Context is King: A Case Study of an Autonomous House in Sweden

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## Table of Contents

1 Introduction  
1.1 Swedish Housing Stock  
1.2 Availability of Affordable Housing in Sweden for the Young  
1.3 Alternatives to Buying or Renting a Home  
1.3.1 Stay at home  
1.3.2 Building Your Own Home  
1.4 Concluding remarks  

2 Background  
2.1 Shelter – the need for homes  
2.2 Buildings as Pollution  
2.3 Sustainable Housing  
2.3.1 Green Building Standards  
2.3.2 Impacts of Standards  
2.3.3 Beyond the standards  
2.4 Autonomous Housing  
2.4.1 Versus Standard Housing  
2.4.2 Earthships  
2.4.3 Limitations of Autonomous Housing  
2.5 Concluding Remarks  

3 Methodology  
3.1 Case Study Methodology  
3.2 Concluding Remarks  

4 Case Study Description  
4.1 Purpose  
4.2 Site Description  
4.2.1 Existing Buildings  
4.2.2 Existing systems  
4.2.3 Cultural Qualities  
4.2.4 Climate Qualities  
4.2.5 Social Qualities  
4.3 New Systems required  
4.4 Concluding Remarks  

5 Analysis and Design Method - A Pattern Language  
5.1 Description of Design Method  
5.2 Results of Method  
5.3 Critique of A Pattern Language  
5.4 My own experiences  
5.5 Concluding Remarks  

6 Systems Design & Integration  
6.1 Water  
6.1.1 Water Requirements  
6.1.2 Water Supply  
6.1.3 Water Storage  
6.1.4 Analysis of Water Systems  
6.2 Electrical  
6.3 Heat Generation & Thermal Insulation
8.4.3 Autonomous housing beyond its boundaries 69
8.4.4 The autonomous apartment? 70
8.4.5 Autonomous beyond residential 70
8.5 Building your own home as an alternative 70
8.5.1 Self Building 72
8.5.2 Scale 73
8.5.3 The next step in architecture 74
8.6 Recommendations 74
8.7 Concluding Remarks 75

9 Summary 76

10 Acknowledgements 78

11 References 79

Appendix A Case Study Location: Nåntuna Lund 84
Appendix B Pictures and Maps Associated with the Case Study 89
Plot and Existing buildings
Appendix C Solar Movement for Case Study Plot 97
Appendix D Case Study Pattern Language 99
Appendix E Details for Pattern Language Design (Selected designs) 115
Appendix F Planning Permission Submitted for New Main Stuga 121
Appendix G New Main Stuga Design Details 127
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Ben Owen


Abstract: Buildings are responsible for 40% of the energy used globally as well as emit as much as one third of greenhouse gas emissions. With small but widespread changes to the way we build and use our buildings, the built environment could quickly reduce our impact on the environment. In Sweden young adults are leaving higher education with an ever increasing limiting set of choices, the housing market has been outstripping inflation for over 20 years and the continuing deregulation of the housing markets, both private and municipal has resulted in young adults returning home after their education has finished. Therefore through the design of buildings that are expected to last for at least 100 years there is a chance to reduce our negative environmental impact and reduce the growing financial gap for young adults, both important factors for sustainable development

The premise of the paper is to design a home for a small family that goes beyond green building standards of energy efficiency and takes into account the resource use and waste production of the occupants. An autonomous house is identified and explored as the solution: a house that has no connections to the municipal systems that supply water and electricity nor the municipal systems that deal with the waste produced by the occupants. This paper asks: Is an autonomous house possible in Sweden? And can one self-design and self-build an autonomous home as a way of avoiding the financial pitfalls of the regular housing market?

