

# CONSIDERATE LIVING SPACES

Shaping Homes to Foster Sustainable Behaviour

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Master's Thesis at Chalmers Architecture

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# ABSTRACT

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More people are becoming aware of the dangers of climate change and of the cradle-to-grave manner which is exhausting the planet of non-renewable resources and destructively affecting ecosystems globally. The manufacture of buildings has a negative impact on the environment with heavy resource use and greenhouse-gas emissions but architecture also has a vital part in increasing quality of life, supporting social interactions and creating a rich cultural environment.

There is a progression towards more sustainable buildings with improved energy-efficiency, healthy materials and innovative system solutions but this will not be enough if people keep living the same consumer lifestyles inside of these buildings. There needs to be a change not merely in the built environment but also in the activities and behaviours of its residents if we are to create truly sustainable environments.

Through research into the relationship between human psychology and architectural residential design, combined with examples and case studies in relation to these topics, this thesis aims to develop goals and strategies to showcase how architecture could support a positive behavioural change. It shows that these added positive effects can be achieved through the development of

intelligent, thoughtful, diverse and quality living spaces while closing loops and giving back to nature.

By reflecting on the role of the architect and the importance of *why* and *how* we create our living environments, my hope is to encourage an alternative way of thinking. We are designing the physical framework for the inevitable changes people are facing and it would be naïve to think that they do not have an impact on people's attitudes and lifestyles. I want to raise awareness of the possibilities which this paradigm enables, hoping to inspire architects and the public alike

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*“...Architects offered themselves as providers of instant solutions, and only the look of a building gives instant gratification. When the space planning doesn’t work out and needs improvement, or the structure indeed rots, where’s the architect? Long gone.”*

*- Stewart Brand, How Buildings Learn*

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# BACKGROUND

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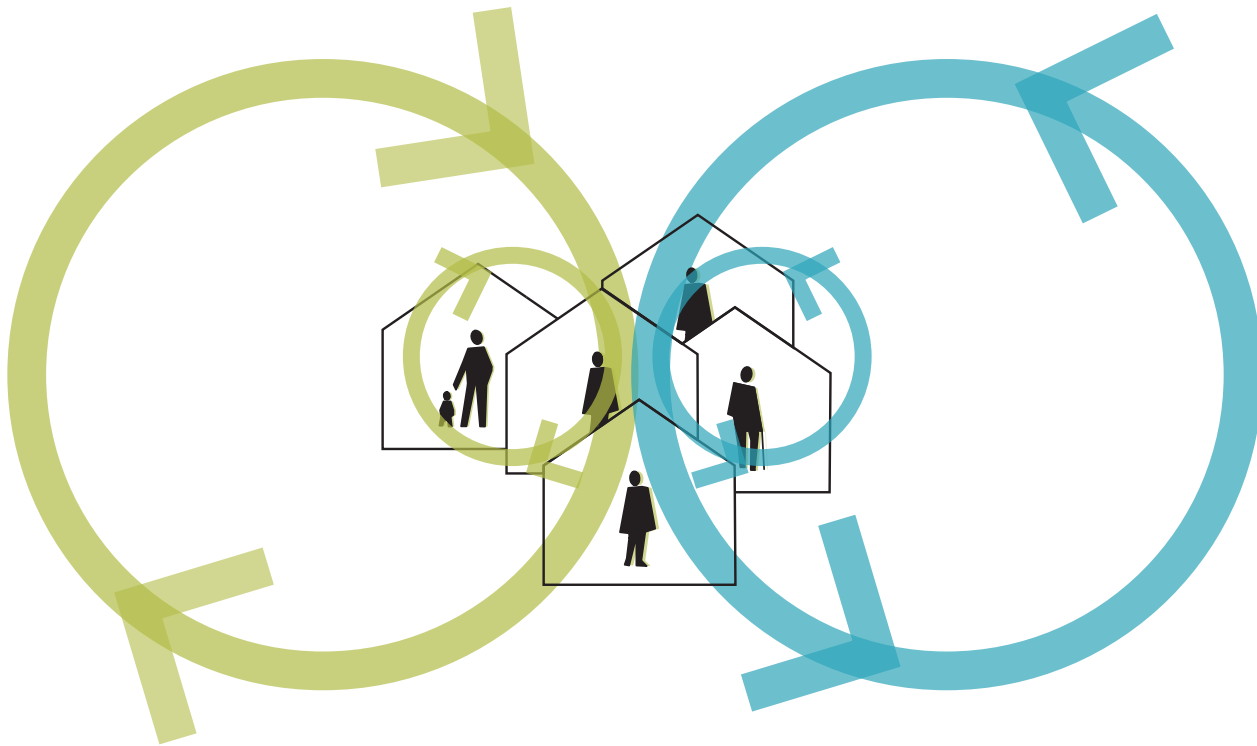
As a student of architecture with an ever-growing interest in sustainable development, I have been introduced to many tools for attacking sustainability issues and have come across several aspects of sustainable building design through the topics of building systems and new technical solutions, biomimicry, cradle to cradle, systems design, biophilic design, eco-system services, and traditional building techniques, among many others.

I have wanted my Master thesis to continue working on the sustainability issues I have been introduced to and the knowledge I have acquired thus far. In most of the projects I have been a part of, I have found that the discussion of sustainable buildings often includes the topic of lifestyles and habits of the building users. I felt that my understanding of these issues and how they are connected to the built environment was lacking and have found that I wanted to explore them further in order to be able to develop my skills as an architect. In addition to the fact that we as architects make decisions that have an impact on the improvement of building performance, building efficiency, material choices and reduction in building cost, I have also wanted to investigate how these choices affect the residents of the buildings that are designed to discuss if architects in some way can influence behaviours.

I started my bachelor in Architecture at Chalmers University in 2011 and continued my master level at the master program Design for Sustainable Development where I participated in the courses Local Context (analytical studies, context research, dialogue with people), Design Systems (connections and consequences, leverage points, exploring different systems design tools), Sustainable Building (Materials, Building Systems, co-housing) and Senior Housing (elderly, accessibility, future visions).

The action towards sustainable solutions from architects are, in Sweden, well below the building sector average which suggests that there are many opportunities for the profession to improve and to find new ways to approach these issues. According to Miljöbarometern (2007), architects in Sweden see quite a few different obstacles for not working with environmental issues more or, in some cases, at all. The most common reasons being a lack of market demand for sustainable solutions (44%), that it is too expensive (32%), no competitive advantages (28%) and lack of knowledge or office structure (both 26%). There is clearly a need to find relevant arguments and new innovative solutions to promote changes in a conservative building industry. If we as architects do not, then who will?





Heimsath (1977) identifies two major complications in changing building procedures through architectural design, the first being the lack of a programming phase where the architect simply conforms to the clients wishes and the second being a feedback phase. He finds that there is an opportunity for architects in most architectural practices to push new innovative ideas early on in projects. At the same time there is a lack of a proper feedback step in the design process at the end, one which acknowledges the cause-and-effect relationship of the designs and much could be gained from adding proper care to these two steps. With current input from my research and from other practicing architects I have no reason to disbelieve this statement. Social success is hardly acknowledged, something which also shows in architectural competitions where it seems award juries are most often not instructed to evaluate the usability of a building, then again judging often occurs at an early stage where this is not yet relevant or appropriate. The user phase of a building must be seen as a more valuable phase of the architectural stage, one which can be both affected and stimulated.

I was inspired, when I was introduced to the mind-set of cradle to cradle as a holistic, inclusive approach to sustainability issues. It had a sensible

description of what the future could look like, an idea that did not limit growth, design, creativity or production, but instead encouraged it, only in a different way. With my own struggled thoughts of "surely not building or producing anything at all must be the best solution for our planet", this was a welcoming and positive idea. The cradle to cradle paradigm does not promote a world of restrictions and limitations but instead encourages one of innovation and growth. A regenerative design where we all live co-operatively in abundance acknowledging the connections between everything on this planet. Sustainability should be seen, not as something layered onto or applied to an existing design, but as something deeply integrated. Human society is an inseparable part of the natural environment and if people want to flourish there has to be a change in behaviour to be able to work with it and not against it. Individuals need to adapt the philosophy that everything is connected, seeing the importance of healthy relationships between people, buildings, site and context. Solutions which only benefit a small group of individuals but not the vast majority of people and ecosystems on this earth are not solving the problem.

# AIM

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The goal of this thesis is through design strategies, demonstrate ways in which architecture and design can promote a positive change in user behaviour patterns towards a more sustainable future. In order to do this there needs to be a better understanding of the building users, the complex minds and decision making of humans, for these to be possible factors to take into consideration through all phases of the design process.

The overall goal is a sustainable ecological, economic and social environment where people's behaviour supports the growth and health of all three of these factors. To have a fully holistic view, the building users' behaviour must be seen as an important factor for a sustainable future change.

By exploring the topic of environmental design and inter-connected fields; the aim of this thesis is to spark a deeper discussion and reflection on how the built environment has an impact on and affects human behaviour. It is also an attempt to encourage other architects and people in similar situations to reflect on these topics in order to make decisions that lead to more satisfactory conditions for everyone in the pursuit of a sustainable fruitful future. I wish to enable architects to better understand the human emotions and actions that are to be represented in the buildings we design.

I promote these ideas as an added perspective to the sustainability discussion and an extra input for someone who already has a basic knowledge of sustainable design.

The research questions have been developed to explore the relationship between the built environment and human behaviour towards a sustainable future.

Research Question –

How can living spaces foster sustainable behaviour?

Sub Questions –

What is sustainable behaviour?

How does the built environment affect behaviour?

What is the definition of living spaces?

How can behaviour be effected?

*How Could Residential  
Spaces Foster Sustainable  
Behaviour?*

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*What is Sustainable  
Behaviour?*

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*How Does the Environment  
Affect Us?*

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*How Can Behaviour  
be effected?*

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Considerate - Careful not to inconvenience or harm others; Showing careful thought.  
Synonyms: thoughtful, kind, accomodating, compassionate, generous, caring.

Behaviour - The way in which one acts or conducts oneself. Synonyms: actions, exploits, doings, efforts, manners, ways, habits, practices.

Psychology - The scientific study of the human mind and its functions, especially those affecting behaviour in a given context.

Influences - The capacity to have an effect on the character, development, or behaviour of someone or something. Synonyms: control, hold, power.

Living - [ATTRIBUTIVE] (of a place) used for living rather than working in.



## METHOD

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This thesis is a result of my work during one semester. The finished result is a combination of literature studies and critical reflection, which has led to the development of design goals and strategies towards a residential building that fosters a sustainable way of living.

Interdisciplinary research into the fields of environmental psychology, social psychology, cognitive psychology and architectural theory has been an important part of the process to better understand the basis of human behaviour and actions and their connections to the built environment. Literary studies collecting information from previous work touching on these subjects have been essential for the development of this master thesis.

To work with the topic of living environments, the use of systems design has been used as a tool for understanding and communicating the inputs and outputs of the actions and behaviours that take place in a Swedish home, trying to define modifiers and leverage points in the built environment that could positively affect these parameters and visualising them.

## LIMITATIONS

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The perspective throughout my work has been from the individual. Single households is an increasing group of people in Sweden and they currently require more space, resources and consideration. Which is why it is vital to acknowledge the importance of peoples interactions to other individuals, society and the environment. Looking at these connections has been an essential part of defining sustainable behaviour and trying to promote it.

The meaning of the terms Living Spaces, Residential spaces and Homes can arguably be interpreted slightly different but I have in this thesis used them interchangeably. Interpreted as spaces where we live and reside rather than work.

# PROCESS

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My interest in residential spaces has been strong throughout my education. I was sparked by the cradle to cradle paradigm to work with a residential building project for my thesis that took these ideas further than most current mainstream building projects. This thesis therefore started out with the thoughts that I would end up with a project similar to the classic layout of traditional Chalmers Architecture design projects. A set up and process that I am used to from several previous projects during my studies at both Bachelor and Master level. A small research part at the start, a site analysis, building design and details with a presentation mostly consisting of sections and plans. In a way a kind of starting-from-the-outside-working-your-way-in approach. Surely a common way of working but one I later found would not quite meet my aspirations and goals for the outcome of this thesis. My project has ended up as something a bit different and it has taken a few turns along the way but I have never stopped learning and exploring and the topic kept growing as I went. The goal has always been to develop a sustainable design, with focus on living spaces and many of the parts I have explored through my work are still very much relevant for my new perspective of looking at the issues of sustainable living through user behaviour. Although the end result is more theoretically laid out than first intended.

My work started with a deeper study into the principles and ideas behind Cradle to Cradle and its connections to the built environment. As this topic spans from all scales, from the development of cities to the type of carpet glue, and as there is not yet a fully C2C certified building I soon realised the complexity of my chosen topic. After an analysis of a newly developed detail plan from Gothenburg City, which would be my project site, I realised that the C2C paradigm has to be implemented through all stages of a project and it has to be a co-operation between all stakeholders involved. By continuing on what the city had already done I would not meet my own goals for what I wanted this thesis to achieve.

I used the knowledge I had acquired thus far and continued to explore the topic of sustainable residential spaces whilst trying to find my part in that process. I realised that many of the topics in relation to sustainable building; growing food, conservation of water, reduction of energy consumption and waste management, all include the building users and lifestyle changes. On many occasions I found that it seems like the architect withholds all responsibility for what happens after a building is completed. That the user phase is not the architect's responsibility at all. I wanted to explore further how architects to a greater extent

can push sustainable solutions to have a positive impact on peoples' lives.

"How will your requirements help the industry to create the materials we need to achieve a C2C home?" (Marshall-Baker, Tucker 2012) It is about being the change, not letting go of the ideas you believe to be right and setting an example. Showing how building designers can affect people both directly, by the size of the spaces, the materials and systems that go into the design, as well as indirectly by encouraging behavioural change and awareness through design.

Citing McDonough and Braungart (2002) "Being less bad is not being good". I believe we should aim for a regenerative future with an abundance of resources and health and happiness for all.

*"To be a good architect you must love people; architectural designs, after all, are not isolated pieces of art – they are frameworks around people's lives, and if, deep down, you don't really care about people, of course you can't create good architecture!"*

*- Ralph Erskine cited by Jan Gehl*

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# THESIS LAYOUT

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The theoretical part of this thesis is divided into five chapters, each exploring a different aspect but all equally important for a basic understanding of the topic as a whole. The different parts touch on similar subjects and are in some cases referring to similar discussions but combined they are aimed at working towards a response to the main research question. How can living spaces foster sustainable behaviour? This is proposed by first exploring today's existing situation and then a suggested driving force for change through goals and design strategies in the second part of the thesis.

## 1. SUSTAINABLE BEHAVIOUR

What is sustainable behaviour?

To be able to develop residential spaces that foster certain desirable behaviours, there needs to be a discussion of what kind of behaviours these are. This chapter investigates different aspects of sustainable behaviour.

## 2. INFLUENCES

How does the environment affect us?

Secondly, this thesis explores important factors for different ways in which the surroundings influence us. In order to develop designs which can foster sustainable behaviour in humans an understanding how people perceive the built environment and in what ways it can affect us is important.

## 3. LIVING SPACES

What are living spaces?

The third chapter explores the definition of living spaces. Discussing the aspects of a current Swedish home and the functions it accommodates. It also looks at living spaces as a vibrant system, considering the processes that take place and the requirements and consequences of these spaces.

## 4. THE INDIVIDUAL

What affects our behaviour?

This chapter aims at acquiring a deeper understanding of people, the building users, in order to be able to meet their needs in the best possible way.

## 5. BEHAVIOUR CHANGE

In what ways can we affect behaviour?

Theories on different ways in which we can encourage behaviour change in people has already been discussed in earlier works. Some of these approaches and driving forces are presented and discussed in this chapter.

The design part of this thesis is divided into three parts.

#### AMBITION

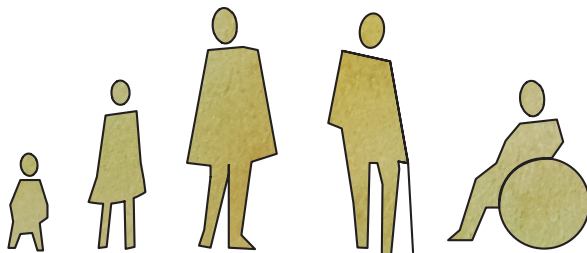
Discussing aspects that are important for the development of strategies.

#### GOALS

Combining the knowledge acquired in the theoretical phase of this thesis, goals for sustainable behaviour are developed.

#### STRATEGIES

This is a development of project strategies that in several interconnected ways help meet the established goals by defining ways of working with design to foster sustainable behaviour. It does this by targeting important factors for behaviour concluded in the research phase.





“Belief in the significance of architecture is premised on the notion that we are, for better or for worse, different people in different places – and on the conviction that it is architecture’s task to render vivid to us who we might ideally be.”

- Alain de Botton, *Architecture of Happiness*

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THEORY

# SUSTAINABLE BEHAVIOUR

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## *what is sustainable behaviour?*

There is a progression towards more sustainable buildings with improved energy-efficiency, healthy materials and innovative system solutions but this will not be enough if people keep living the same consumer lifestyles inside of these buildings. There needs to be a change not merely in the built environment but also in the activities and behaviours of its residents if we are to create truly sustainable environments. But what does this entail?

