitants were in between 67-98 years, 85 years in average, many of them having different type of health issues, most of them suffering from aches resulting in low mobility. Nevertheless, considering their age many of them were rather in good condition and still able to communicate fluently; most of them had succeeded in retaining their social skills on good level. All of the residents had single room apartment with a bathroom and a tiny kitchen corner. Every one of them used to eat most of their meals in the house canteen as well as bought cleaning and laundry services. They had hobbies e.g. reading, watching TV, handcrafts and the ones who are able to leave the building independently used to go for walks in the nature outside the house.

Fig. 40 Lux levels of the original lighting (in red) and the piloting lighting (in black) related to the functional spots of the room, both measured without daylight affecting the results, 2nd floor (left) and 3rd floor (right)
Fig. 41 Photos of the lighting settings: originals (left) and piloting settings (right), photos of the original lighting conditions include effect of day light but the light casted from the fixtures can still be recognized
Collecting information and feedback
The research related to piloting consisted of two monitoring periods lasting for four weeks each. Both living rooms were monitored before and after mounting the piloting lighting installation. Monitoring was executed with cameras recording still photos of the space for a period of 30 seconds every time they detected movement in the piloting spots. The idea was to be able to follow activities happening in the living rooms and measure the usage levels during the two monitoring periods. The aim of video monitoring was also to double check if the subject’s behavior in living rooms correlated with their own reporting when interviewed. However it turned out that the cameras did not record all the activities happened in the spaces and therefore provided only suggestive data. Nevertheless the camera data revealed what type of activities happened in the spaces in general as well as indicated roughly the usage levels and the main users of the monitored spots.

Interviews were also run to get feedback from the residents about the change in lighting conditions, how they perceived the new lighting installation and if it had affected their behavior in the living rooms or their usage of the rooms. Based on the challenges faced during the mock up testing interviewing this time the interviews were more structured
including versatile supportive questions helping interviewees to answering and keep the focus on the topic. Last part of the interview included comparing the pilot lighting to the original one by choosing of contrary adjective pairs which one describes more the piloting lighting. The interviews were conducted in a face-to-face situation in the actual piloting spots to be able evaluate the lighting in real time without relying only on memory. Photos of the original lighting were shown to refresh the image how the lighting used to be.

In addition to the senior inhabitants also personnel of the assisted living building working there on daily basis were interviewed to also consider their opinions. Nevertheless the feedback from the seniors was emphasized since they are the people the place is built for and they are the ones spending most of their time there.

The interviews were run three to four weeks after the lighting piloting was set up. Perhaps the seniors would have recalled the old setting better if the interviews had been run sooner after the change. 17 seniors and four personnel members were interviewed. The interviewed seniors were 75-97 years old and had been living in that specific building varying from periods of a couple of months to 15 years. Only four out of 17 were males because the majority of the inhabitants were female. Only two of the 17 interviewees were visually impaired and the rest did not report any major problems with their sight. Five of them have had cataract operated.

The Interview questions consisted of structured questions under the themes of effects of lighting related to daily life, glare, perceiving spaces, lighting levels, level of activity, coziness, invitingness, happiness / joy as well as questions to compare the original lighting to the piloting lighting (see the appendix). The questions were defined in order to understand how they perceive the lighting conditions in their common residential areas as well as their lighting preferences and if they have faced challenges in orientation or other lighting related issues aiming at exploring the hypotheses earlier defined in the process. Interviews lasted from 30 minutes to one hour depending on the talkativeness of the interviewee. Very many residents also refused to be interviewed. In total 30 % of the residents living in the 2nd and 3rd floors, were the piloting was run, were interviewed.
PILOTING RESEARCH RESULTS

- INTERPRETATIONS OF THE INTERVIEWS AND MONITORING DATA

In general all the interviewees evaluated the pilot lighting as a positive or neutral change. The most positive feedback was given by a visually impaired person whose vision had lowered dramatically during the past year. She appreciated the lighting because it helped her to orientate better in the space and its brightness was contributing in recognizing shapes and colors. Most of the interviewed inhabitants (15/17) and all the interviewed personnel (4/4) preferred the piloting lighting setting over the previous lighting. Only the rest two interviewees evaluated them as equally good. The original lighting was described without any exception as dim or dark while the piloting lighting was evaluated as bright and comfortable. The questions structured under specific themes assisted well in focusing on the topic and providing a framework making it easier for interviewees to tell about their ideas of lighting as a very intangible element of their living surroundings.