This paper uses the Case Study methodology to follow the journey of the authors desire to reduce their impact on the surrounding environment. A final design is based upon the design methodology A Pattern Language to develop and explore thoughts and ideas of the human requirements and the built environment’s interaction with nature. Given the length of time allowed to produce this paper and to continue the narrative, the results of as-built home are also presented and discussed. The final as-built solution thinks beyond the house as a single entity and looks to the neighbourhood for solutions for resources that can be shared. The scale of autonomy is expanded upon with autonomous communities seen as a solution with a strong realisation that context is the main driver for design.

Keywords: Sustainable Development, Sustainable Housing, Autonomous Housing, Pattern Language

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Summary: Buildings are responsible for 40% of the energy used globally as well as emit as much as one third of greenhouse gas emissions; at the same time there is a housing crisis in Sweden with young adults priced out of the housing market. Demand outstrips supply. There is a clear need to reduce impact that buildings have on the environment and society and that the built environment should be a major focus for sustainable development.

This paper looks at one case where the owners of a small home are trying to reduce their impact on the surrounding environment. The premise of the paper is to design a home for a small family that goes beyond green building standards of energy efficiency and takes into account the resource use and waste production of the occupants. An autonomous house is identified and explored as the solution, a house that has no connections to the municipal systems that supply water and electricity and also the municipal systems that deal with the waste produced by the occupants.

The paper is a journey of the author over a period of 18 months, through the design process and actual build. The result is a smaller house than the original idea designed using A Pattern Language; with the author calling into question the idea of houses being seen as individual entities and solutions must look beyond the borders of a singular house, towards the community and the shared resources that they create as well as designing within context a main driver in sustainable solutions.

Keywords: Sustainable Development, Green Building Standards, Autonomous Housing, A Pattern Language.

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1 Introduction

The Game of Life was a board game that we had as a family when I was growing up. The aim of the game was to make your way along a path that twisted its way around the board leading you through a series of life’s events: go to university, find a job, get married, buy a house, have kids and finally into retirement all the while collecting Status Symbols such as a fast car or a speed boat. The game, when I played it, was indicative of the time (the early-mid 1990’s) and made ‘life’ as simple as spinning the wheel and moving to the goal of retirement and Millionaire Mansion; it perpetuated the ideal of materialism, associating financial success to a success in life, the importance of buying insurance and enviable social comparison as we raced to end. The winner of the game was the player with the most valuable assets in financial terms. There was no mention of death or quality of life.

Fast-forward twenty years and away from the board game emerging adults, a term to describe the years of development for the period from the late teens through the twenties (Arnett, 2000), are stumbling over these first few steps identified in the Game of Life. Educational inflation has led to a competitive job market and buying a home is not quite as simple as it was made out to be.

The purpose of this thesis is to explore the idea of young people designing and building their own home and to highlight the need for more affordable housing for emerging adults in Sweden. The second purpose, and one that may have a wider audience, is to promote the need for houses, or any buildings built in the modern era, to be built with their lifecycle in mind regarding construction materials and energy efficiency.

I will now set out a few arguments that triggered the initial idea in this thesis, after which I will outline some traditional housing options available to emerging adults before going further into the focus of this thesis: self-building sustainable homes.

1.1 Swedish Housing Stock

Sweden has experienced a rapid, in a historical perspective, change in economical fortunes and development going from a country whose growth was dominated by the agricultural sector to one dominated by the industrialised sector.

With the groundwork of implementing a social welfare system, an increased engineering sector with manufacturing around electrification and motorization in the early part of the 20th Century. This groundwork enabled Sweden, after the Second World War, to have an economic boom; leading to a rapid rise in wealth of the country and an increase in social status for its people. A rising work force and a new consumerism lifestyle led to a demand for housing, highlighting the need to increase and improve the housing available (Schön, n.d.).

During the period 1965-1974 the Swedish government introduced a mortgage and housing policy collectively termed Miljonprogrammet (Boverket, 2014), a name coined from the slogan that Ernst Michanek used as the title of SAP's political action "One million homes in ten years" and later used in political propaganda (Jönmark, n.d.). Over this period, Sweden built 1,006,000 homes that led to a decrease in demand for housing (Roxvall, 2010).