## DEFINITIONS

I would generally define sustainable human behaviours as actions and attitudes that supports a thriving sustainable future for all. The also support the different parts of sustainability, the definition with a division of the social, natural and economic environment being one of the most common. Sustainable behaviour also consider the needs of forthcoming generations along with the satisfaction of present needs. (World Commission on Environment and Development, 1987)

McDonough (2007) states that people should support growth, but that what we want to grow is prosperity, health, security, community, peace and culture. To live in a flourishing regenerative world with sustainable human behaviours that

support the growth of all these factors is the goal. Connecting to the Cradle to Cradle principles we also need to support biodiversity, use renewable energy and not regard anything as waste, but see everything as valid nutrition for something else in a long chain of interdependence.

Mock and Werneke (2011) developed McDonough's Hannover principles (2003) as an approach for sustainable land development using the concepts of People, Planet and Profit. Similarly to the support of growth, adapting behaviour to these goals would work towards a sustainable future.

Tapia-Fonllem et al. (2013) suggests a division of sustainable behaviour into four categories. Pro-ecological, frugal, altruistic and equitable behaviours. They also found that one sustainable action is likely to lead to others, and their study confirmed that individuals who engage in pro-ecological and frugal actions are also more likely to then practice altruistic and equitable behaviours. This has however been discussed and is being argued against.

Two other aspects, not mentioned previously, I believe to be significant for sustainable behaviour

are personal health and happiness. Tapia-Fonllem et al. (2013) believe that happiness is something which profits from practicing sustainable behaviour. Health is another aspect which benefits from a behavioural change. The more people adopt a sustainable lifestyle, the easier it is to support health and happiness for all, starting a positive cycle.

### HEALTH FOR ALL

If people feel well and healthy, they are more likely to take part in activities and display behaviour that benefit more than themselves. We all know how hard it is to concentrate and focus if we are not

feeling our best. Understandably, most research in connection to human wellness have been made in relation to healthcare. These have proven that in addition to care by staff, outlooks towards nature, natural light and fresh air can stimulate a healthy recovery, and ultimately contribute to human health. They also state that people are stimulated and more likely to take part in activities if they are visible, leading to a more active and social lifestyle (Fridell Anter, 2006). I question why the same wellness goals should also not set for residential buildings, with more stressful lifestyles and an increase in mental health problems, these factors

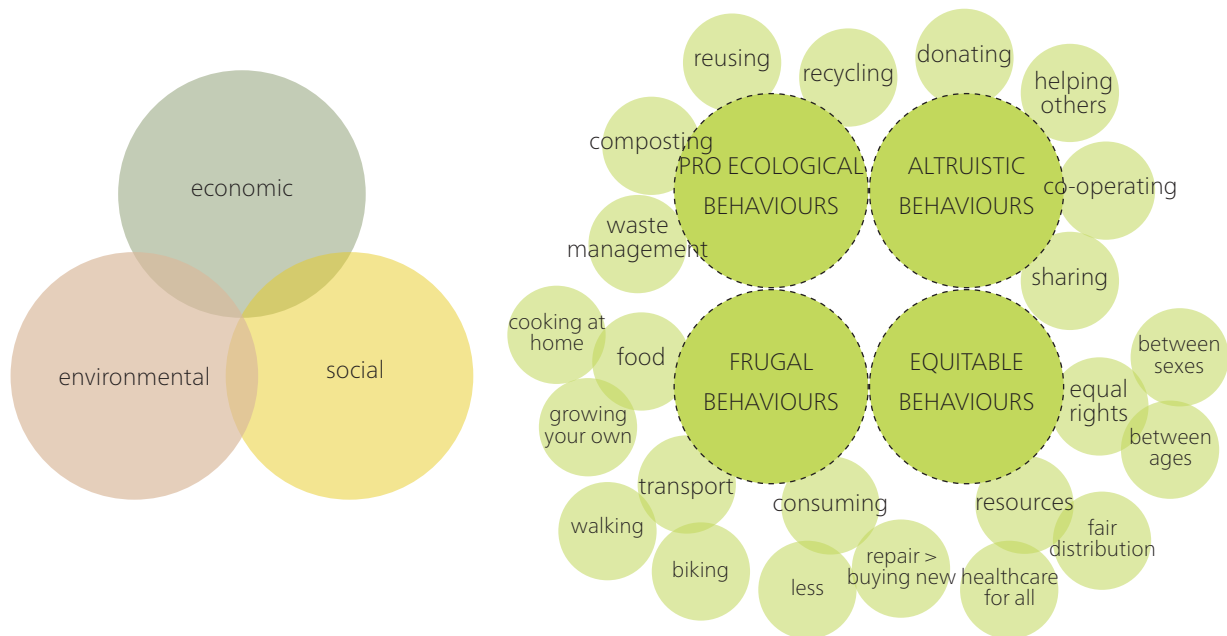


Fig. 1 Matrix developed by author from Tapia-Fonllem et al.'s (2013) sustainable behaviour categories



Fig. 2 Sustainable Development Matrix (Mock 2011)



are becoming increasingly important and there is much to learn from what has already been done in other sectors.

When discussing wellness, it is important to mention that there are several dimensions to the topic. Dr Bill Hettler, former Executive Director of the National Wellness Institute US, in 1979, (Russ & Ford Montgomery 2007) defined the different kinds of wellness as:

- Physical wellness: Regular physical activity, diet and nutrition.
- Emotional wellness: Awareness and acceptance of one's feelings. Included is also trust and respect for others.
- Spiritual wellness: Our search for a peaceful harmony, meaning, purpose and value of life.
- Intellectual wellness: Creative stimulating mental activities.
- Occupational wellness: Personal satisfaction and enrichment through a contribution to work.
- Social wellness: Making healthy living choices, initiating better communication with others, contributing to one's environment and community and building a better world for everyone.

The built environment can negatively affect our physical health directly in ways of damp, mould and mildew, static electricity, radon and air pollution

which is why materials and finishes are especially important. Lighting, ventilation, acoustics, texture, colour, use of space, ergonomics, universal design, incorporation of nature, use of art and sustainability (Russ & Ford Montgomery 2007) are other interior design elements which may directly impact the dimensions of social, emotional, intellectual, occupational and spiritual wellness.

### HAPPINESS FOR ALL

The pursuit of happiness. People are happiness seekers. Happiness is a mix of positive emotions, novelty and stimulation, something that encourages individuals to continue with a certain behaviour (Harré, 2012). Suggesting that people will not continue an advised action if it does not give them the feeling of happiness. The interest will then quickly fade. If we want people to continue their sustainable behaviour it is therefore important to include happiness as an important factor. It is also shown that positive emotions encourage creativity, co-operation and a stronger openness to change (Harré, 2012) which can all contribute to positive lifestyle changes.

The importance of architecture however, can also be very inconsistent in how it has an effect depending on people's mood at the time. A trip to a most aspiring building by any famous architect

could still have us feel overwhelmingly sad, in a bad mood or have us fall into arguments, it is not a fool proof generator of happiness. De Botton (2006) means that architecture can propose moral messages, sentiments and ideas, but it cannot enforce them. That what individuals surround themselves with in the physical space should reflect their needs, moods, values and ideas and that what a person call home is a place where they can feel this harmony, a connection to what they feel is their inner identity. Connecting happiness to a finding of their true selves.

Montgomery (2014) found in his work that social connections is the most vital ingredient for happiness stating that a happy city = a social city, above all other factors. This because social trust and connections between individuals increase

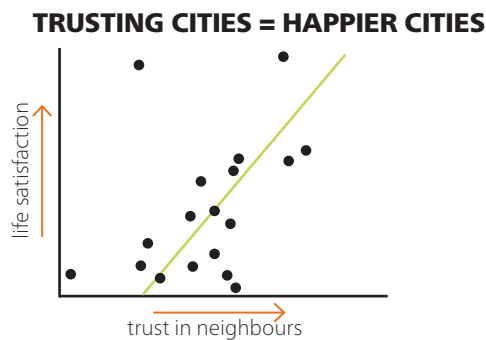
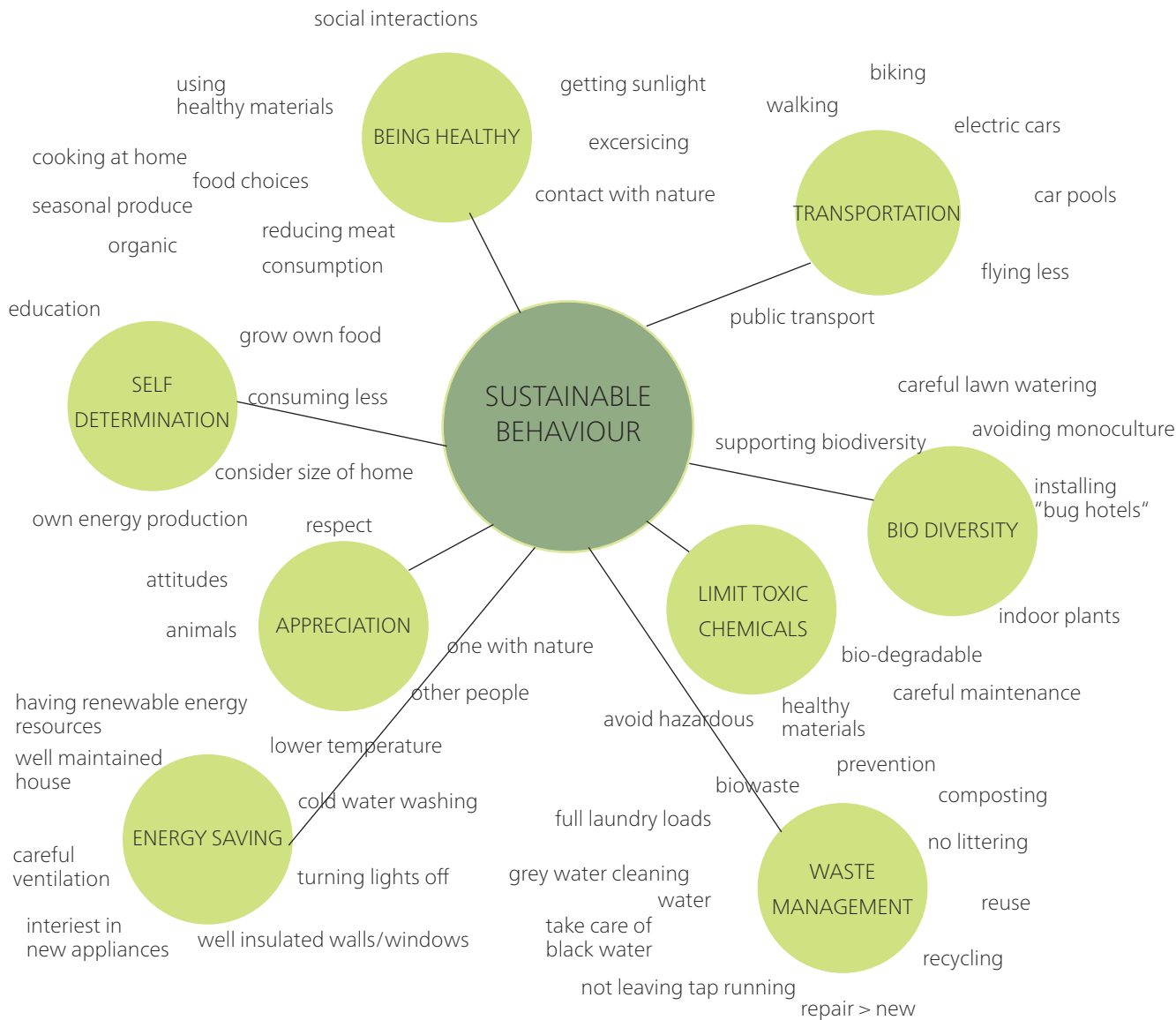


Fig. 3 Life satisfaction in relation to trust in neighbours (Montgomery 2014)

the resilience through hard times and through changes in society. He supports this through research by Helliwell who tested a similar theory on cities in Canada. He found a connection between urban design and people's emotional and social life. Sprawl and car dependent neighbourhoods contributed to a more isolated lifestyle, leading to less participation in team-sports, communal activities and volunteering and he found similar experiences in large building towers. In summary, if people are happy, they trust their community and their neighbours and they are more likely to care for them and build upon something which benefits more than themselves. By creating environments that generate positive emotions immediate well-being can be provided, as well as securing welfare of the future. As happy individuals are more cooperative, pro-social, charitable, and focused on the needs of others this creates a positive upwards spiral towards behaviour change. As previously suggested, by practicing sustainable behaviour this also contributes to our personal happiness, the two are connected and positively affects each other.

In the sustainability matrix on the right is a development of the meaning of sustainable behaviour, as I felt some aspects was missing in previous definitions. By categorising them, and specifying specific behaviours they could entail, a better overview of what it could mean for the residents is created.



*Sustainable Behaviour Matrix by author*

# INFLUENCES

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## *how does the environment affect us?*

The built environment can influence people in different ways; physically, socially and emotionally. Combined they help steer our behaviour and the actions we make. The question is how these influences happen and in what ways they can change to enhance sustainable behaviour patterns and foster new ones. This chapter aims at giving a brief overview of some of the different aspects.

The idea that individuals are influenced by the built environment is not a new concept. Secular architecture has been used to affect people in a desirable way for thousands of years. Claims that beautiful striking architecture has a better effect on shaping people than reading religious scriptures has been made by theologians of both early Islam and Christianity. Belief that architecture could reinforce people's determination to be good and improve them both morally and spiritually is based on the idea that they react and behave differently in different spaces (De Botton, 2006).

## SENSES

People experience the environment around them through their senses. The perceptions are then associated to previous experiences and beliefs, leading to a perceived quality, then resulting in actions and behaviours. As people grow older and

the senses weaken, some become more significant than others. How well an individual can orientate and read a space and the perceived comfort levels are important factors for our behaviour.

VISION - Arguably the most important sense for perceiving architecture being through visual stimuli. People notice the size and atmosphere of a space and the light, colours and aesthetics through their sight. What people see gives an overview of the environment and helps them understand how to behave. Two of the most significant visual stimuli being colour and light.

COLOUR - How important are the colours and light settings for wellbeing, comfort and performance? Much has been studied in relation to colour and behaviour. It is believed that rooms with many strong colours and complex patterns activate our brain which could lead to more stress, more so than the same situation in a more neutral coloured room. Theories also suggest that different types of activities require different types of stimulation, where a complex task would benefit from a calmer and simpler setting whereas a simpler, more repetitive task can handle additional stimulation from the surroundings. (Fridell Anter, 2006) Another common discussion in relation to colour theory and common concepts of how colours

could have an effect on mood and behaviour, are associations to warm vs. cold colours. Few of these theories have actually been scientifically proven to be true. It is not as simple as blue vs red but also dependent on hue, colour strength and equal blackness (Kuller, 1973). There have been several studies on different colours of rooms in relation to productivity in working environments, but how people behave and feel are dependent on many additional factors which makes the questions complex and no definite answers can be given. Even though scientist agree that colours do have a significant effect on individuals, the outcome can vary dependent on social situation, preferences and emotional and physical state at the specific time.



*Fig. 4 Pink prison wall experiment*

This was also proven in an experiment where prison walls were painted pink with the ambition that the colour of the walls would reduce violence. A change in behaviour was noticed during the experiment but there was a lack of proof to this theory and it later turned out that it was rather the change and care for the environment, and not the colour itself, that had evoked a change in behaviour. (Kuller 1973)

Being that people are so individually different, it might then be more important that colours can be flexible and adapted to individual needs, than finding general one-fits-all solutions, and that it is more important to look at the activities taking place in different parts of a building to accentuate certain essential elements and to create different atmospheres. Because there are certain cultural aspects of colour and specific connotations, they have to be taken into account if giving character to certain places (Fridell Anter, 2006). They can also be beneficially used for associative purposes, to help with orientation, identity, accessibility and meaning. An easy understanding of the environment can affect people's behaviour, encourage them to act and increase the feeling of both safety and well-being. Another important factor is the project demographic as elderly and people with different visual disabilities have a bigger need of stronger contrasts and specific colour settings.

LIGHT - The importance of natural sunlight to healing and wellbeing has been explored in a number of studies (Schweitzer et al. 2004). Even the same amount of light from an artificial source has proven to be less comfortable than that of daylight and it can also affect people's mood, productivity and health. Disruptive hormonal balance, ability

to concentrate, brittle skeleton, depression etc. could all associate to a lack of daylight, something that is especially important to acknowledge during Sweden's winter months.

Light and colour work together in synergy, there is no one without the other. Light alters the information we receive through our visual field. Too much direct sunlight or glare could be perceived as uncomfortable whereas too much artificial light affects our health and productivity. Meaning that the orientation of buildings and how solar income is used is a very important aspect in relation to health as well as the possibilities to make use of it for energy efficiency. If as previously discussed health is an important part of a sustainable future, these aspects also have to be taken into serious consideration as part of the design process.

TOUCH - Materials and the size of a space affect both touch and sound levels. When people feel texture, soft and hard surfaces, warm and cold surfaces, they react instantly to comfort and make associations to previous experiences. What is physically felt is an important factor for the perceived comfort level. Negative reactions to cold surfaces develop, even if the air temperature is at a comfortable level. If people perceive something as uncomfortable, they are less likely to continue with that behaviour.

HEARING - Noise pollution can lead to sleep deprivation or stress. Echoes from large voluminous spaces, sound reflecting from hard materials and humming from ventilation, heating, lighting systems, appliances and equipment are all parts of the built environment that affects noise levels. (Winchip 2011) These parts can however be affected by the architect.