Lighting affecting in daily life
14 of the interviewees reported that they coped well with the original lighting. "I'm used to it so it's good enough", was a comment describing the general attitude of the interviewed seniors. As an exception a visually impaired senior revealed that light influences very much on how well she can cope emphasizing the importance of good lighting. Also one other interviewee described the corridors of the residential wing as very dark, gloomy and even scary.

Glare
The interview subjects did not report of being distracted of glare indoors apart from one of the visually impaired person interviewed who was very sensitive to glare and therefore always preferred dim lighting.

Spatial perception
According to the interviewees they had no difficulties in perceiving the structures and objects of the common spaces in the assisted living building. Only the visually impaired person who accentuated the importance of bright lighting stated that she can best perceive the dimly lit spaces by recalling them in her mind. She had developed a surviving system in order to be able to orientate in dim spaces by counting how many steps are needed to be taken to go to certain spots in the building. She was the only interviewee strongly concerned of lighting conditions while the other accepted the present lighting as it was.

Preferable lighting levels
Most of the interview subjects preferred bright lighting in general. Even though they recognized that the lighting in their building was rather dim particularly in the corridors but still reported to be happy with the lighting how it was because they were used to it. However two seniors defined good lighting as functional lighting e.g. bright light for reading and dimmer for other tasks while another two residents told preferring dim lighting over bright.

Level of activity
All the residents utilize the canteen services of the building, and going there several times a day is the main daily routine for the residents. Going to the canteen usually includes social interaction while waiting for the canteen to open as well as discussing while eating. Also once a week there is organized a handcrafts club in the living room on the second floor and occasionally some special program is arranged for residents to enjoy in the festive hall of the building. Some of the residents also exercise in the gym and utilizes the computer of library room. Nevertheless according to the interviewees reporting they spend most of their time in their own personal rooms reading, watching TV etc. The living rooms are mostly empty and unused besides when residents are passing by, a couple of seniors are sitting in the rocking chairs, residents meeting their guests sitting in the sofas. Only handcrafts club creates active and lively atmosphere to the second floor living room. Few main reasons were
reported for not staying and spending time in the living rooms; movability challenges, weak physical condition, there is nobody staying in the room and no arranged program and therefore no reason to enter the space. Also some of the interviewees preferred to stay alone in their rooms watching TV etc.

**Coziness and invitingness**

Quite many of the interviewees found it difficult to describe what kind of spaces and lighting they consider as cozy and inviting. However, light conditions e.g. fireplaces, warm light, pendants emitting bright light softly were described as examples of cozy and attracting lighting. Very many comments considering invitingness were actually relating to meaningful activities and facilitated events. Very many mentioned that places full of people or organized activities as well as places were their family or children were living were attractive and inviting. One interviewee described that he meets his guests in the living room and have earlier wished that there were partitions separating sitting areas to give some privacy but with the new lighting setting the light creates more private atmosphere around each separate functional spots in the space and partitions are no longer needed.

**Happiness / joy**

Question about happiness and joy enhancing lighting was the most abstract to grasp to. Many interview subjects were relating to lighting objects rather than to the intangible light itself. Glittering chandeliers were mentioned as well as some luminaries sentimentally valuable. Also bright light, daylight, sunlight and spring light were mentioned to affect mood and cheer up. The visually impaired person valuing bright light also mentioned that lighting that shows the shapes of the environment makes her happy.