As of 2012 there are 4,550,779 residential buildings calculated to be in Sweden (SCB, 2013a). Nearly one quarter of these are considered to be the result of the Miljonprogrammet initiative (Roxvall, 2010) the building of new homes in Sweden has fallen sharply since the end of the
Miljonprogrammet initiative (see Figure 1) whilst the population of has increased by nearly 17% from 1974 figures to those of 2012 (see Figure 2).

With the population of Sweden rising unabated and a drop in newly completed residential buildings, it can be concluded that demand for housing can only have risen, having a large impact on the prices of residential housing in Sweden.

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**Figure 1:** Number of completed residential buildings (SCB, 2013c)
- *x-axis = Year, y-axis = No. of homes built*
- *Småhus = Homes for single families, Flerbostadshus = Apartment Buildings*

**Figure 2:** Population of Sweden 1974-2014 (SCB, 2015)
- *x-axis = Year, y-axis = Population of Sweden*
1.2 Availability of Affordable Housing in Sweden for the Young

In his article *A Monstrous Hybrid: The Political Economy of Housing in Early Twenty-first Century Sweden* Brett Christophers describes how Swedish housing is between “a rock and a hard place” (Christophers, 2013, p 902). After years of neoliberalism with deregulation leaving the housing market perceived as an “ungainly hybrid” of regulation and free markets (Christophers, 2013).

Deregulated markets have seen the cost of homes, whether buying or renting, increase way above inflation (see Figure 3) leaving *The Economist* to evaluate that Sweden’s housing market is one of the worlds most over-valued and unaffordable (The Economist, 2011).

However, in a survey of young adults by *SBAB Bank* the views towards saving for somewhere to live have changed. The number of emerging adults now choosing to save for their own home in the future has fallen from 60% to 47%, with 48% of emerging adults saying that they will be able to buy a home in the future (SBAB, 2014).

This positive outlook (by a mortgage lender) is in contrast to the realities of the house prices in Sweden. The house prices in Sweden have been rising above inflation for over a decade (see Figure 3). No matter how much money young Swedes save they are always going to be out priced by market inflation. Not only has demand for housing increased the cost of buying a residential property with the reduction in newly built housing; there has been an increase in the cost of renting a home beyond inflation as well. Figure 4 shows the increase in the annual cost of renting privately and publically owned 3-room apartments in Sweden.
The unaffordability of renting or buying a home hits those outside of the market – those who are looking for their first home – hardest, leaving Christophers to conclude that “...in recent decades housing has become a pivotal locus for the creation, transference (across generations) and thus reproduction of socio-economic inequality in Sweden” (Christophers, 2013).

A recent report from the UK states that this is the first time in over a century that the children from middle class backgrounds will “be materially less well off in adulthood than their parents” calling it a ‘perfect storm’ of “graduate debt, lack of finance to buy homes and job insecurity that threatens middle-class children as they emerge from full-time education.” (Wright, 2013) Although this report was based on UK findings, the report can be extrapolated to Sweden which, along with the finding of Christophers has seen similar increases in house pricing beyond that of inflation.

A housing crisis is bubbling away in Sweden with a report from Hyresgästföreningen calling for 189,900 new homes for young, emerging Swedish adults (Hyresgästföreningen, 2013, p 3). This is undoubtedly a large number and is in stark contrast when placed against the actual homes built annually (shown in Figure 2). More significant is that this number has increased on a similar report two years earlier. The same report carried out by Hyresgästföreningen in 2011 called for 163,000 homes (Hyresgästföreningen, 2011, p 3). Demand is increasing, supply is staggering to catch up, the market buoyant.

1.3 Alternatives to Buying or Renting a Home
Taking the leap from living at home to owning a home is a huge financial decision. The increase in house prices applies more pressure on emerging adults to be financially stable before approaching mortgage lenders, something that does not come easy in the current financial climate post higher education. With the options of buying or renting financially crippling for emerging adults, here I will discuss some of the alternatives to buying or renting your own home once leaving higher education.