The effects of a noisy environment are said to be that people become less interpersonally engaged, less caring, and less reflective thus displaying less altruistic behaviours. Cognition is hindered and there is a loss of determination in addressing complex tasks and a tendency to seek simple solutions (Grumet 1993), leading to a reliance on old habits and patterns. Factors that would all negatively affect sustainable behaviour and change.

TASTE + SMELL - Claims are made that pleasing aromas can reduce blood pressure, slow respiration, and lower pain-perception levels ultimately affecting health and comfort in the built environment. As the opposite, it has been observed that bad smells can stimulate anxiety, fear, and stress. (Schweitzer et al., 2004). Building materials and actions do have a certain impact on these influences. I have however found very little connections between the built environment,

behaviour and taste. It is in this thesis therefore treated as a less important factor crucial for our daily actions and behaviour affected by the built environment.

Ohno (Wapner 2000) divides the human senses into two basic variations: subject centred (autocentric) and object centred (allocentric). The former concerns people's feeling and pleasure whereas the latter is concerned with objectification and understanding, and involves attention and directionality (Rapoport, 1977). It could be interpreted as a scale where the built environment has the most effect on the senses with a strong directionality.

Our senses as described in this chapter provide us with comfort and an understanding of a space, where a positive impact also could have a positive influence on behaviour in that space.

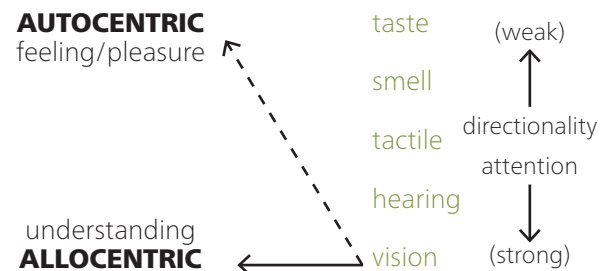


Fig. 5 Ohno's differentiation among senses

## COMFORT

There are many dimensions to the experience of comfort in a space. The different types; physical, emotional, psychological, spiritual and social comfort as categorised by Maclay (2014) are an example of this, proposing that for people to be truly comfortable all of these have to be acknowledged. It is important to notice that it is not only about physical comfort but aspects that are very much subjective or hard to measure are equally as important. Rybczynski (1986) suggests that comfort is also very much determined by cultural and historical patterns, containing complicated layers that are constantly evolving. Adding domestic attributes such as convenience,

efficiency, leisure, ease, pleasure, domesticity, intimacy and privacy. He defines comfort as the level in between discomfort stating that "comfort is that condition in which discomfort has been avoided", as it varies individually it is not always the same specific set of settings. What people think of comfort ultimately determines their behaviour. A goal in regards to promoting sustainable behaviour is that we need to design spaces in which sustainable behaviour is more comfortable than that of unsustainable lifestyles. But as Rybczynski also stated, comfort is an evolving factor and as we get used to a certain type of behaviour, our ideas of comfort can change. If this is the case maybe even

"We must rediscover for ourselves the mystery of comfort, for without it, our dwellings will indeed be machines instead of homes"

– Witold Rybczynski





uncomfortable solutions can have such a positive effect that they can persist and eventually become perceived as comfortable.

Physical comfort is the aspect most discussed in relation to the built environment as it is affected by ventilation, outdoor climate, solar radiation, design materials, activities, and amount of people. These factors change the temperature, noise, humidity, change of air of a space which influence our perceived comfort levels. Being able to regulate temperature, ventilation and lighting around own space therefore becomes important. Natural ventilation can increase energy efficiency of buildings as well as improving indoor environmental conditions Operable windows also benefit the resident with ambient smells, breezes, and all the sensory stimuli of an "open" environment (Schweitzer et al. 2004).

## NATURE

Maybe you associate nature with fresh air, running, walking, picking berries or climbing mountains? People have their individual specifics that they value about nature, but nature enhance much more than personal experiences. Nature, or even views of nature, are said to have health benefits and restorative effects such as reducing stress levels, improving moods and lower blood pressure.

HEALTH BENEFITS - Studies in relation to healthcare has proven that outlooks towards nature can stimulate a speedier recovery in patients and it is also suggested that outlooks towards nature and activities can stimulate us and make it more likely for us to take part in activities if they are visible to us. (Fridell Anter, 2006) In addition, it has been found that views of nature can reduce anxiety and pain and have a restorative effect not only in patients but also in staff. Most research towards the health benefits of outlooks towards nature however are aimed at patients in healthcare who are in different ways already ill or under stress. I question why these concepts are already not consistent goals also in residential buildings, as with people's increasingly stressful lifestyles and a growth in mental health problems, these matters are becoming increasingly more important also in our everyday living environments.

URBAN GREENERY - But what about nature in cities? Is it only outlooks to traditional green parks with trees that give us health benefits, or could green vegetated facades, sedum roofs and urban cultivation be equally beneficial? Buildings with natural characteristics and visual features, including daylight, nature views and indoor plants, are shown to be more highly preferred by occupants, hence perceived as more comfortable or pleasing. Indoor

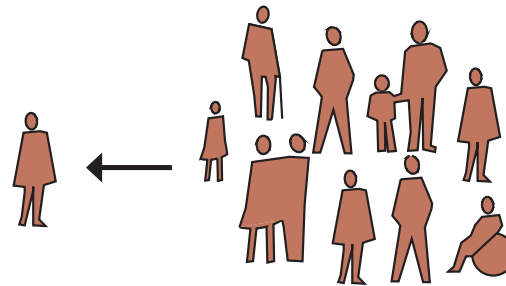
plants have been shown to increase work efficiency and attentiveness as well as decreasing perceived stress, lowering blood pressure, and reducing physical discomfort (Lohr, Pearson-Mims 1996), similar to outlooks of nature. However Backer and van der Voordt (2010) found through their studies that although indoor plants do have a positive impact on health and productivity, the diverse scope of different plants and human characteristics makes it difficult to state exactly how or how much it affects individuals.

CONNECTIONS –I often come across talks about humans’ lost connection to nature. Urbanisation and resource gatherings from other parts of the world contribute to the fact that people do not see or experience a change in the natural environment around us. Creating positive associations to nature in early stages of life could be seen as beneficial to create a stronger bond and emotional connection to nature. An interest in environmental issues are believed to be connected to our personal experience to nature, especially early childhood memories. We reminisce about picking berries in the forest, fishing or animal spotting which could, later on in life, lead to a reflection about the consequences our actions could have on these environments that we remember appreciating so much as younger selves (Angelöw, Jonsson1994).

There is also a growing awareness of the importance of nature for children’s development – intellectually, emotionally, socially, spiritually, and physically (Backer, van der Voordt 2010).

## SOCIAL INFLUENCES

People are, even though they like to see themselves as independent individuals, deep down social beings. They constantly imitate other people and are heavily influenced by stories heard about other peoples’ actions as well as societal norms. Copying what is believed to be “normal behaviour” is one of the strongest driving forces for human actions. Because of these tendencies it is important to make visible the behaviours that is desired for people to implement. By making people see the positive effects of sustainable behaviour, not only the consequences of the unsustainable, and by showcasing what others are doing as well as hearing success stories could consequently help sustainable behaviour develop in other individuals (Harré, 2012). People do not like being outside



of mainstream. Social norms play a huge part in sustainable behaviour for that reason. Niedderer (2013) suggested that legislations together with social pressure and norms are the ways in which we can reinforce changes in behaviour the most.

Below is a diagram of another way of trying to describe the relationship between the environment, society, the individual and people's actions and motives (behaviour).

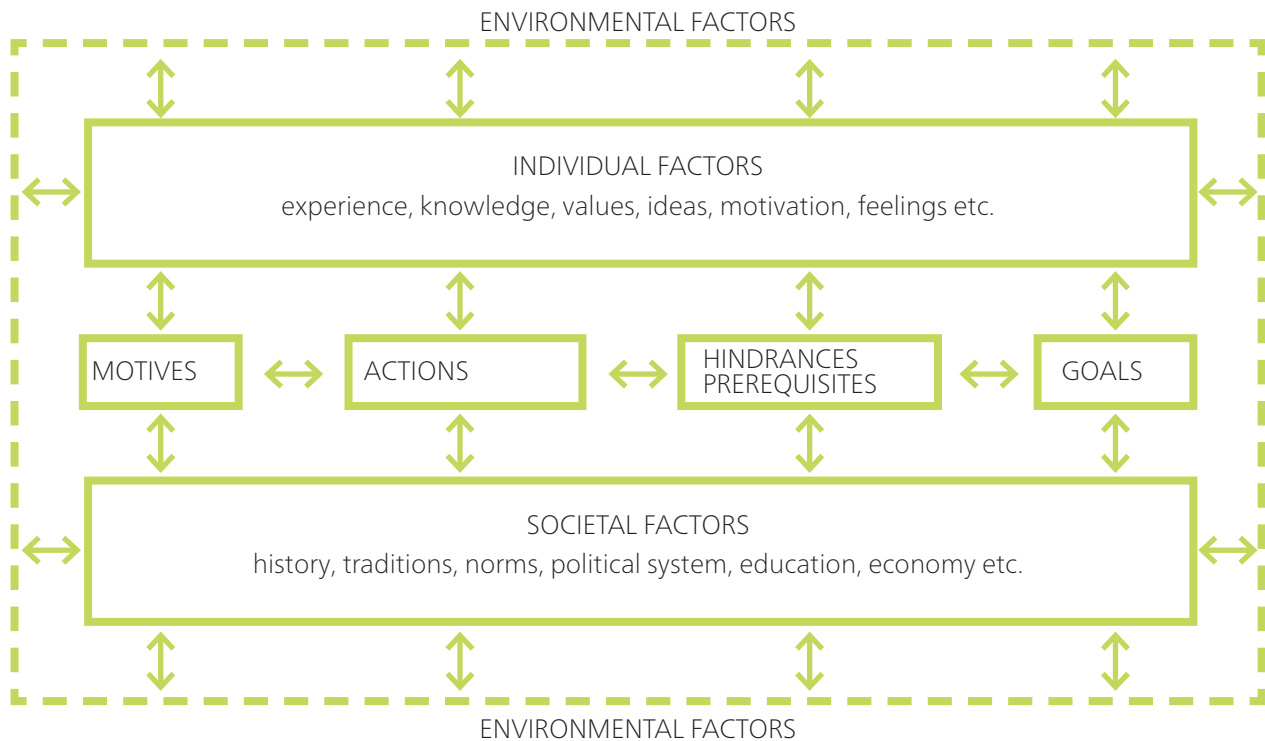


Fig. 6 Social-psychological theory of action (Angelöw Jonsson 1994) Translated by author.

# LIVING SPACES

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## *what are living spaces?*

Sweden is currently faced with a lack of housing, partly due to the increase in single households, and numerous new residential buildings need to be built in the coming years. This is a great opportunity for new ways of looking at living with different lifestyles and new family configurations and the possibility to accommodate for a different kind of needs. It is not only about the traditional core family any longer and single households does not have to be the resource heavy alternative that it is turning into today. A majority of the housing stock that is being built today are targeted towards the same type of lifestyles and family setting, making it difficult to promote other more sustainable ways of living.

Michelson (Wapner 2000) describes the problem of the relationship between the built environment and behaviour as complex because of the specific variables involved. He defines these as the type of social group, the purpose of the unit(s) of built environment, and by the scale of one or both of them, as they all significantly change the outcome of the connections. An example is made of the difference of behaviours observed in schools, which are not the same as those in hospitals, even though both deal with many people and large buildings. Surely some similarities and important factors

can be established in certain cases regarding these three parameters but it further draws on the conclusion that there is no measure that fits all purposes, and the difficulty of finding previous research done on a specific set of parameters. We can assume that there is a difference in how we behave depending on what type of building we live in, in regards to location, function and size but Michelson has also found differences in behaviour separating high-rise apartments from single-family homes, ranging from time spent outside of the home to time spent on maintenance etc.

*“In essence, what works of design and architecture talk to us about is the kind of life that would most appropriately unfold within and around them.”*

*-Alain de Botton, Architecture of Happiness*

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## STATISTICS

TYPE – How Swedish people live follows a pattern with their age. Nearly 70% of all children in Sweden live in single family housing. As they start to move out nearly 70% of people in between the ages of 20-29, end up living in multi-family housing, most of them in rental apartments. As this

group approach their 30's and many of them have children, a large part of them move back to single family housing again. Until they reach their pension when the amount living in single households start to increase again as people move to easier maintained apartments or specialist housing (Boverket, 2014).

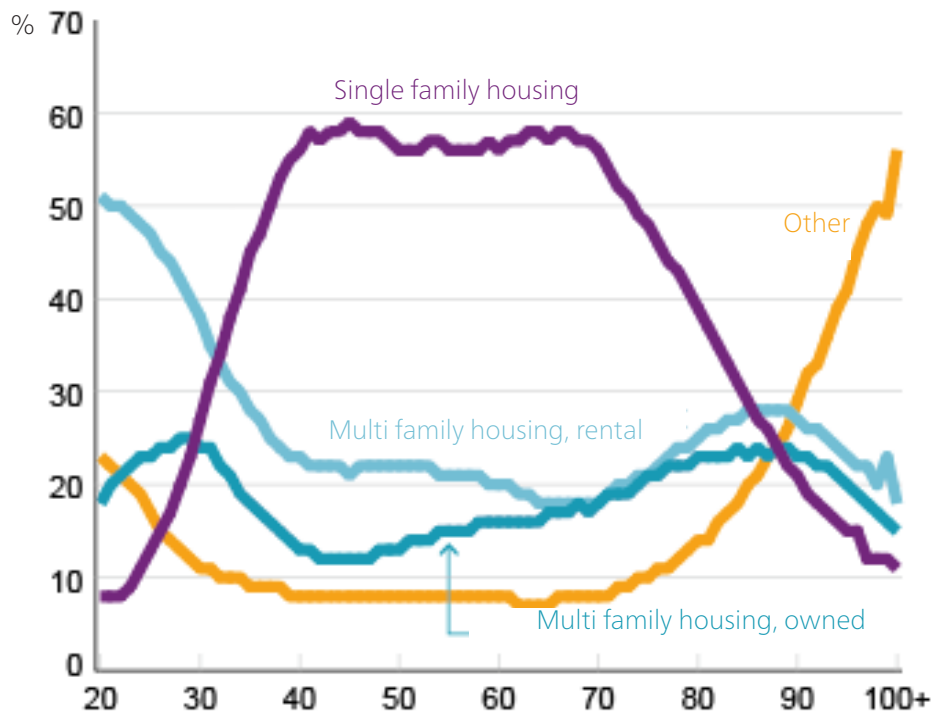


Fig. 7 Types of housing adults >20y live in in Sweden by age. Purple; single family housing, Light blue; multi family housing rental, Dark blue; multi family housing freehold, Orange; other (Boverket)

**COST** - One of the issues with new housing today is that even the smallest new flats being built are too expensive for a large part of the population, and as can be seen on the graph, the prices, for owned apartments particularly, have drastically increased. Affordability is an important aspect of sustainable buildings, especially if gentrification and standard gaps are to be avoided. By building smaller and more resourceful there can be a reduction both in the use of resources as well as energy consumption and accessibility for a larger group of the population.

**SIZE** – The average living area per person in Sweden is 42 m<sup>2</sup>. Swedes live on more than twice the space per person now than they did in the early 1950's (Bokalders & Block, 2014). There should be an aim for a reduction of living spaces again rather than an increase if we want to carefully use our resources.