**Comparison between the original lighting and the piloting lighting**

Open comparison as well as adjective guided comparison clearly indicated that the lighting piloting was preferred over the original installation (see figure on the right). The original lighting setting was described on one hand as: “very good, good, quite good”, and on the other hand as: “dim, too dark, miserable uneven and grey” while some interviewees had not paid any attention to it. The piloting setting was evaluated as: “super lovely, much better than original one, very good, very nice, the best lit spot of the building, successful and as the brightest spot in the building.” Many positive comments were reported e.g.: “Now it is much nicer to invite guests here, I could even arrange a party here now.” “We were all very delighted when we got the new lighting; please do not take it away!” The room was also perceived as larger and the lit walls were noticed. One interviewee even reported that guests visiting the building have been admiring the new lighting. Also the personnel reported that they had heard only positive feedback about the pilot lighting. However few of the interviewees did not appreciate the new lighting any higher than original one. In more particular one senior described the change as weird and according to the visually impaired person sensitive to glare evaluated the pilot setting as glary.

**Comparison results (interviewing seniors and personnel = 21 persons)**

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<th>Not sure</th>
<th>No difference</th>
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<tbody>
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</tr>
<tr>
<td>Dimmer</td>
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</tr>
<tr>
<td>Cozier</td>
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<td>0</td>
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</tr>
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</table>

**Change in the behavior**

According to interviews and monitoring data it seems that the change in the lighting barely affected the behavior of the residents. Only two seniors reported spending now more time in the living rooms after the change. There was no change in the behavior of rest of the residents.
related to space usage of living rooms according to the video data either.

**FINDINGS FROM VIDEO DATA**

This data was utilized as a complementary material to support interviewees’ reports of their space usage of living rooms; how often they go there, what do they do there and do the residents socialize there with each other. The video data was also utilized for examining if there was any change in the space usage before and after the piloting. The suggestive data supported rather well the reports of the seniors also showing who the main users of the space were and the main activities happened there. The suggestive data quite clear indicated that there were approximately two to four seniors spending time in the living rooms on daily basis mainly sitting on the rocking chairs, meeting regularly friends and sitting and reading. Occasionally the recorded data also showed residents sitting on the rocking chairs and on their walking aids socializing with each other.

**Interactivity of the lighting**

Surprisingly many residents (6/17) spontaneously mentioned during the interviews that they appreciated the slightly interactive element of the lighting piloting that the lights switch on automatically when a person is approaching the space. They described the phenomenon as a pleasant experience prompting happy feelings. Also the importance of saving electricity (a typical attitude for the generation experienced the world war) and having lights on only when someone is staying in the space was mentioned. They also considered the phenomenon as welcoming and delightful effect which even made them smile. By bringing these opinions forward can be interpret that this simple interactive element of the lighting seemed to create meaningful value for the residents.

**EVALUATION OF THE PILOTING**

On one hand the piloting was unsuccessful because it barely affected the behavior of the residents related to time spent in the living rooms and socializing with each other. On the other hand the lighting implementation was successful because of all the appreciation and positive feedback. The piloting also provided some evidence in supporting the hypotheses of the designed lighting concept; the living rooms were evaluated as cozier more inviting and more spacious as well as the slight element of interaction, automatically strengthening lighting, was reported as prompting positive feelings. Based on the interviews and personnel preferences the lighting piloting installation will most likely to be purchased to be a permanent setting of this specific senior house.
RESULTS
In this chapter is summarized a collection of suggestive lighting related issues to be considered when designing lighting for wellbeing supportive environments particularly suitable for seniors. The listed ideas are drawn from theoretical findings and learnings during the process described earlier in this thesis. The ideas can be utilized as a check list of point of views or tips to be applied in practice to assist professionals working with spatial design. The list might be later entered the Arvi assessment tool (which is an open data base for professional practitioners designing built environments emphasizing accessibility administered by The Housing Finance and Development Center of Finland).