1.3.1 Stay at home
In their working paper, Katherine Newman and Sofya Aptekar, conclude that the housing market plays a key role in ‘residential independence’ and relates a decrease in the rental sector to an increase in emerging adults returning home (Newman & Aptekar, 2006). These returning young adults are referred to as ‘boomerang kids’ and this trend is seeing a departure from the traditional social and financial patterns of families in the Western world (Otters & Hollander, 2015).

In a new report by the European Foundation for the Improvement of Living and Working Conditions (Eurofound) shows that the number of young people (aged 18-29) living at home with their parents has increased from 44% in 2007 to 48% in 2011 for the 28 European Member States (Eurofound, 2014, p 3). Going deeper into the report shows that Sweden has seen a larger increase in the nation’s youth staying at home with the number increasing from 27% in 2007 to 35% in 2011 (Eurofound, 2014, p 8). The increase in the cost of owning your own home and the increase in rental prices in Sweden have already started to have an impact on emerging adults.

1.3.2 Building Your Own Home
An alternative option for the emerging adult, and the focus of this thesis, is to build your own home. This option still remains an outside choice. There still needs to be financial capital to fund the land purchase/rental and build a house, but it could offer the opportunity for people
to really find a place they can call home and reconnect the lost relationship between the human and natural worlds.

In the introduction to his book *Housebuilder’s Bible* Mark Brinkley looks at self-building solely through the financial aspect. He states that self-building is effectively “property development” and a risky undertaking that is closely tied to the housing market and the cost of land. Brinkley also warns against “Trying to build an ‘Eco’ house” amongst a long list of complications you can make to a design in order to maximise financial return (Brinkley, 2013, pp 10–15).

On a human level, the basic relationship of human to house hasn’t changed (Snell & Callahan, 2005, p 8). We still want a place of shelter from the environment to keep us warm, to provide us with the basic services of water and electricity but the way in which we see houses – as commodities, as status symbols – to be traded and influenced by markets has led to the standardisation of materials, to cheapen the construction process and reduce the ability to make our homes individual, beautiful and truly ours (Jones, 2009, p 18).

By building a house where we are deeply involved in the design process as well as the building process, we will develop positive feelings for the finished home, feelings that care about the buildings and want to look after and preserve them (Jones, 2009, p 16 & Snell & Callahan, 2005, p 19).

We are losing the skills required to build, relying on a number of specialists to design and build individual aspects of the home rather than seeing the building as a whole set in a unique location. In the television series *How Buildings Learn*, architect Christopher Alexander argues that “people have lost confidence in themselves”, blaming the architectural profession of convincing people that architecture is for them only and for people to need an architect before they even think of building (Brand, 1997).

One man who decided to bring the two worlds of standardisation and self-building together was Walter Segal, an architect born in Germany in 1907, who sought to remove the ‘wet trades’ (concreting, brick layering and plastering) from the act of building a house. These are heavy duty tasks that often require a certain skill set. Segal tried, through his architecture, to allow the average person the possibilities of building their own home. He relied on timber structures with simple cladding, insulation and lining in standard sizes available to all. Through these standard dimensions, the idea was, that anyone would be able to pick up a set of his architectural plans, go to a series of local hardware stores and buy the necessary material required to build a house from scratch (Ward, n.d.).

This thesis aims to discredit the claims by Brinkley and to show how a self-build can be ‘Eco house’ without overcomplicating the design and to provide an antithesis of the build-to-make-money mind-set of a property developer. This thesis will show that through building our own home we have a stronger connection to where and how we live; and how the buildings we construct have large and long lasting impacts on our environment.