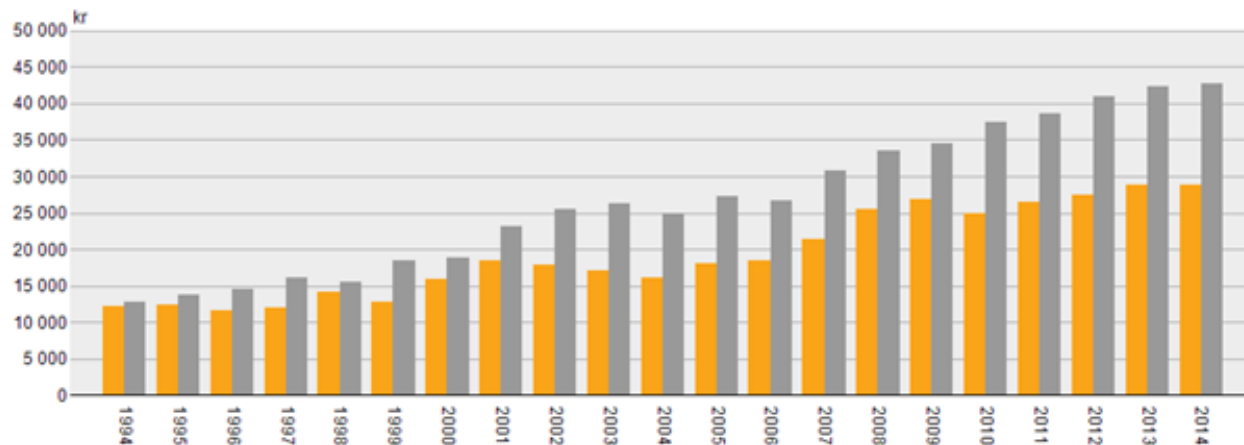


Fig. 8 Total production cost (kr)/living m<sup>2</sup> for newly built multi family housing between 1994-2014 in Sweden. Orange bars represent rental apartments, Grey owned apartments. (Statistics Sweden)

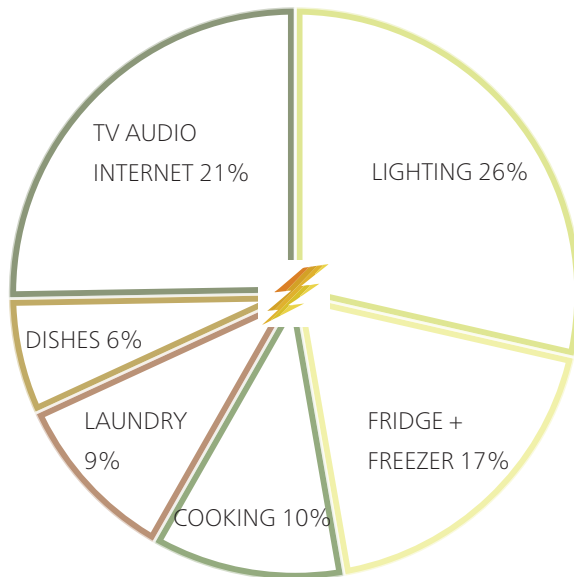


Fig. 9 Energy Use in dwellings (family households) from different loads. (Energimyndigheten, 2014)

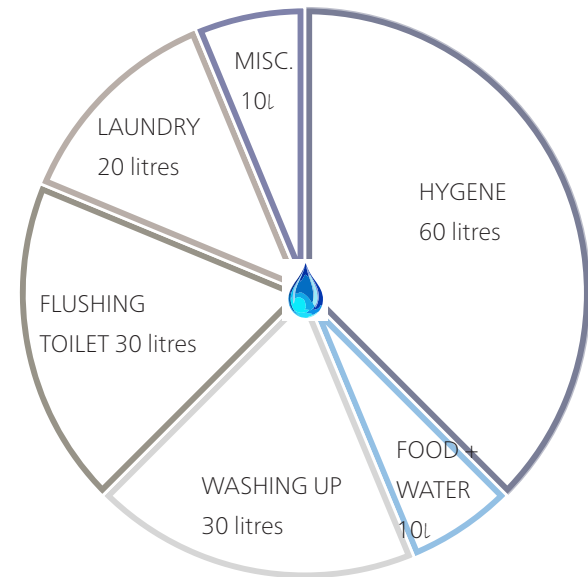


Fig. 10 Domestic Water Use Per Person/Day in Sweden (160 litres total) (Sydvatten, 2014)

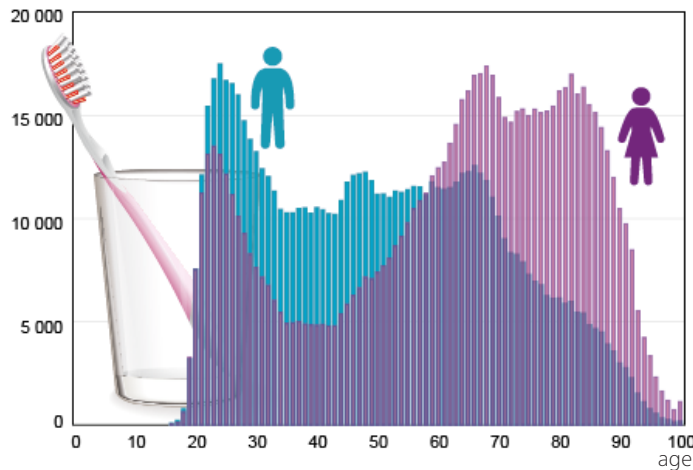


Fig. 11 Amount of single households in Sweden by age and sex. (Statistics Sweden, 2014)

SINGLE HOUSEHOLDS - 38% of housing in Sweden are single households. According to Energimyndigheten (2014) single households are the most energy demanding, using 1742 kWh/year/person compared to families using 1187 kWh/year/person.

## DAILY ACTIONS

The everyday behaviour of people are determined by what they do in a day. It is about looking at architecture from an inside out perspective, trying to understand the life that unfolds within buildings and to support and enhance activities and experiences that benefit not only humans but the whole planet.

A study by Statistics Sweden (2012) has given a great insight into how the Swedish population currently use their time. What types of activities and, as the first survey was conducted in 1990/91, also how these have changed during the course of time. The types of activities are divided into five categories, including but not excluding of:

### Gainful Employment

- Paid work

### Unpaid Housework

- Household chores, Maintenance, Care,  
Purchase of goods and services

### Personal Care

- Sleep, Meals, Hygiene

### Studies

- Education, Reading specialist literature

### Free Time

- Social Interactions, Watching TV, Cultural activities, Fitness, Hobbies, Browsing

Free time has increased for both men and women in the last 20 years and although women still spend more time on unpaid housework than men, this difference has decreased. Time for socializing has decreased for both sexes. Both sexes spend more time on hobbies, which include computer and internet use, than before.

If the building is to be truly durable it has to be able to adapt to different users, cultural patterns and to new technologies. Flexibility is as important as material durability. The time-use survey determines what people spend their time on, but not where, in what spaces, these activities take place. People use the spaces differently, it varies from one resident to the next one moving in. Some may use the space as mainly for sleeping accommodation where as someone else might use their home as an office, or as a social meeting place. There is a possibility to create multi-purpose spaces where rooms easily can change function or simply provide a variety of different living spaces, among the housing stock, with the possibility for the resident to choose what suits their specific lifestyle the best.



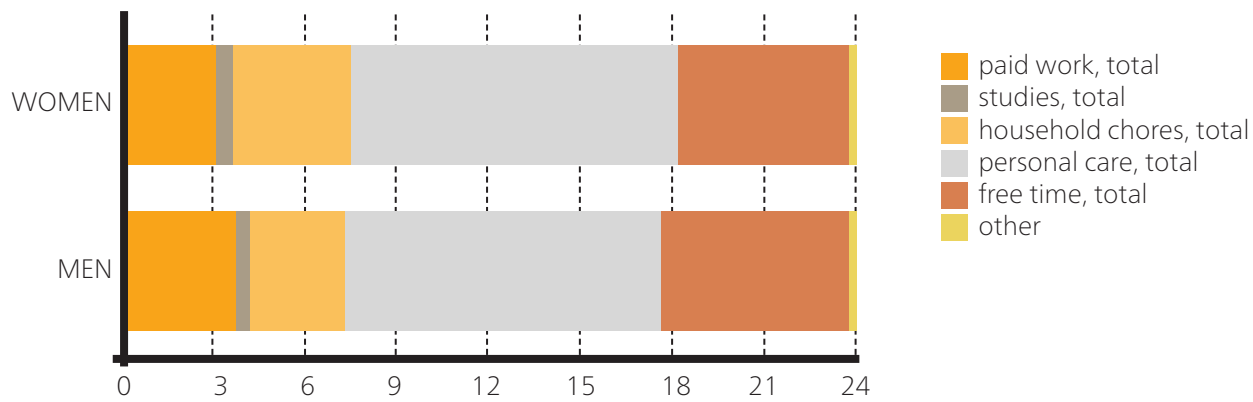


Fig. 12 Average hours spent on activities daily divided between women (top) and men. (Statistics Sweden 2012)

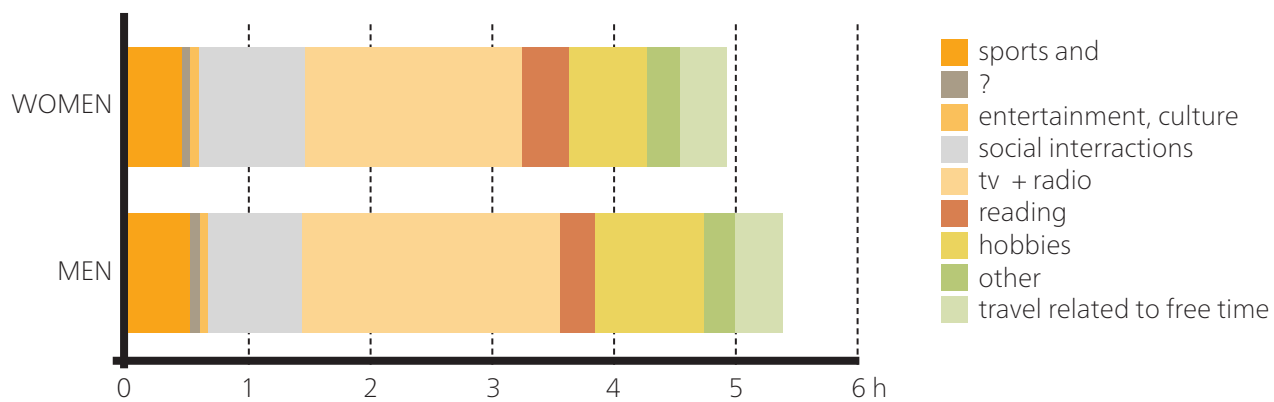


Fig. 13 Average amount of hours spent on activities during free time. (Statistics Sweden 2012)

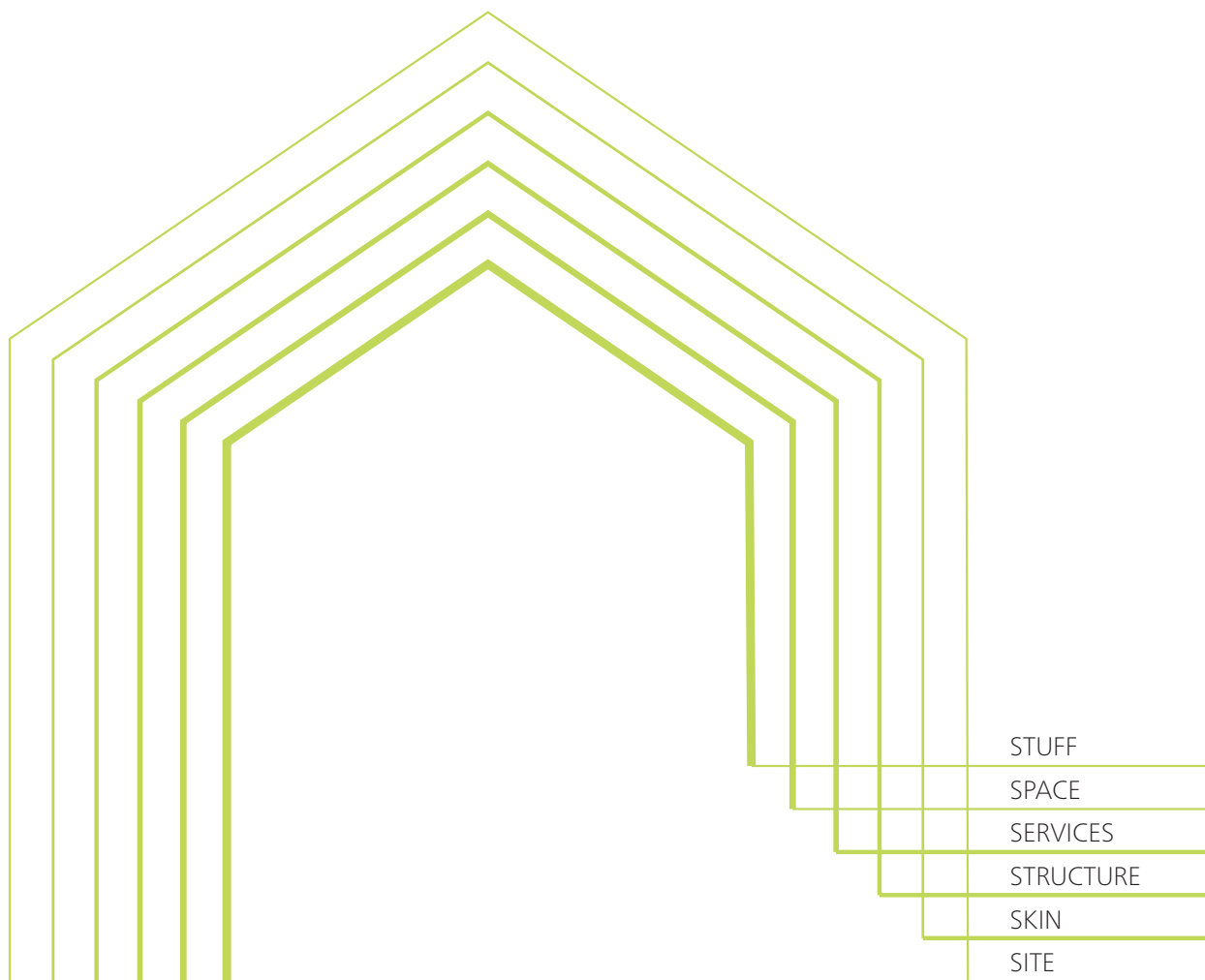
## AS A LIVING SYSTEM

Brand (1997) developed the previous ideas of Francis Duffy about the building as consisting of different layers, each with their own lifespan. The idea is that these layers because of their different durability should be separated from one another so that they can be easily exchangeable and renewed when needed, without affecting one another.

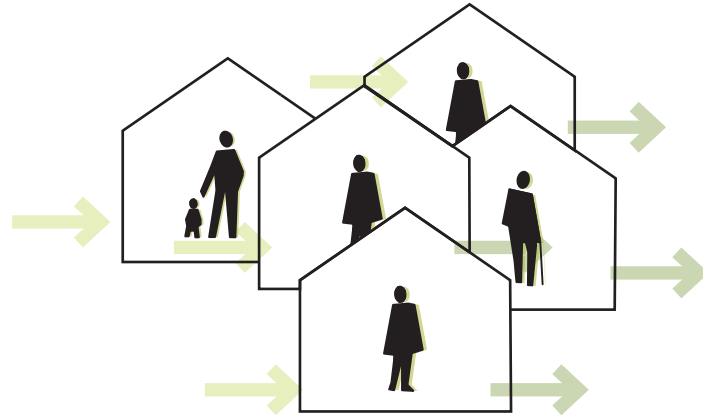
The six layers range from the timeless site to the frequently exchanged furnishings. By separating the different layers of the building you can create a flexible building system where if one part has to be renovated, it does not have to affect the other layers. For a long-term perspective as technology, function and cultural patterns change the building need to be able to adapt to future needs. If change, renovation or demolition is inevitable, this also has to be possible. Designing in a way that materials and layers are to be separable at the end of a product's life should be an important step of the process and considered from the start.

Although people might want to see themselves as separated from nature. The buildings as separated systems, machines, the truth is that both are a vital part of the natural system and it is necessary to treat buildings and actions as such. By developing the concept of home, what it looks like and what behaviour it accommodates, and to trying

to promote the design of a variety of housing arrangements rather than the same type of layout that is mainly being built today there is a possibility to create environments to suit new behavioural patterns and living constellations.



*Fig. 14 Stewart Brand's Building Layers*



- Fresh Air →
- Food →
- Tap Water →
- Time →
- Money →
- Cleaning Fluids →
- Equipment →
- Toxic Chemicals →
- Goods →
- Knowledge →
- Fossil Fuels →
- Renewable Energy →
- Awareness →
- Educational Materials →
- Internet →
- Connections →
- Social Interactions →
- People →
- Interest →



- Emissions →
- Bio-waste →
- Heat →
- Moisture →
- Recycling →
- General Waste →
- Emissions →
- Sewage Water →
- Experience →
- Wear and Tear →
- Human Wellbeing →
- Knowledge →
- Awareness →
- Relationships →
- Social Connections →
- Ideas →
- Desire to Consume →

Fig. ? Homes as a Living System

CURRENT SITUATION - By using the categories of actions defined by the time use survey (Statistics Sweden, 2012) gainful employment, unpaid housework, personal care, studies and free time, I have attempted to describe people's living spaces like a system, with inputs and outputs.

The current system functions in a linear process. There is an import of goods and services to be able to accommodate the behaviour inside the system boundary, the living space, and an output as a result of the action that take place. People inside this system, the actors, seldom knows exactly where these inputs come from, neither where they end up as outputs once they leave the system. Most households function this way, independently from each other, all ending up with all kinds of waste. The system treats the physical boundary, the building, as a machine. Something separate from the process.