IN ORDER TO ENHANCE ACCESSIBILITY AND ORIENTATION:

Consider:
- Lighting being in balance with other spatial sensory messages
- High lighting levels

Emphasize with lighting:
- Indicating changes of level e.g. stairs etc.
- The view of floor plane emphasizing continuity
- Room structures e.g. pillars, walls and furniture
- Functions and usage of the space

Avoid in lighting:
- Its emphasized dominance over other spatial sensory messages
- Uniformity of lighting
- Creating contradictory spatial messages e.g. distorting perspective, creating illusions of unexisting structures or layers in the space
- Glare from light sources within fields of view should be low in luminance or indirect and the light sources should be positioned away from sight directions of users e.g. people moving with walking aids, wheelchairs or lying on a bed
- Very strong contrasts and sharp shadows e.g. they might be perceived misleadingly as obstacles or gaps
- Contrasts between different spaces because eyes need to adapt less when there is no big difference in lighting levels and perception is smoother
- Light levels below K4 (5lx) are not sufficient for seniors and visually impaired people
DISCUSSION & CONCLUSION
DISCUSSION & CONCLUSION
When designing architectural lighting installation, and particularly considering light as part of multisensory environment, the focus automatically concentrates on paying attention to other spatial sensory messages and peculiarities. Aspiration for enhancing harmony comes naturally and irrelevant lighting effects are forgotten. Multisensory environment as a framework for designing, guides to consider the fundamental meaning of an existing space or possible central human-centric meanings for a future environment. Multisensory approach according to my experience serves well when working with architectural lighting design. Its suitability to artistic lighting projects may not be that evident even though considering visual accessibility also when working with artistic lighting installations would be advisable from the point of view of visually impaired.

According to the light study described in this thesis, positive spatial experiences can be supported and enhanced with lighting. Nevertheless lighting as medium is in close relation with other spatial mediums and therefore cannot easily change a negative spatial experience to a positive one. Lighting among other spatial mediums of multisensory built environment can improve or ruin a spatial experience. This is why it would be beneficial to take purposely into account also other spatial elements related to accessibility in order to achieve in rather contributing in creation of sensory balanced environments instead of designing an installation as an independent work of art.

CHALLENGES OF STUDYING THE EFFECTS OF LIGHTING
Sitting on light or eating light? Living in a house made of light? The challenge of studying the effects of a lighting installation is complex. The issue is complex in two different dimensions. On one hand light is an intangible element that empowers beings and objects to perceive their environment through vision. In other words it might be said that light is a lubricator which enables perceiving our environment visually. Light is always a medium between beings and environment because its immateriality. By changing light conditions in a space it is possible to effect on the spatial atmosphere and influence on moods and feelings of people. It is challenging trying to effect on behavior of people and prompt them to gather together for socializing if e.g. furniture cannot be utilized at all. It is rather improbable that if there are no physical elements providing the opportunity to really sit down it is less likely to also happen. Light is always in close relation to physical structures and objects. I would say that the value lighting can provide is acting in the role of an empowerer.

According to the video monitoring and interviews conducted during the project, the new lighting conditions did not change the behavior of the people. Such a change might need also improving other spatial elements particularly the furniture. In this case the unergonomic furniture was limiting the accessibility of the living rooms. However despite of the furniture e.g. more interactive lighting concepts could have been prototyped if there was an access to interactive technologies or opportunity to develop interactive lighting products within the project. Also the culture of a space, created by people ruling or using the space, influence on the behavior of people. Rules and limitations might also restrict usage of certain spaces even though being accessible from the architectural point of view.

USER-CENTEREDNESS
This thesis introduced one approach to design lighting for senior environments. For sure there is no right or wrong approach to perform a design process but the least a designer can do is to respect the future users by aiming at understanding them as profoundly as possible. Even though guidelines, recommendations and practical tips about accessibility when designing environments for special groups are useful and needed their utilization only will not manage to provide as insightful information for the designer as having also personal contact to your users in the right context. It may not be easy and you may need to go beyond your comfort zone but definitely it is worth it. To study your users you have to leave your design studio and go to the place where you can meet the users. It takes time, it may be complex, you might meet difficulties as well as it might be inconvenient and even depressing.
experience but after you have a connection to the users you have gained knowledge that cannot be learned from a paper or book. Without any personal contact to the users in their own context, it is rather improbable to succeed designing artifacts, environments or services that really add value to the life of the users. Without realistic understanding of the users a designer can only rely to stereotypes and conventions which may not have anything to do with reality. Studying the users is not complicated if there is a chance of entering places where they normally are. According to my own experience gained in many projects, when reaching the users the simplest way to study them is to observe them, spend time with them, listen to what they have to say and prompt them by asking, asking and asking any questions related to the topic. In the case of communication challenges more structured methods can be applied e.g. art therapy based workshopping methods created and utilized in MONA project.

During the lighting study, in addition to the senior residents, also personnel of the assisted living building working there on daily basis, were interviewed related to piloting, in order to also consider their opinions. Nevertheless the feedback from the seniors was emphasized because they are the people the place is built for and they are the ones spending most of their time there. If designing built environment only based on the user knowledge from people working in the spaces, it might switch the concentration on mainly supporting their working processes forgetting to consider the reasons and functions the space initially was meant for.

SENIORS AS USER GROUP
All the seniors contacted during the lighting study were marveling why someone was interested in their opinions. Apparently they were not asked nor listened to what they would prefer and need. Some of them underrated their own opinions and one interviewee even questioned why she was interviewed. Seemingly they did not feel that they could have an influence on their living environment. This reflects well how seniors are treated in our society as passive receivers of supporting services instead of activating them. There is a need for a change to be done in very fundamental level in order to activate and empower seniors. People feel better when they are active subjects of society. It emphasizes feeling of being important and respected. Nowadays the situation is unfortunately opposite. Seniors could be empowered by providing them a chance to impact the conditions of their own life e.g. involving them in the decision making when planning any condition change which affects their life whether it considers their environment, assisting services or activities provided for them. Actually even more importantly than fulfilling the physiological basic needs the psychological needs should be paid attention to. It is self-evident that fulfilling basic need is important but if there is no access to fulfill psychological needs, “food for soul” or feeling happy, life is rather meaningless. This is why I suggest that now when the “functional needs” are fulfilled already rather successfully the society’s goal related to seniors should be switched to support meaningful life instead of mechanically feeding, assisting in hygiene etc. This meaningfulness does not have to be a new separate function of the system but an embedded attitude or goal of the people working with or for seniors. This includes also us designers whether designing anything from lighting or medical equipment to shopping or sport services.

Seniors as lead users
I would consider seniors as a great lead user group when exploring ideas and developing environments, products or services related to daily life suitable for all user groups. The fundamental idea of utilizing a special group as lead users when designing for all, suits particularly well also to the context of lighting designing. The ideas explored and tested during this lighting study would in my opinion suit very well all type of public environments for people to gather together. Spaces with good accessibility are not affecting negatively any type of users but respecting them all.
PROTOTYPING DRIVEN ATTITUDE
In the context of lighting design, prototyping is often part of the design process. Mostly prototyping is conducted as well as evaluated by the designer or design team themselves. Often prototyping is conducted rather assuring that lighting design plan works in practice than in order to involve actual users in the development or evaluation of the space the lighting is for. Prototyping can offer possibilities of “failing fast and succeeding sooner” and open up new possibilities and insights which cannot be identified without acting in the real context. In the field of lighting it is rather common that lighting design practitioners conduct prototyping in the final stage of the design process when the plan is ready to be assured that the lighting setting works in practice as it was planned. Often prototyping would be most beneficial if started already in the early stages of the design process. Even though it might feel as a big effort it usually pays back by pointing out the weaknesses of the design and forcing to meet the reality and suitability of ideas in relation to the real context. Running the mock testing round in the early stages of the process turned out to be very valuable by forcing adapting ideas from idealistic level to practice and forcing to adjust and iterate my ideas according to users’ feedback.
CONCLUSIONS

This lighting study, in which wellbeing supportive lighting was explored, was conducted as part of “MONA” project aiming at promoting social and physical accessibility in built environment concentrating in public and semi-public spaces. The goal of the study was to explore the possibilities of supporting the wellbeing of seniors when the medium is light; how can lighting eliminate daily challenges seniors face, how can lighting enhance positive spatial experience and as an ultimate goal increase happiness?