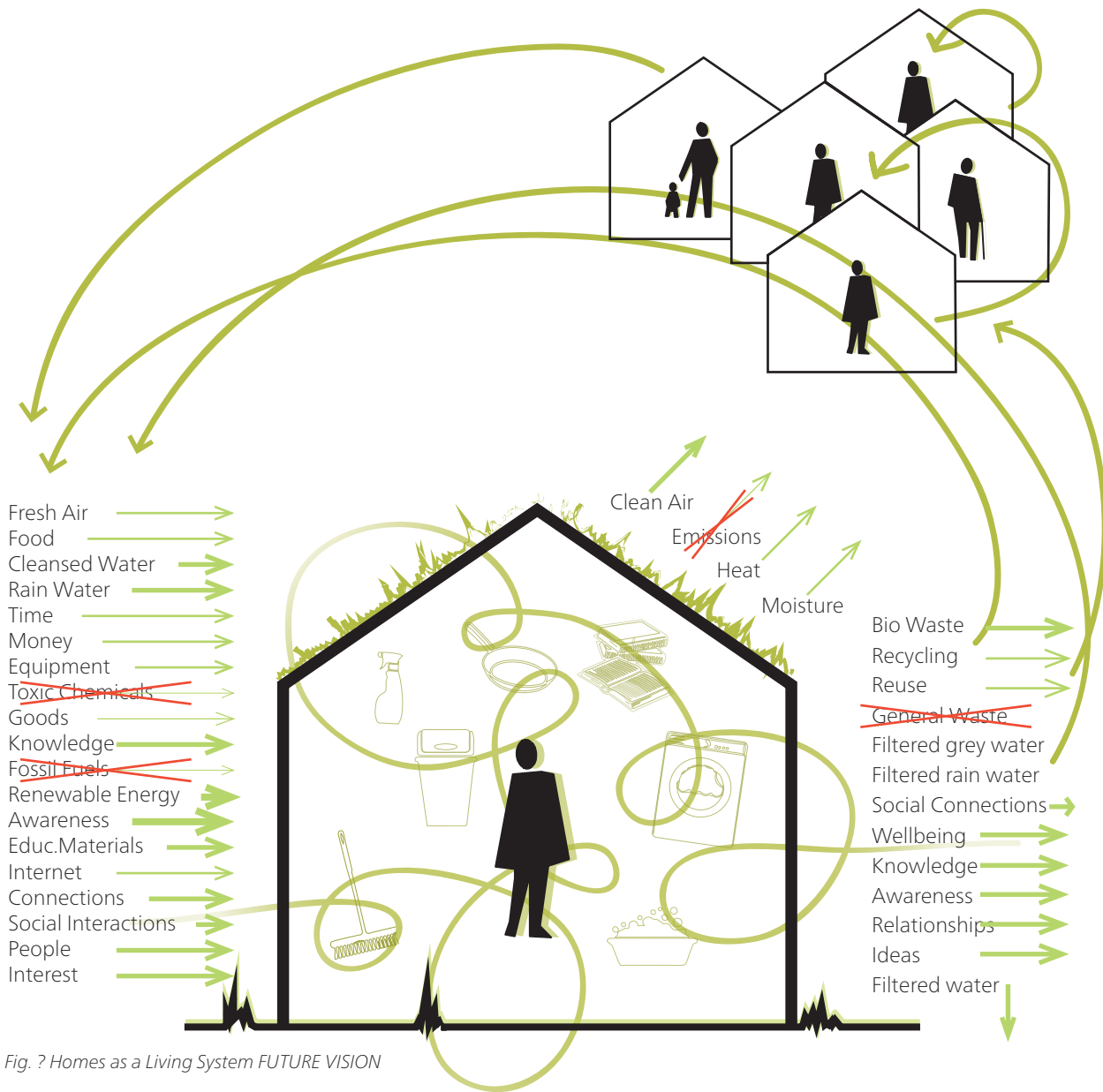
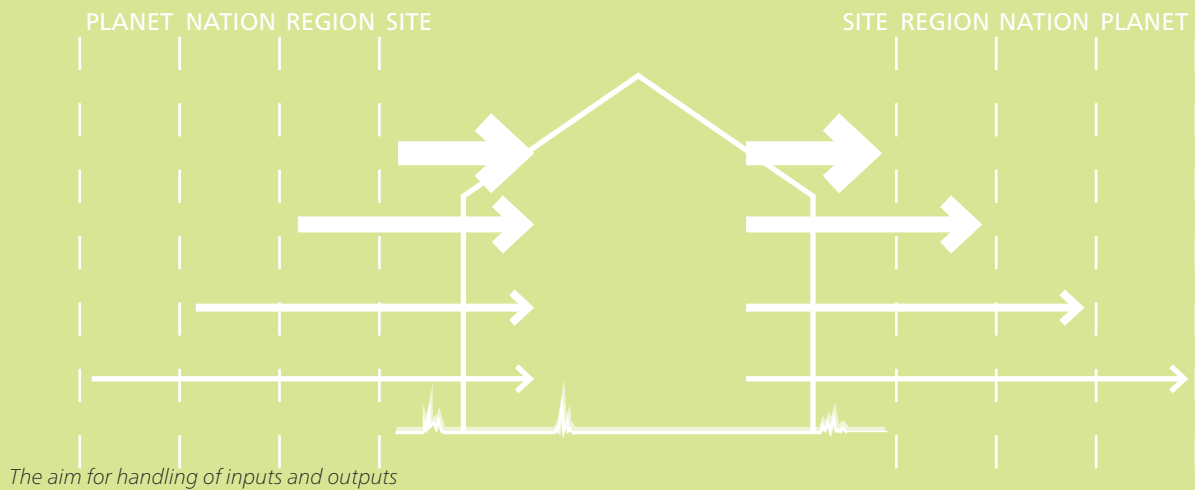


Fig. ? Homes as a Living System FUTURE VISION

FUTURE SITUATION – In an optimal future scenario, we eliminate hazardous inputs to the system, and support behaviours inside the system that no longer produce non valuable waste and emissions. All outputs are of value and many of them are shared in the community and are in new ways used as inputs into the system. The building as well as the actors are seen as a part of the system with constant interactions.

The goal is also for impact and process of both inputs and outputs to be handled as close to the living spaces as possible. If there is a possibility of processing these on site, or in the region, more can support the local economy and less impact will be on the planet as a whole. But if everything that comes out of the system is of value, who would not want to take advantage of that?



# THE INDIVIDUAL

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## *what affects individual behaviour?*

What factors are important for the individual's own motivations and drivers for behaviour? This part tries to explore the topic of behaviour from an individual perspective.

### NEEDS

People's most basic need is to survive, but what in terms of sustainability does it mean to survive or even sustain or regenerate? Surely we do not want to risk the future of our children, but we want to grow and provide an even better future. As Cradle to Cradle authors McDonough and Braungart (2002) describe it "being less bad is not being good", and surely we want to be good?

Maslow's hierarchy of needs attempts to describe human needs through a range, from basic physiological needs to those of self-actualization. It describes how needs at the bottom of the triangle need to be met for individuals to be able to flourish at the top. The most basic goals for the individual is to survive, and the relationships and care for others come second to those needs. Buildings are shelters supplying people's basic needs, but a good design accommodates for more than just that. Sustainable behaviour is about a discussion on how the spaces we create support or detract from the needs further up the triangle.

As a result, the individual pursuit is for all needs to be met, the quest never ends. Michelson (Wapner 2000) points out; people with nothing appreciate the most elemental aspects of housing and people with everything still find reasons for dissatisfaction and the need to change.

### HABITS

We repeat 40% of our behaviour every day. These habits develop so that we do not have to spend energy on decision making and self-control as this requires more brain activity (Rubin, 2015). People always try to seek the easy way out. This makes changing habits a very complex problem. You can easily promote the benefits of using a bike over driving a car, but the action is affected by more than our willingness to change. Weather conditions, time, safety and convenience also affect decision making and create barriers that will weigh more than information about the consequences of actions alone (McKenzie-Mohr, 2000). Advertising or showcasing a behaviour might not be enough to foster sustainable behaviour, people probably already want to change. The task is to make it actually happen.

McKenzie-Mohr (2000) suggests targeting specific behaviours and assessing the potential impact





Fig. 15 Maslow's Hierarchy of Needs

of that specific behavioural change. While Boks (2012) acknowledges the huge time consuming task this would be. McKenzie-Mohr's second step in the process is the importance of identifying barriers for the targeted behavioural change and the importance to connect to a specific context in order to develop thorough strategies to eliminate these barriers. While doing this, a differentiation between repetitive, or habitual behaviour, and one-time behaviour i.e. buying a house or car, has to be made. Often the one time behaviour makes the largest environmental impact for the individual, but small habitual changes amongst many add up to significant positive changes as a whole.

A lack of time, habits and convenience were in a survey by Angelöw and Jonsson (1994) stated as some one of the most common reasons for individuals not living a more sustainable lifestyle. Hectic lives and unhealthy lifestyles give us a lack of energy to engage in new information and gives us less motivation for a change of habits. As discussed earlier in the thesis, creating positive emotions and instant feedback could help make the change and ensure that people continue the new behaviour, encouraging new habits.

## IDENTITY

While residential buildings have a history of providing basic needs and shelter, homes are now developing into something more excessive and meaningful in new ways. With the around the clock access to internet and social media where many people share their everyday lives, homes are becoming an extension of themselves. People connect to their living spaces and use them as a representation of who they are, their identity, but also as a representation of how they connect to different groups of society. How people live is becoming a way of self-expression, just like the way they dress or act.

Bergman (2012) suggests that there are two types of consumers, those who want to make a statement, and do not mind spending a bit more money doing so, comparing it to the current kind of green statement architecture, and those who will change only if it does not mean they have to compromise on existing lifestyles or it makes them stand out. As already discussed, most people do not like to feel like they are going against the mainstream, but people would at the same time benefit from starting to identify with sustainability. A sustainable identity strengthen sustainable actions.

If people feel they know how a place functions, its history, the connections to the surroundings and if they understand it, they can more easily connect to it (Bokalders & Block, 2014). Place and identity could be associated to both the identity of a place but also to peoples' identity connected to a specific place. These associations are often created with other people, history and memories. How individuals agree that certain places have a certain identity. These memories affect peoples' behaviour in certain settings. The sharing of ideals and cultures make people like the same types of spaces (Axelsson 2010). It is even suggested in an American study that the size of your office space or office chair could make you feel more powerful leading you to act in certain ways (Schiller, 2013). This is presumably connected to cultural ideals and people's habit of comparing themselves to others.

## AWARENESS

One approach to the topic of sustainability is informative solutions where knowledge is used as a tool for behavioural change. It has however been found that only providing more knowledge is not enough to change behaviour and it can be quite ineffective for what it wants to achieve. This is similar to economic motivations which are sometimes used as a driver for change. They are also, more often than not, not strong enough to

change behaviour alone (McKenzie-Mohr, 2000).

Population growth, climate change, resource scarcity, poverty, inequity are all current issues that people are aware of but for daily behaviour, they have little influence on the decisions we make as they often have little impact in that particular moment. Information exchange and awareness, in this case, could be more about making your own actions visible to others and to discuss the issues in order to help in the development of new social norms as this has a much stronger influence.

The relationship between preferences, attitudes and behaviour and verbal statements has a low correlation to actual behaviour. Most people would argue that they value clear water and air and are aware of the current issues, but they at the same time continue to contribute to the pollution of both. There is clearly a conflict.

Pfarr et al. (2010) describes how irrational behaviour follows certain patterns. People rely on shortcuts to not get overwhelmed, often behave for what feels right in that particular moment, they do not consider all options or don't value them equally and they value immediate gain more than future gain.

The topic of awareness and knowledge are

correlating to other factors of individual behaviour. It could be a contributing factor to a behaviour change, but it is much stronger in co-operation with other influences than as a single approach.

### MIND YOUR WAYS!

INTENTIONS – Collecting all this information about individual behaviour and trying to figure out ways in which it can be influenced is not an easy task. It always comes down to the fact that people will always still have the freedom of choice which makes prediction of behaviour difficult and goals might not always go as planned. The intention of people's behaviour will always be determined by the individual. There is only really the option to provide the best possible structures for behaving sustainably. As an example, individual home owners have their own responsibility for arranging their produced waste for convenient disposal in a correct manner. But I believe architects have the means of providing sufficient space and attractive solutions for this to be more likely to happen in their spatial design.

There is always a complicated pattern of conditions, which vary immensely, and as long as human choice is part of the equation nothing can be certain.

In a report by Sifo (2000), as seen on the right, it demonstrates how a majority (9/10) of the Swedish population agree that it is important or very important that we change our behaviours to lower the use of non-renewable resources which are believed to be the main cause of climate change.

“How important do you think it is that each and every one of us in our daily life change the way we travel, to work and in our free time, the way we consume electricity and hot water and lowering indoor temperature to reduce the use of petrol and oil?”

“What can be done other than raising taxes?”

People believe that giving more tax money towards research for developed technology and improved public transport are the best solutions for tackling environmental issues. Not really acknowledging how their own actions could have a big impact.

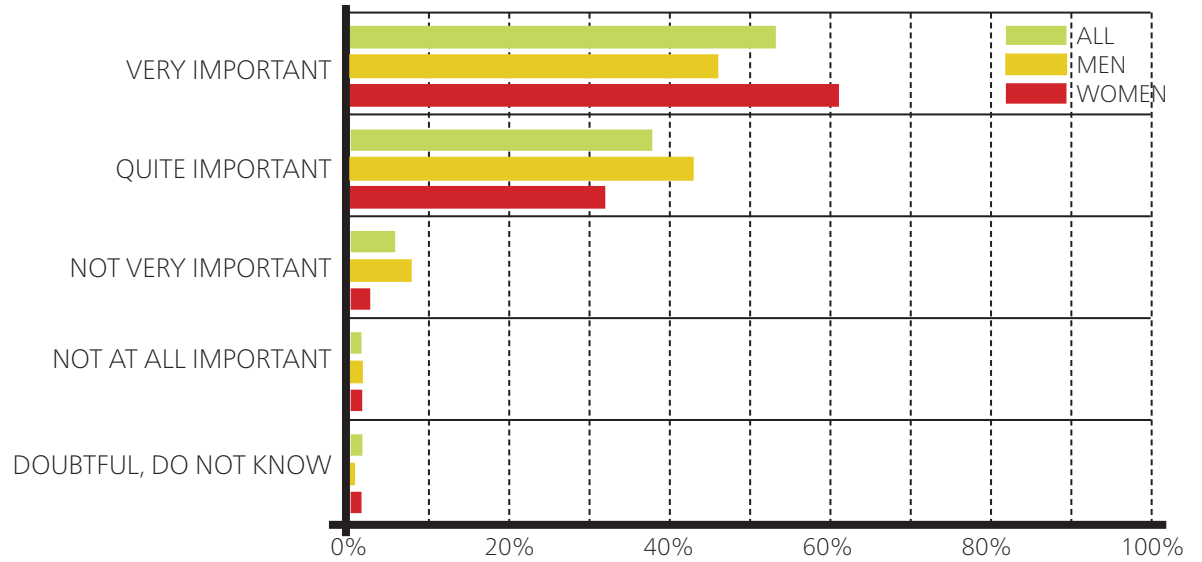


Fig. 16 "How important do you think it is that each and every one of us in our daily life change the way we travel, to work and in our free time, the way we consume electricity and hot water and lowering indoor temperature to reduce the use of petrol and oil?" (Sifo)

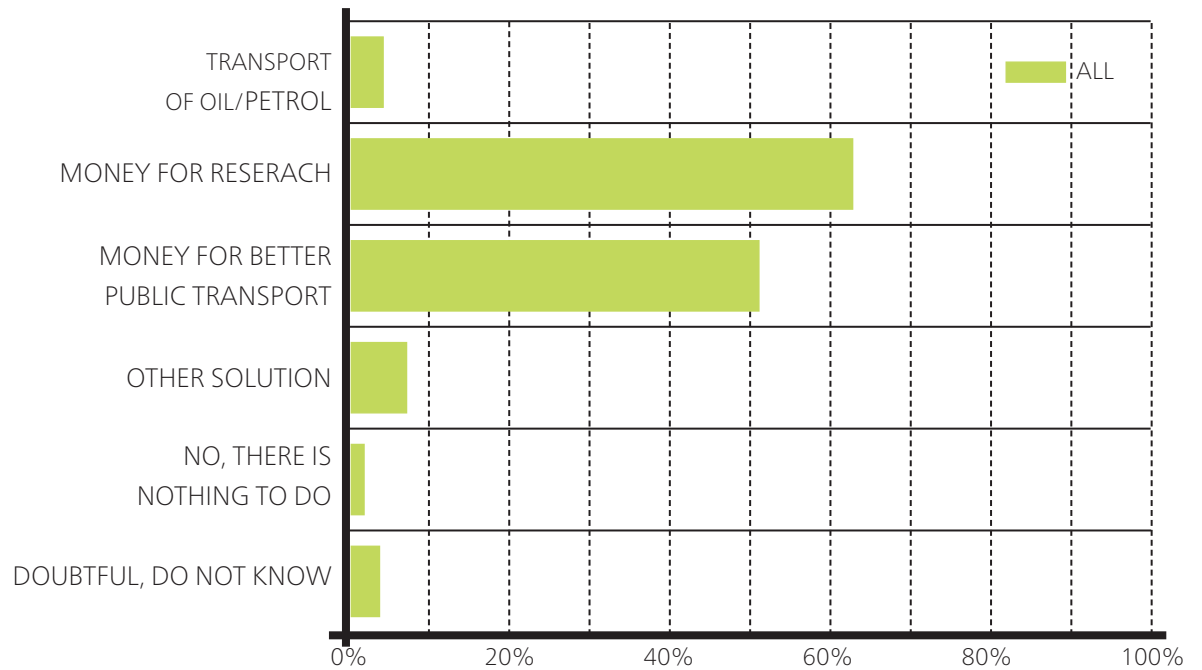


Fig. 17 "What can be done other than raising taxes?" (Sifo)

# BEHAVIOUR CHANGE

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## *how can we affect behaviour?*

How do we approach design for behaviour change and what has been discussed previously?

### APPROACHES

There is currently a growing field of research, referred to as Design for Sustainable Behaviour (DfSB). This field tries to describe ways of reducing environmental impact through the way people interact with products, services and environments. It does this by taking inspiration from multiple disciplines and connecting it to sustainable design. Most of the research I have found in this area however, focuses on the way people interact with user products rather than recognising environmental relations. Fortunately, much of the thought processes behind these ideas and strategies could also be extended to this area of design.

One of the first categorisations of design for sustainable behaviour was made by Lilley (2005), by defining three types of product led interventions: eco-feedback, behaviour steering and intelligence. Wever et al. used a similar categorization using ecofeedback, scripting and forced-functionality as mechanisms to trigger the desired behaviour. While Bhamra et al. elaborated the distribution by Lilley et al. further by splitting it up into seven parts (Boks 2012).

Elias et al.'s (2007) behaviour matrix showing three strategies in relation to product design and user behaviour, with a fourth (top left) which is a continuing of the current situation.