This thesis presented a point of view on how to tackle lighting design challenge with a user-centric approach processing with prototyping-driven attitude to outline a senior environment specific lighting concept and test it in order to understand better how lighting can be harnessed to support wellbeing and accessibility in built environment.

According to the user study results, the ones who pay most attention to lighting, are the ones whose accessibility is depending on the lighting conditions in other words people who are visually impaired. For them the lighting might crucially affect the size of their territory they feel comfortable to move within. Lighting as a mean can be harnessed to support visual accessibility enhancing spatial perceiving in several ways. Most probably, environments suitable for visually impaired would also suit normally sighted people better than spaces signaling contradictive multisensory messages.

Nevertheless to affect the behavior of the seniors in order to activate and prompt them in socializing requires physical accessibility in the first stage. When the accessibility is actualized physically (e.g. ergonomics of furniture in addition to elimination of physical barriers) the higher level accessibility “intangible accessibility” should be paid attention to. Lighting as a mean can be utilized in order to enhance intangible accessibility e.g. in the form of accentuating spatial perception and orientation in space, atmosphere of safety as well as emphasizing mental and social accessibility e.g. including interactive elements to the lighting installation, prompting feelings and possibly even enhancing happiness.
ACKNOWLEDGEMENT

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LIST OF LUMINARIES AND CONTROLLING SYSTEMS UTILIZED IN PILOTING

Pendants:
3 pieces, Ateljé Lyktan, Clara 202004-133 (extra serial number -133 = Tridonic PCA Excel – connection applience), effectiveness 1x40W, down

Functioning:
When a sensor detects movement the luminaries are controlled to turn to full power (100%). The time delay before starting to dim back to the sleeping mode when no more movements are detected is 12 minutes. The dimming takes 32 seconds to get to the sleeping mode (30%). After 30 minutes they switch off (0%).

Wallwashers:
8 pieces, Fagerhult, Gondol, 17892-133 (extra serial number -133 = Tridonic PCA Excel – connection applience), effectiveness 1x35W

Functioning:
When a sensor detects movement the luminaries are controlled to turn to 16%. The time delay before starting to dim back to the sleeping mode when no more movements are detected is 12 minutes. The dimming takes 32 seconds to get to the sleeping mode of 5%. They never switch off automatically.

Wallwashing the pillars:
2 pieces, Ateljé Lyktan, Bergamo 203421-299 (extra serial number -299 = Tridonic PCA Excel – connection applience), effectiveness 1x26W

Functioning:
When a sensor detects movement the luminaries are controlled to turn to 16%. The time delay before starting to dim back to the sleeping mode when no more movements are detected is 12 minutes. The dimming takes 32 seconds to get to the sleeping mode of 5%. They never switch off automatically.

Desktop pendant:
1 piece, Fagerhult, Loop Light 19289-17 (extra serial number = switched on manually with coupler) effectiveness 2x35W

Functioning:
The luminary is controllable with manual switch enabling choosing from three different lighting levels. Pulling one switch turns the luminary on to 50% for general lighting. When more light for working, reading or handcrafts is needed by pulling also the other switch turns the power to 100%.

Desk luminaries:
1 piece, Ateljé Lyktan, Ibis 201890
1 piece, Ateljé Lyktan, Ibis 201891 effectiveness 1x26W

Functioning:
The lights are controllable with integrated switches (on/off).
MOCK UP TESTING INTERVIEW QUESTIONS

Background info:
1) How old are you?
2) How do you cope with your vision in daily life
3) Do you have any eye diseases?

Spot 1: info board in the lobby
4. Can you read the announcements on the info table? At what distance? (original lighting)
5. How is the situation now? (test lighting)
6. Which lighting do you prefer?
7. How would you describe them?
8. What do you think about the atmosphere in both lighting situations?
9. What do you think were the main differences between the two lighting?
10. What kind of lighting you prefer in general?