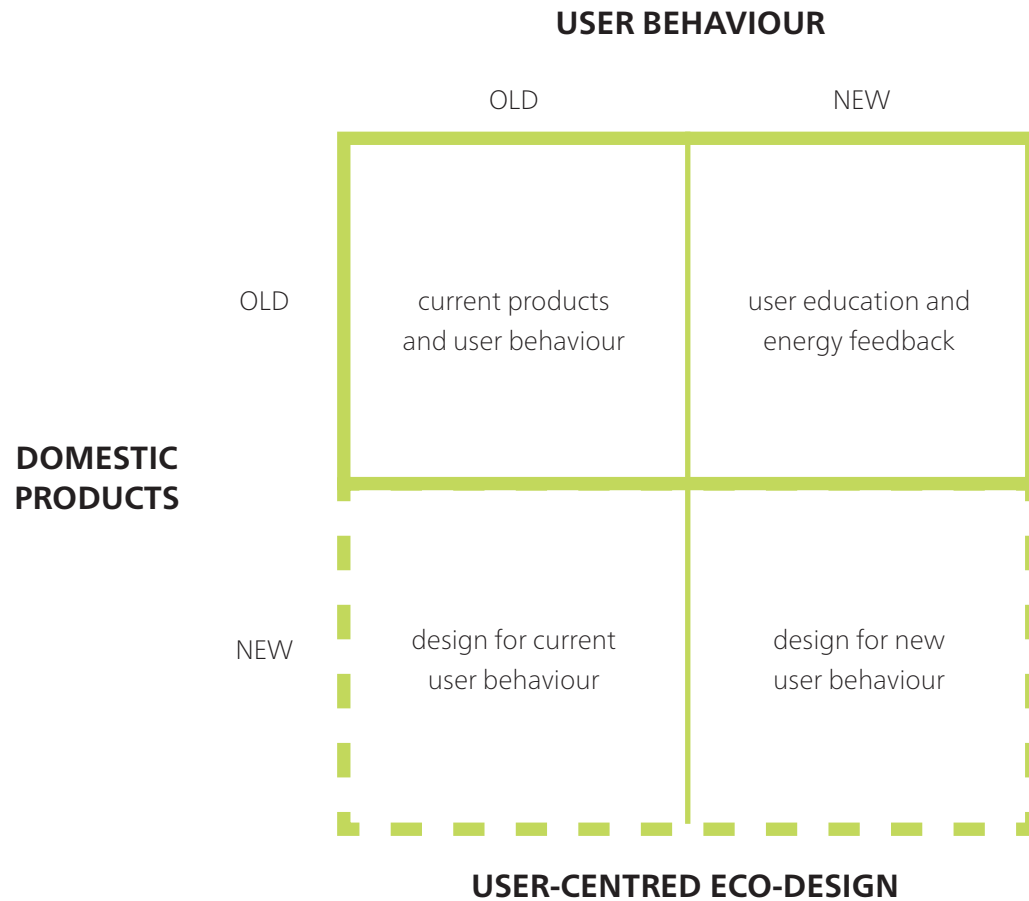
In Lockton's toolkit design for intent (2010) he suggests strategies where you approach the design in three different ways. Motivating behaviour, enabling behaviour and constraining behaviour.

-Motivating behaviour - Motivating users to change behaviour by education, incentives and changing attitudes.

-Enabling behaviour - Enabling 'desirable' behaviour by making it easier for the user than the alternatives.

-Constraining behaviour - Constraining users to 'desirable' behaviour by making alternatives difficult or impossible.

Niedderer (2013) introduces the term 'mindful design' where she discusses design more in terms of user responsibility and how the reflection of free choice could have a positive impact and raised awareness. This is proposed to give longer-lasting effects on user change in behaviour with a stronger sense of self-empowerment.



*Fig. 18 Elias et al.'s (2007) behaviour matrix showing three strategies in relation to product design and user behaviour, with a fourth (top left) which is a continuing of the current situation.*

Lidman och Renström (2011) have five categories of design strategies for influencing more sustainable behaviour: Enlighten, Spur, Steer, Force and Match.

Tromp et al. (2011) distinguish four types of influence that designers can utilise (coerce, persuade, seduce or decide), and add another dimension, namely salience where a design can apply influences that can vary from an implicit to a more explicit manner (salience).

Another way of approaching behaviour change is a proposed design process which acknowledges how humans react to spaces through clinical and neurophysiological evidence of the impact of physical design connected to our health, safety and needs. Bio-sensors are here being used to collect data from the brain, body and behaviour through a virtual world, in order to scientifically measure changes, for a more research-based design approach. (Edelstein, 2015)

What seems to be most recommended is using a combination of approaches for each issue. Not necessarily specifying one single strategy.





Fig. 19 Zachrisson and Boks (2011) 'distribution of control' spectrum

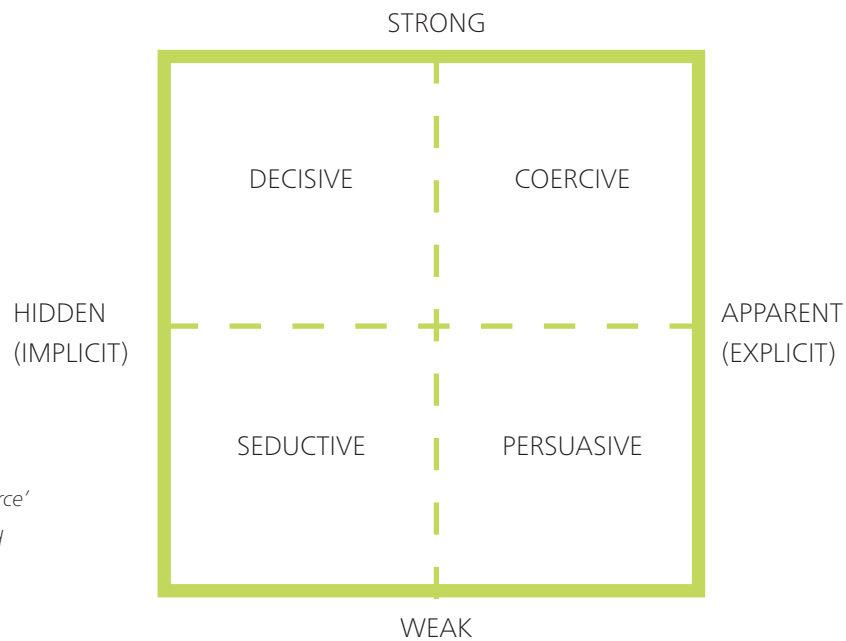


Fig. 20 Tromp et al.'s (2011) diagram with 'force' (strong and weak) and 'salience' (hidden and apparent) as two dimensions, leading to four possible types of influence.

A behaviour setting diagram describing how a modifier in the built environment can affect the outcome of a behaviour.

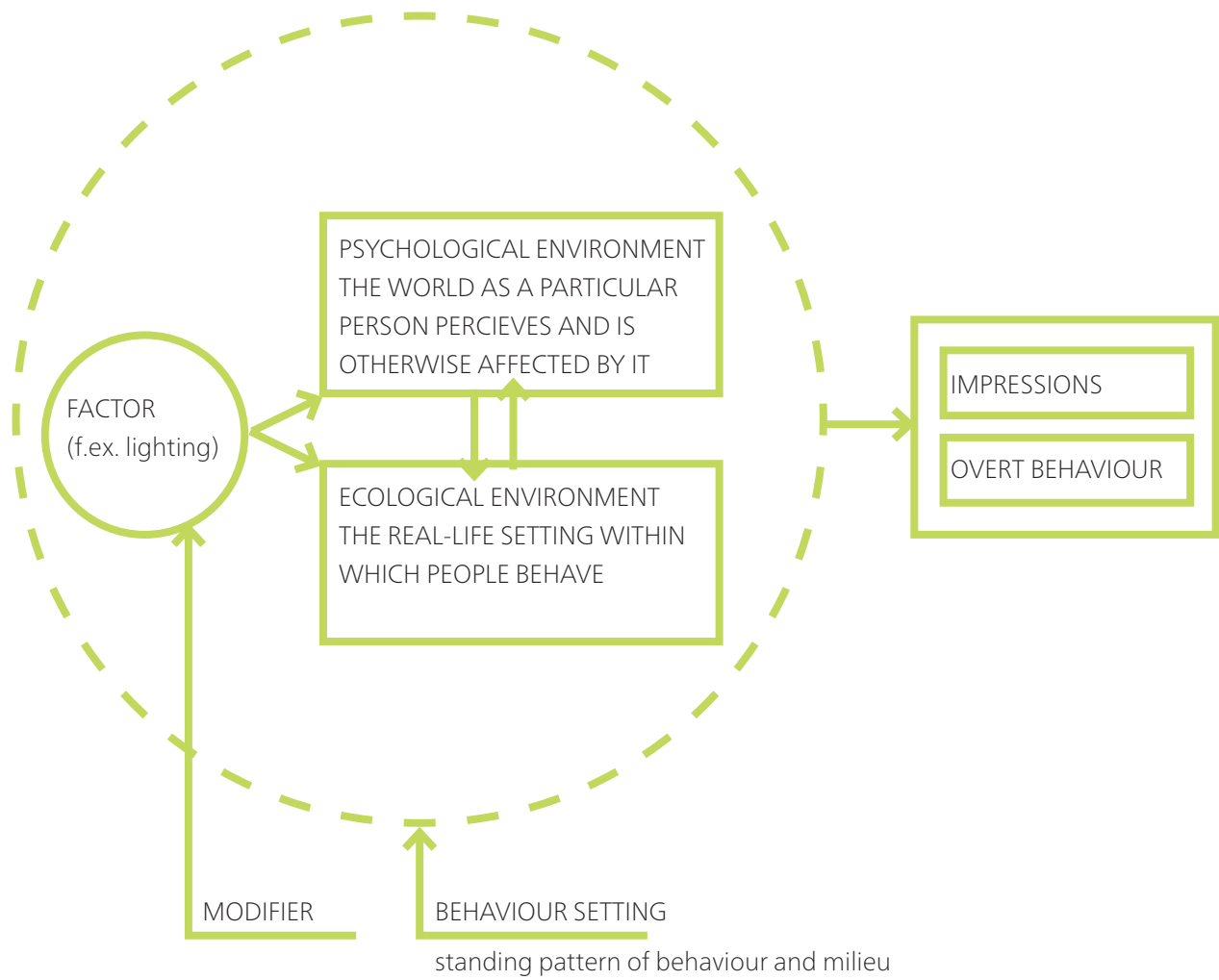


Fig. 21 A behaviour setting (Kuller 1973)

## TRENDS + CHALLENGES

By taking a step out from individual homes and looking at trends that might affect behaviour in residents from a greater level it is possible to get a better understanding of these driving forces that also sometimes even show themselves on smaller scales. These trends can be seen as barriers and challenges for behaviour change, but also as opportunities.

McKenzie-Mohr (2000) states that identifying barriers to promote specific behaviours should be an important part of the work of program planners, something that is often neglected due to prejudices or time-and financial constraints. She suggests that an interdisciplinary approach between psychologists and architects could be important in identifying the most valuable activities to then focus on.

### GLOBAL MEGATRENDS

- ▶ DEMOGRAPHIC CHANGES AND URBANISATION
  - increased globalisation
  - ageing population
  - migration
- ▶ CONSUMERISM
  - lifestyles
  - individualisation
  - personalisation
  - competitiveness
  - waste production
- ▶ TECHNOLOGICAL PROGRESS
  - digitalisation
  - new technologies
  - need for new knowledge
- ▶ CLIMATE CHANGE
  - increased precipitation
  - sea level rise
  - greenhouse gas emissions
  - seasonal changes
- ▶ RESOURCE SCARCITY
  - fossil fuels
  - fresh water
  - sand
- ▶ HEALTH ISSUES
  - obesity
  - poverty
  - mental health issues
  - allergies

## RESIDENTIAL TRENDS + CHALLENGES

That in some ways are connected to the global megatrends but also geographically specific.

- ▶ INCREASED SINGLE HOUSEHOLDS
  - isolation/loneliness
  - resource heavy
- ▶ ACCESSIBILITY
  - inclusive design
- ▶ CONTINUED WASTE PRODUCTION
- ▶ NEW INNOVATIONS
- ▶ COST PRESSURE
- ▶ SUSTAINABLE ATTITUDES
- ▶ NEW LAWS AND REGULATIONS
- ▶ SOCIAL NORMS
- ▶ FAMILY IDEALS
- ▶ CULTURAL VALUES
- ▶ HEALTHY ENVIRONMENTS

# PREVIOUS WORK 1 3XN/GXN

*what in relation to behaviour has been done before?*

Behavior design is one of the Danish office 3XN's 5 working strategies, developed by their internal research division GXN. (The five strategies are: Green Design, Informed Design, Behaviour, Design, Technology Design and Experimental Design.) A few of their projects have had behaviour design as main focus including Middelfart Savings Bank and Ørestad College. The topic *Mind Your Behaviour!* has also been the centre of an exhibition and book published by the office.

## ØRESTAD COLLEGE, 2006

"The building was designed based on 3XN's belief that architecture can shape behavioural patterns. They did not want to be limited to traditional spacial layouts but rather think of new ways of working that fit its users while still being flexible. (Nielsen, 2010)

"The buildings we reside in affect our behavioural patterns and social interaction. Hence, we work with behaviour design to adapt the architecture to the activities and way of life that characterizes its use"

- Mille Sylvest, Behaviour Specialist, GXN

## WHAT IS IMPORTANT?

A special consideration to the building users can lead to ways of optimizing performance and to discover new solutions . GXN has worked with logistics, floorplans and functional design. By exploring the relationship between function and space you also have the opportunity to lower building cost as well as increasing wellbeing and effectiveness.

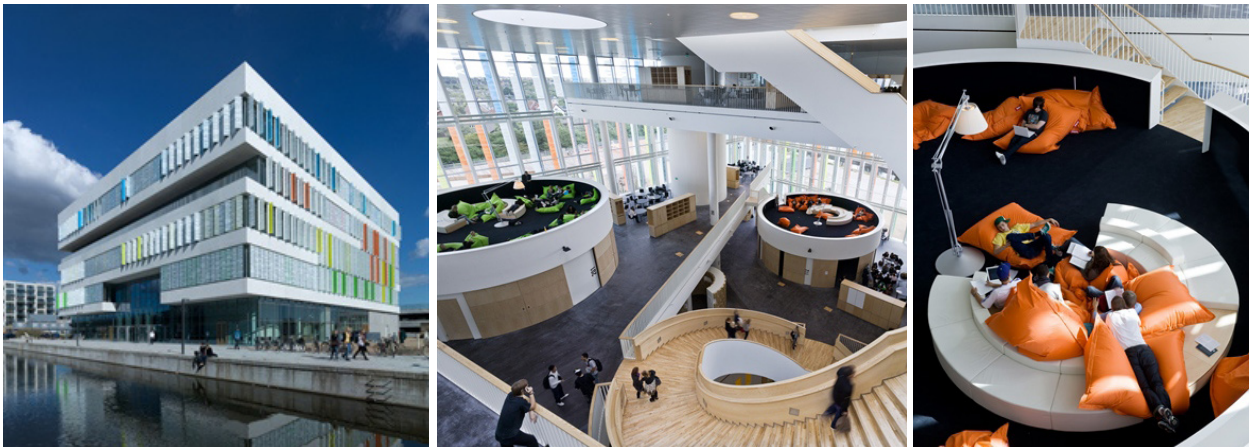


Fig. 22 3xn.com

## PREVIOUS WORK 2 EFFEKT

*what in relation to behaviour has been done before?*

The Danish office EFFEKT has developed a project which has won several prizes for its clear focus and consideration of its users. Livsrums, a cancer counselling centre is one of many healthcare facilities developed from the idea that architectural design can aid in promoting psychological and physical wellbeing. Livsrums being one of the most successful examples of along with UK's Maggie's Centres.

### LIVSRUM, 2012

The building offers a wide range of different rooms for informal advice, therapy and interaction with a focus on the individual users' comfort and wellbeing by working with daylight quality, mood, colour, material, sound and the ability to be private and secure, (EFFEKT, 2016).

Care has been taken into developing a variety of spaces as well as private quiet spaces and more active communal areas.

### WHAT IS IMPORTANT?

It is inspiring how the office has worked with the users as a main focus, clearly focusing on aspects of architecture that can support the wellbeing of its users. Proven that daylight quality, material, atmosphere and layout can have an important influence on individuals. A clear focus has been on the feelings and behaviours of the users of the building. By breaking up the volume into seven small clusters, they have achieved a smaller human scale and a more homelike feel, as this is valued more, rather than like an institution.

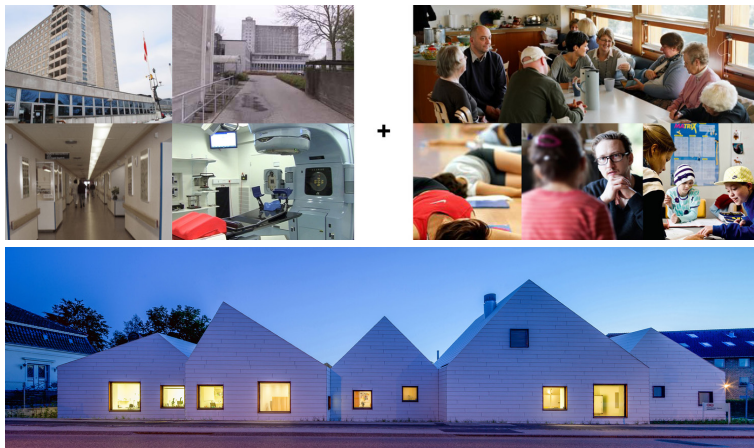
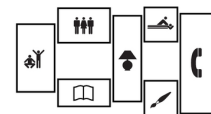
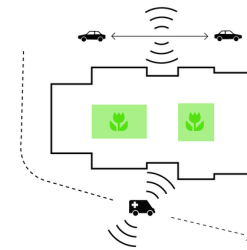


Fig. 23 effekt.dk



“If success or failure of this planet and  
of human beings depended on how I  
am and what I do... How would I be?  
What would I do?”