Spot 2: reading small text in the activity room
11. Which one of these text fonts sizes you find challenging to see?
12. Tell me when you can see text the best and feel most pleasant reading it? (starting from 0 lx and controlling it continuously until 1500 lx and back to the most pleasant level of the test subject)

Spot 3: corridor lighting, comparing direct and indirect lighting
13. How would you describe each of the lighting settings?
14. Can you see any difference between them?
14. Which one do you prefer and why?

Thank you!
LIGHTING PILOTING INTERVIEW QUESTIONS
/ QUESTIONS FOR RESIDENTS

Explaining background info of the lighting study to the interviewee.

Background questions
1. How old are you
2. How is your sight?
3. Do you have any eye diseases?

Lighting affecting daily life
4. How does lighting affect your orientation, walking and staying in the common spaces of the building? Or your life in general?
5. Do you find seeing challenging in the common spaces?
6. How would you describe the differences of lighting in different parts and spaces of the building? Do you think the lighting conditions vary?

Glare
7. Do you suffer from glare?
8. Do you think that the lighting is glary in the common spaces of the building? If so where exactly?

Spatial perception
9. Do you find perceiving the common spaces easy? E.g. Do you perceive the shapes of the rooms: walls, pillars, furniture, corners etc. well?
10. Are there some spaces in this building that you find particularly easy or difficult to perceive?

Lighting levels
11. In what type of lighting conditions you prefer to be? In what type lighting it is most convenient to act?
12. Do you think there is enough light in the common spaces of the building? Which spaces are enough lit and which ones are not?

Activity level
13. Do you spend time in the common areas of the building?

Cozyness
15. What type of lighting do you find pleasurable? Are there some specific places e.g. in this building that you find particularly cozy?

Invitiness
16. What type of spaces you find welcoming? Why?

Happiness / joyfulness
17. Is there some specific lighting that makes you feel happy and cheerful? What sort of? Why?

Comparison (before and after the lighting change)
18. What do you think about the original lighting of the living room? (a selection of photos of the original lighting as material)
19. How do you find the new lighting?
20. Did you used to spend time in the living rooms?
21. Do you stay there now?
   - What do you do / used to do there? Or why do / did you go there?
22. When passing the space do you walk along the corridor or throught the living room?
23. Has the lighting changed your route?
24. Do you find the space different than it used to be? Compared to the original lighting is it now...
   a) brighter / dimmer
   b) cozier / more unpleasant
   c) more homelike / less homelike
   d) more quiet / noisier
   e) more welcoming / more aversive
   f) happier / sadder
   g) more spacious / more narrow
   h) more glary / less glary

25. Is there something else you would like to tell related to lighting?

Thank you!
LIGHTING PILOTING INTERVIEW QUESTIONS
/ QUESTIONS FOR PERSONNEL

Explaining background info of the lighting study to the interviewee.

Background information
   A) What are the most common reasons why seniors move in this assisted living building?
   B) What is the average age of the inhabitants in the building?
   C) Has there happened any changes in the inhabitant composition of the house after Christmas? Did some residents leave the building to go for a holiday to visit their families?
   D) What type of activities have been organized in the second and third room living rooms in between 2.1. - 15.4.2012? When?

Comparison (before and after the lighting change)
   1. What do you think about the original lighting of the living room? (a selection of photos of the original lighting as material)
   2. How do you find the new lighting?
   3. Did you used to spend time in the living rooms?
   4. Do you stay there now?
   > What do you do / used to do there? Or why do / did you go there?
   5. When passing the space do you walk along the corridor or throught the living room?
   6. Has the lighting changed your route?
   7. Do you find the space different than it used to be? Compared to the original lighting is it now...
      a) brighter / dimmer
      b) cozier / more unpleasant
      c) more homelike / less homelike
      d) more quiet /noisier
      e) more welcoming /more aversive
      f) happier /sadder
      g) more spacious / more narrow
      h) more glary /less glary
   8. Is there something else you would like to tell related to lighting?

Thank you!