- R. Buckminster Fuller

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DESIGN

# AMBITION

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## *What do I want the design strategies to achieve?*

Architects can set the physical framework for what happens inside the buildings. Size, quality, spatial relationships, finishes, natural lighting and atmospheres can all be directly affected by what is designed and as discussed in this thesis they can all in some ways influence the way we behave in these spaces. The challenge is not to force or control behaviour, but to foster, enable and encourage it and to discourage unsustainable behaviour by providing better alternatives and showing the benefits.

It is essential in design to support individual needs and desires as well as communal and it is about finding a balance well suited for each specific situation while at the same time always having a holistic mind-set.

One approach to the development of design strategies would be to analytically identify the one behaviour that would have the most impact on a specific sustainability issue. However, I found that they are all relevant and because of the complexity of behavioural change, there would be more gain from finding solutions which could influence several aspects of sustainable behaviour. As long as the goals of what we want to achieve are clear. We need to improve drastically, and even small positive

changes in the right direction adds up, especially if it reaches a large target group. And as previously discussed (Tapia-Fonllem et. al., 2013), one small change towards sustainable behaviour can lead to many other.

*“There is no doubt about the influence of architecture and structure upon human character and action. We make our buildings and afterwards they make us. They regulate the course of our lives.”*

*- Winston Churchill*

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# GOALS for sustainable behaviour

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Goals for sustainable behaviour in living spaces. A development of the Cradle to Cradle principles and definitions of sustainable behaviour in the first part of the thesis.

## RESOURCE MANAGEMENT

- People conserve energy
- People conserve water
- People can control their environment

## WASTE MANAGEMENT

- People reuse and recycle everything
- People value nothing as waste
- People live more frugal

## BIO DIVERSITY

- People treat themselves and buildings as a living part of the natural environment
- People acknowledge future consequences of their actions
- People do not consume toxic materials

## HEALTH + HAPPINESS

- People live together as a community
- People share and co-operate
- People are healthy, active and happy
- People feel safe

# STRATEGIES how to achieve the goals

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Ways for architects to work with the built environment in a residential context to achieve the goals of sustainable behaviour in residents.

As a result of my research and the goals I have set, I have developed 7 design strategies that can be implemented in a residential building design. I believe these strategies can foster a more sustainable lifestyle in the building users by positively influencing their behaviour.

These strategies have been developed by defining living spaces as a system where we can find leverage points (Meadows 1999) that would affect the desired outcome of the system i.e. sustainable behaviour.



IMPLEMENT VISIBLE SUSTAINABLE SOLUTIONS



DESIGN USER FEEDBACK SYSTEMS



CREATE SPACES FOR PEOPLE TO COME TOGETHER



STIMULATE THE SENSES



MAKE IT EASY



MAKE SPACES ADAPTABLE AND FLEXIBLE



IMPLEMENT A VALID FEEDBACK PHASE

#### RESOURCE MANAGEMENT

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- People conserve water
- People can control their environment

#### WASTE MANAGEMENT

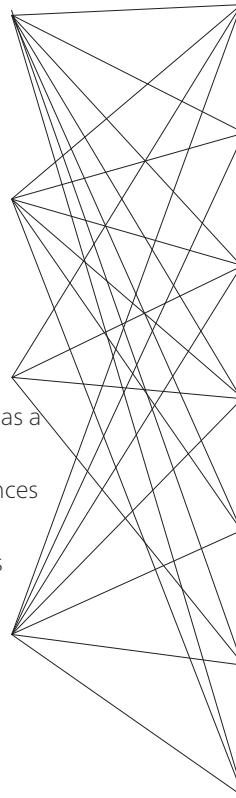
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IMPLEMENT A VALID FEEDBACK PHASE

The following spreads will present each one of the strategies in more detail. It describes how they connect to the different chapters in the theoretical part of this thesis, the types of behavioural influence and which goals each one mostly address.

### STRATEGIES ANALYSIS BY PROJECT APPLICATION

As a way of testing the developed design strategies I have used them as an analytical tool for one of my projects in a previous master level studio. The project was a senior housing design I developed together with another Chalmers Architecture student, Carlos Martínez. This project is relevant as it is a residential project, already with some sustainable design aspects. The goal of this is to explore if the outcome of this senior housing project would have been different, if I had known about the strategies developed in this thesis and to further explain ways in which they can be implemented in the design process.

#### PROJECT SUMMARY - GIBRALTARGATAN 47

This project has a mix of one and two bedroom flats with high accessibility, common shared spaces for the residents, rental apartments and rentable larger open spaces and services for the community. It has solar panels on the roof as well as storage for

## SENIOR HOUSING GIBRALTARGATAN 47

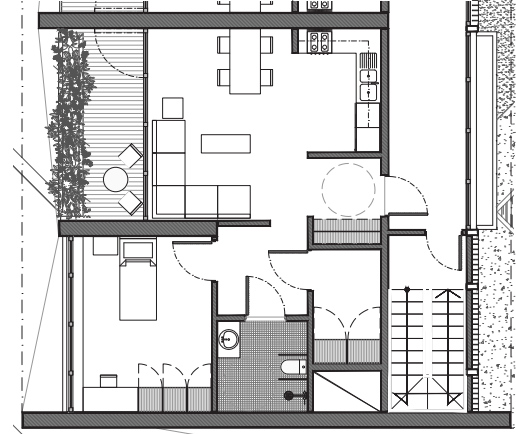


*View from the street*

rain water harvesting in the basement. One of the main goals was to get people together, to create a social environment where people spend time together and share experiences to limit the feeling of loneliness as they grow older. This also required careful consideration of different privacy levels and accessibility.



VIEW FROM CONNECTION BETWEEN BUILDINGS  
View from connection between buildings



One bedroom floorplan



Section

STRATEGY

IMPLEMENT VISIBLE SUSTAINABLE SOLUTIONS



TOPICS

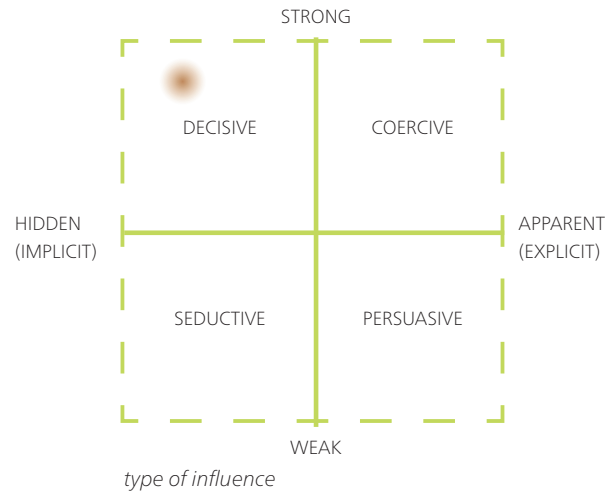
*social influences, identity, as a living system, comfort, nature, awareness, mind your ways*

CONCLUSION

As previously discussed, people are imitators and strongly driven by what is believed to be normal. By accentuating and showing what is believed to be sustainable behaviour others can be encouraged to do the same. People also strongly identify with their living spaces and by having inhabitants associate their homes with sustainability could spur on a positive change in other parts of their lives. Green roofs and façades, solar panels, water purification systems, material choices and greenery can all be integrated into the design. They benefit bio-diversity, resource use and health as well as a positive behavioural change.



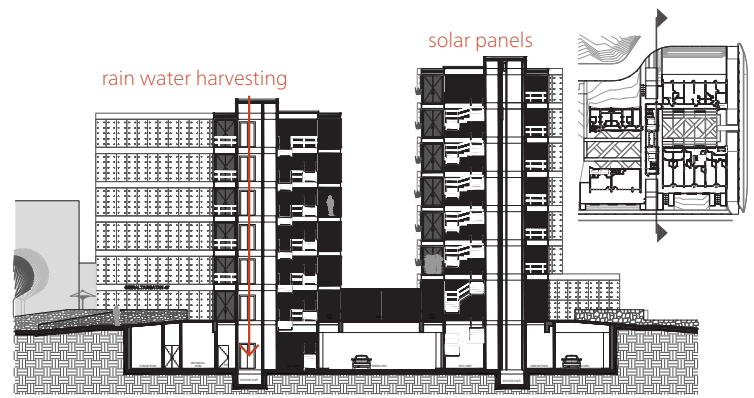
*relevant goals*



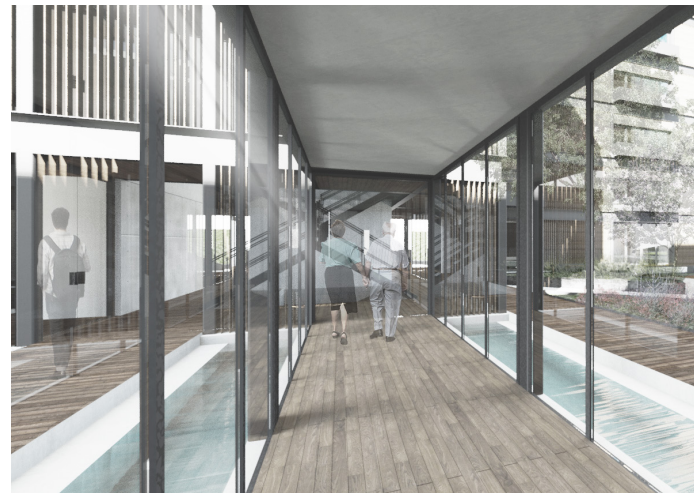


## STRATEGY ANALYSIS THROUGH PROJECT APPLICATION

Solar panels, green roof and rain water harvesting was used in the design of this project, however these have been placed out of sight on the roof and in the basement respectively. The possibility of having rain water visible through filtration, ponds or as water instalments is a way of making it aesthetically attractive as well as sustainable. The solar panels were designed to be placed out of sight on a flat roof, but could have been made more visible. There is also the possibility of using them more integrated in the design or as façade elements. Grey water treatment systems could also have been added with an implementation of ponds and plants instead of purely sensory water installation to increase awareness while taking care of water on site.



*building section*



*water installation*

STRATEGY

DESIGN USER  
FEEDBACK SYSTEMS



TOPICS

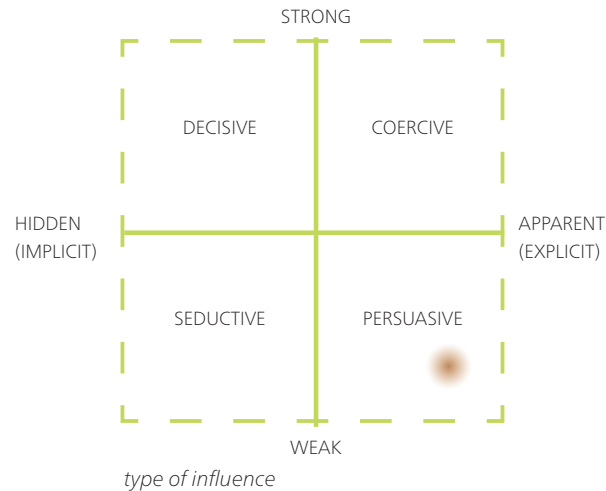
*habits, awareness, senses, prosperity, as a living system, frugality*

CONCLUSION

The developing technologies that people are already familiar with, can be used to an advantage. Sensors connected to monitors and smart phone apps could be integrated into the building design. People have a difficulty seeing delayed benefits and consequences. By utilising instant feedback systems for energy and water use we could encourage people to live more frugal. This also makes it easier to set goals, increase awareness and encourage behaviour change while seeing instant results. This would also encourage a new kind of interaction between the buildings and the residents.



*relevant goals*



*type of influence*

## STRATEGY ANALYSIS THROUGH PROJECT APPLICATION

There is no way for the individuals of this building to monitor their energy and water use or the impact of their behaviour. Monitors and screens could be installed in the individual apartments to visualise instant energy and water use or in a common area for the figures of the building as a whole. If people also see what others use or collective goals are being set, this could help people to spur on each other to change. Another aspect for elderly as this is a senior housing project, with people having increased memory loss and loss in mobility, automated systems could be beneficial with light fixtures and appliances that turn themselves off, or can be remotely controlled, for energy saving and security.



*possible spaces for monitors*

STRATEGY

CREATE SPACES FOR PEOPLE TO COME TOGETHER



TOPICS

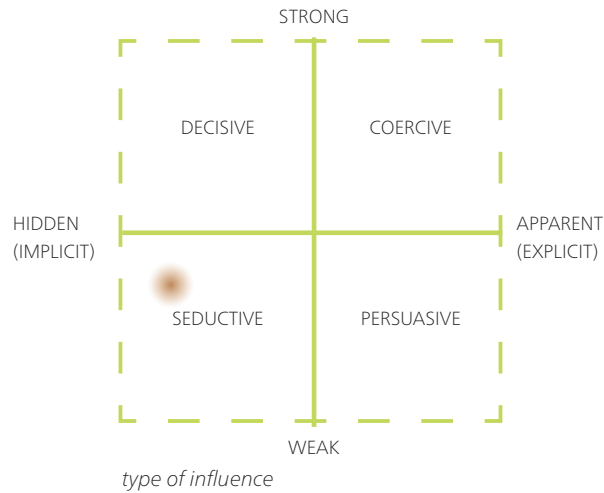
*happiness, health, social influences, comfort, needs, identity, awareness*

CONCLUSION

It is difficult for people to meet, share, discuss and co-operate if there are no physical meeting places for them to do so. This becomes especially important in the context of single households. As they are resource heavy and people in some ways lose the connection to other individuals, independence in this sense is something which should be discouraged. These spaces could be shared kitchens, common rooms, laundry rooms, libraries, gardens etc. for sharing physical things as well as knowledge. This would reduce environmental impact and by bringing people closer together and by making them see positive changes that others do and think, an attempt to shift societal norms can be made.



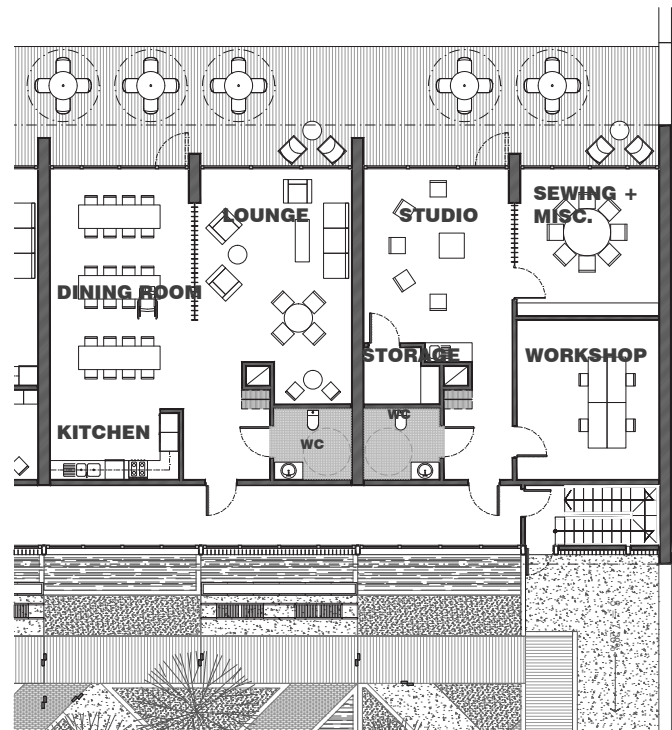
*relevant goals*



*type of influence*

## STRATEGY ANALYSIS THROUGH PROJECT APPLICATION

In this project there was a strong focus on common spaces for meeting places and social interactions, not only between the residents but for the community as well. Places where people can spend time together and be active in their older age. There could however have been a stronger focus on the possibility of shared storage for tools, books, etc., not only the social aspect but the physical one. Another way of working with this is to make the individual apartments even smaller and space efficient for the possibility of added common spaces without the cost increase. This project also provided public services on the ground floor and larger spaces belonging to the complex that could be rented out to the surrounding community. This is a great way of inviting the community into the building and not separating it from what is already there but adding qualities.



*common spaces*

STRATEGY

STIMULATE THE SENSES



TOPICS

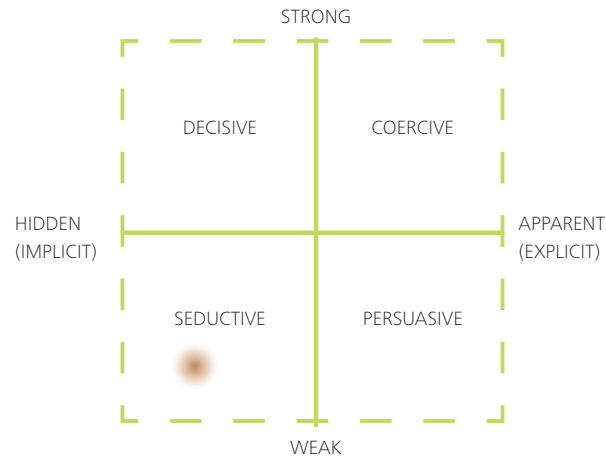
*sesnses, health, happiness, comfort, nature, needs, habits, identity, awareness*

CONCLUSION

Materials and details play a large part in how we experience our living environments and our perception of comfort. Wood is not only a sustainable material, it has strong associations to sustainability in general as well as a feeling of warmth, comfortable sound levels and a long history and cultural value. These associations can be used to an advantage. The use of materials, colours and light could direct and divert attention to where it is desired in order to stimulate certain types of activities. The use of colours are for example already commonly used in waste rooms to foster a desirable behaviour.



*relevant goals*



*type of influence*

## STRATEGY ANALYSIS THROUGH PROJECT APPLICATION

Wood was used as one of the materials throughout the building design, but this was combined with concrete. Wood is a renewable material with sustainable associations whereas concrete is not. A stronger focus on sustainable materials could have been possible. Maybe with the use of clay plaster or new innovative materials for a similar expression. Testing and exploring new sustainable materials could have been made. As this was a senior housing building, attention to contrasts and light conditions was made but there could have been a more playful testing of colours in the common rooms for example to accentuate certain parts of the design or by working with stronger contrasts and colours to attract residents, increase spatial understanding and comfort.



*wooden design elements*



*wood, concrete and contrast*



STRATEGY

MAKE IT EASY



TOPICS

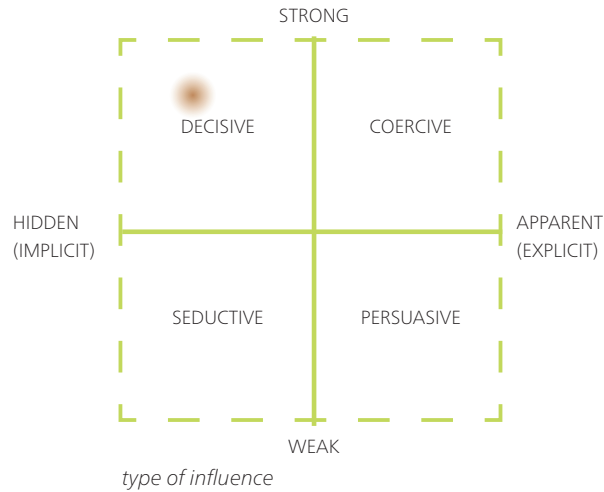
*comfort, health, as a living system, awareness, habits, daily actions*

CONCLUSION

Make it accessible for people to be more sustainable than not. By designing smaller homes we directly reduce resource and energy use but we can also utilise efficient floorplans, solar income, porches and different tempered zones in buildings for the same reason. The placement and orientation of the building, its protection from wind, impacts energy use and comfort levels. Building systems which can be used, understood and maintained by the building users should be prioritised. This strengthens self-confidence and connection to the building. The possibility to open and close windows is an example of this. If complicated technical systems that demand dependence on someone in another part of the world are avoided, we can strengthen the local communities.



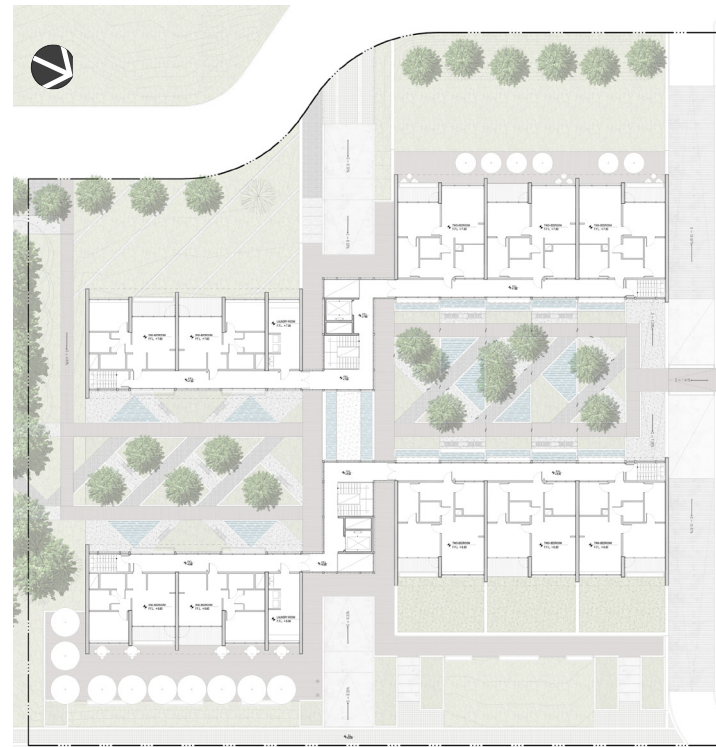
relevant goals





## STRATEGY ANALYSIS THROUGH PROJECT APPLICATION

As the apartments were designed to be 59 m<sup>2</sup> for the one bedroom and 85 m<sup>2</sup> for the two bedroom. More attention and work could have been put into space efficiency or the design of other types of apartments f. ex. sibling or friend-apartments. Innovations of other types of communal living to offer a different type of housing stock should be encouraged. Balconies where people easily can enjoy the outdoors and balcony railings designed to be plant holders for the possibility of bringing more greenery into the building design was also implemented and positively affects health and quality of life. To reduce the building's energy use, more attention could have been put into the building orientation and passive solar income.



*apartment layouts*

STRATEGY

MAKE SPACES  
ADAPTABLE  
AND FLEXIBLE



TOPICS

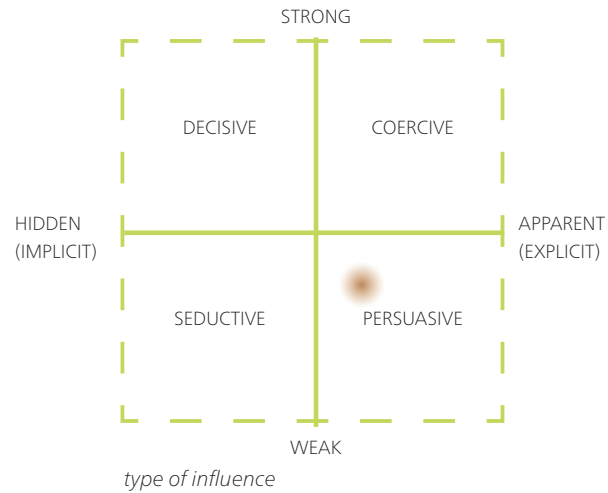
*happiness, comfort, needs, as a living system, prosperity, social influences, daily actions*

CONCLUSION

People, as well as their behaviour, are always evolving and will be different from one to the next. As people grow older their needs change and in order to let people grow with their living spaces it is important to make them adaptable and flexible. There are different ways of working with this strategy. Rooms can be designed in general forms and sizes to accommodate different functions through furnishings or they can be changeable in terms of being able to move walls and arranging spatial layouts. It is important to evaluate in each specific case which strategy is most valuable for that project.

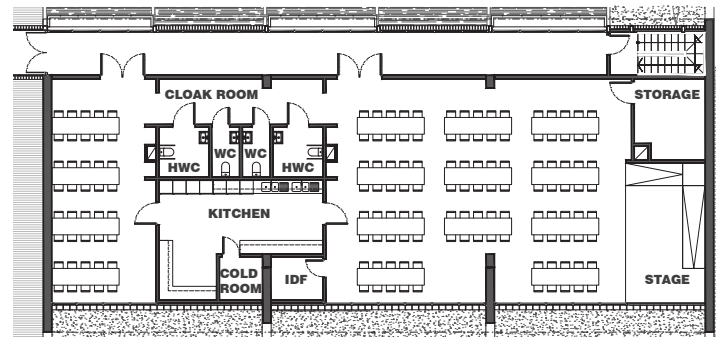


*relevant goals*

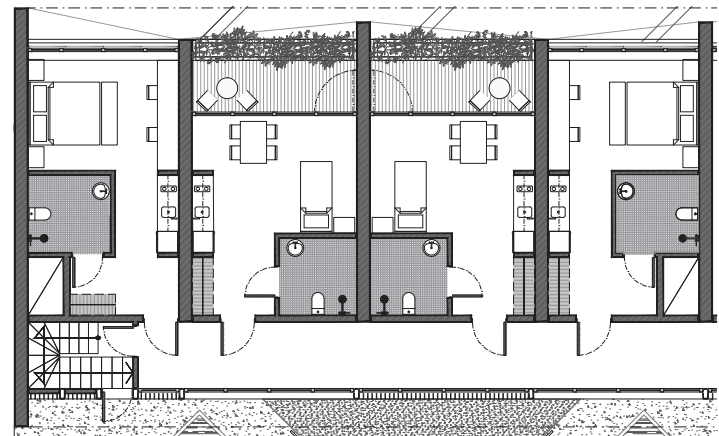


## STRATEGY ANALYSIS THROUGH PROJECT APPLICATION

The design of this project was made with concrete walls in-between the apartment units which makes it difficult to change spatial layout between apartments (easier with interior walls inside these units). It is also difficult to demolish the different parts if individuals wish to personalise their space for specific behavioural needs. Some of the larger common spaces could however be divided into apartments if needed in the future. The strict grid structure is adaptable but also constraining in its design. If more detail was to be worked on with this strategy there could have been the possibility of designing kitchens and bathroom units that are easily dismantled and interchangeable without any demolition waste, for easy and sustainable personalisation.



*rentable flexible spaces*



*rentable apartments*

STRATEGY

IMPLEMENT A VALID  
FEEDBACK PHASE



TOPICS

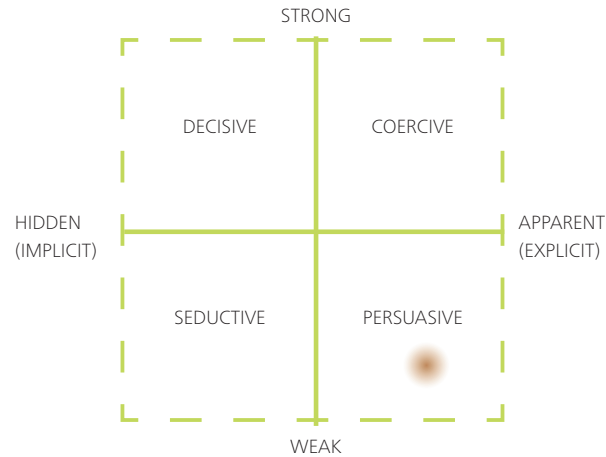
*health, happiness, prosperity, comfort, nature, social influences, daily actions, as a living system, needs, habits, identity, awareness, mind your ways*

CONCLUSION

It is extremely important to evaluate everything that is being done in order to evolve and improve. If there never is any received feedback or a reflection on what is being done and built, how will people ever know what is truly successful or what can be improved? This strategy is aimed at both architects and residents. The building users need to reflect on their behaviour in order to know what can be changed and the architects have to evaluate what they design so that updates can be constantly implemented as society evolves.



relevant goals



type of influence

## STRATEGY ANALYSIS THROUGH PROJECT APPLICATION

During this project we made study visits to several other senior housing projects. This is a great opportunity to talk to other building users to evaluate what has been done before and how it works, or what does not. There is a possibility of learning, from not only what you have designed yourself, but also from what others have done. Interviews and questionnaires are other ways of gathering valuable information. Residents could every so often evaluate how certain behavioural changes has affected their energy or water use, this would be easier if the strategy feedback systems were also implemented.



*study visit during senior housing course*

# CONCLUSION

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In summary, this thesis has aimed at acquiring a deeper knowledge into the relationship between the built environment and human behaviour. Trying to discover ways in which architects can encourage a lifestyle change in residents as this transition is an important part of our journey towards a sustainable future. I have discovered that the topic of human behaviour is much broader and more complex than I had ever imagined. It has however been surprisingly difficult to find studies connecting behaviour to the built environment, more specifically residential buildings, and even harder to find architectural offices who have openly approached this in their work. Co-operation between architects, psychologists, researchers and other inter-disciplinary collaborations are found in an increasing amount of projects, especially, and almost exclusively, to those of institutions. Schools and pre-schools with pedagogical aims and hospitals promoting recovery through environmental factors, where evidence based design is becoming an increasingly important tool, are more common. I believe that happiness and wellbeing should be a goal during all stages of life, not only in instances when we are already ill. I feel much is to gain and learned from advancements in healthcare design that can be applied in residential environments. I see no reason why these findings

and similar principles could not be applied to residential spaces, or any other spaces which we inhabit. Goals of wellness and happiness for everyone on this planet should be incorporated into everything we do. However, I have found that it is easier to state the kinds of behaviours we would like to achieve from the perspective of sustainability than it is to account for how such behaviours could be sufficiently encouraged

I have come to the conclusion that the built environment has an impact on human behaviour, but this connection is complex and it is not the only factor. To tackle this issue I have defined living spaces as a system where we can find leverage points that would affect the desired outcome of the system i.e. sustainable behaviour.

This thesis has developed into a project that attempts to give an overview into the many different elements that have an impact on behaviour, trying to define elements of the built environment that have an impact on behaviour and that could be developed into design strategies. This has resulted in 7 strategies that can be applied to different residential building projects to foster sustainable behaviour.

There is a difficulty in measuring the success and outcome of a design or strategies that attempts to address behaviour. This connects to the feedback phase. Does the building work as planned? Certain things can be measured such as water and energy use, and the amount of discarded waste. But how do we evaluate the change in other behavioural patterns and habits that lead to an increase in happiness and mental health? Observations, interviews and surveys could be ways of implementation as we need to find other types of evaluation methods.

# REFLECTION

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My thesis has since the start taken many forms and undergone several transformations. The overall goal has always been the same. To explore architecture with a sustainable holistic mind-set and a people centred design. It has been a steep learning curve and a very interesting exploration as it turned into something much more complex than I ever imagined, forcing me to question my own morale, ethics and values, along with those of others.

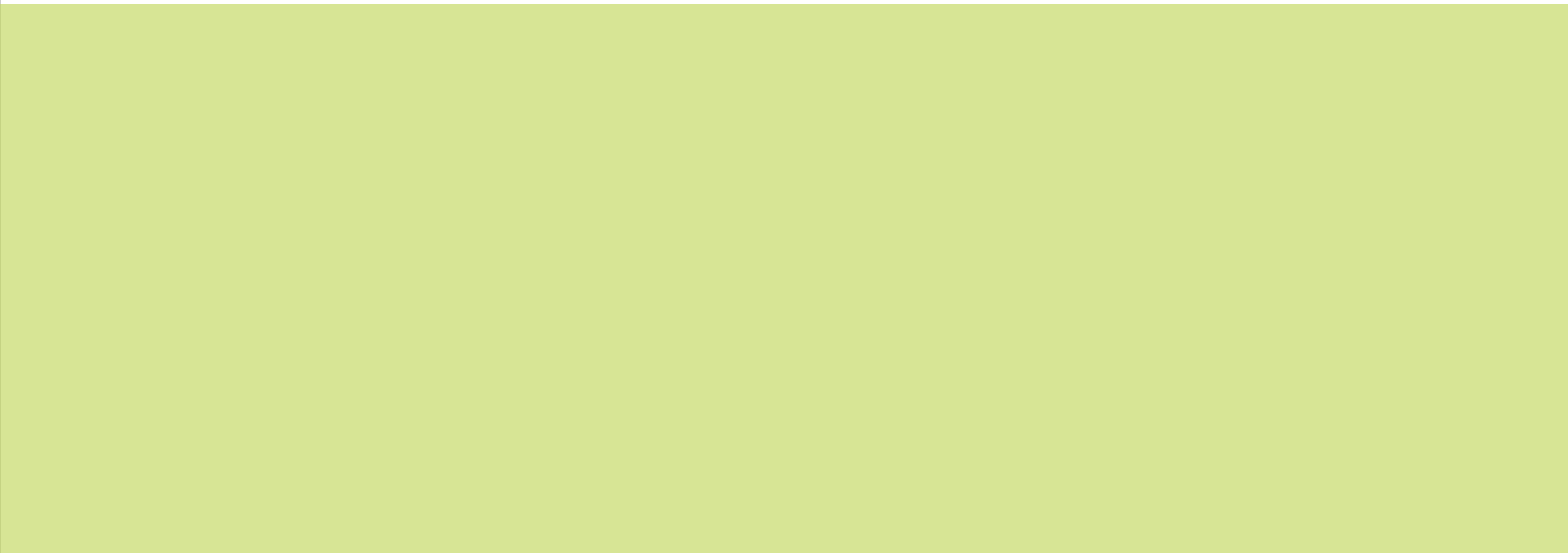
I started with the aim to show how the cradle to cradle principles could be applied on a mainstream residential building. Attempting to combine my interest in the cradle to cradle paradigm and residential buildings but I quickly realised that it is not as easy as just applying the principles on a building, it has to be there from the start, through the whole process. As a continued my exploration, my interest in human behaviour grew but as I later learned, it did not ease my work.

It has proven to be a difficult, complex task to design for behaviour, enough research and practical examples have not yet been studied. It is nevertheless still an important factor to consider when designing buildings and other objects that can have a direct impact on user behaviour and attitudes. I believe that health, happiness

and behaviour are strongly connected to each other, and they are all also influenced by the built environment.

The thesis has been a way for me to leave the traditional abstract ways of looking at architecture and form, and to connect my work to some sort of reality. I have tried to find my own ways of approaching design and to recognise the importance of seeing architecture from the inside out, by starting with people. I hope that I, in the pursuit of a better understanding, will be able to more successfully meet the needs of a sustainable future.





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