### 1.4 Concluding remarks

Through highlighting the demand shortfall, the increasing prices of the current housing stock in Sweden and limited alternatives, the aim of this thesis is to provide an alternative to the emerging adults of Sweden looking for a place to settle and start the next phase of life. The thesis will look at the possibility of self-building a home in the spirit of Walter Segal, building
it with locally available materials with maintenance and future requirements of the building in mind. Also to look long term to the potential dismantling of the building when it reaches the end of its life, when it becomes, for whatever reason, structurally unsafe or no longer needed.

This thesis will not be over theoretical and will focus on the more practical elements of building a year round living space. This is not to say that the thesis has no academic value; theories that lie behind the practical elements will be referred to and expanded upon to inform the reader where necessary.
2 Background
This section will follow two tracks: the need for shelter and shelter as pollution; these two juxtaposing angles come together to formulate the need to build more sustainable buildings. I later argue that autonomous housing is the ‘next step’ in sustainable buildings.

2.1 Shelter – the need for homes
In 1943, American psychologist Abraham Maslow proposed a Theory of Human Motivation, 5 basic needs often represented in a pyramid (see Figure 5) that shows the Hierarchy of Needs. The lowest or first level of ‘needs’ identified by Maslow are the ‘Physiological Needs’ – the ‘homeostatic’ or biological needs that we, as a human race, need to survive – air, food, water, shelter etc.

With these physiological needs satisfied one can consciously start to think about or desire the next level up – the ‘Safety Needs’ and with these needs met one can start consciously wanting or be motivated to attain the next level up the pyramid – the ‘Needs of Love and Affection’, and so on up until we fulfil our ‘Creative Needs’. However, Maslow admits there is no direct order and the wants and needs flow from one level to the next. He sums up that “…man is a perpetually wanting animal…” (Maslow, 1943).

Where this thesis intersects with Maslow’s Hierarchy of Needs is on the very first level – the psychological need for shelter and protection from the elements that has been with Man since early development. Clarke Snell discusses in his book Green Building: A Complete Guide to Alternative Building Methods the histories and origins of housing saying that “traditional housing approaches were specific to the culture, climate, and environment from which they sprung.” (Snell & Callahan, 2005, p 18) and argues that “[t]he modern concept of housing is to build a strong box and hook it to adjustable life-support systems that provide temperature, light and air circulation as well as bring water in and flush waste out” (Snell & Callahan, 2005, p 18).
Given the topic of his book, it is hardly surprising that Snell’s discussion on the transition away from natural and locally sourced building materials to the modern manufactured building methods of today is seen in a negative light. Housing, according to Snell augments the human body providing the same kinds of functions (Snell & Callahan, 2005, p 45) (see Figure 6), he recognises that the main concept of housing hasn’t changed, even the modern examples of housing achieve the basic psychological need to shelter, it’s a basic human need.

Looking forward, the UN has recently released a working document for the Sustainable Development Goals (SDGs). The intention of these goals is to take over from the Millennium Development Goals (MDGs, which ran from 2000-2015) and guide organisations and governments to a more sustainable future. Of the 17 goals mentioned in the SDG proposal Goal 11 is “Make cities and human settlements inclusive, safe, resilient and sustainable” (UN, 2014, p 17). Although focused on cities, the first sub-target, 11.1, is focused on providing affordable and safe housing for all that provide the basic services to meet the basic human needs highlighted by Maslow.

Whereas there has been plenty of debate over the hierarchy proposed by Maslow there can be little debate of the ever present human need for shelter, particularly in Sweden where the climate can be harsh and impossible to survive without shelter from the elements.

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Fig. 6: The Augmented Body: The Four Functions of a House (Snell & Callahan, 2005, p 16), here the authors argue that the home is an extension of the functions provided by the body.
2.2 Buildings as Pollution
As more and more structures are designed and constructed to meet the demand of a rising population to fulfil the basic human needs, the environmental impact of buildings has increased.

The UN Environment Program (UNEP) has reported that buildings now account for 40% of the energy used globally as well as emit as much as one third of greenhouse gas emissions (UNEP, 2009, p 9). Although these are substantial numbers, the UNEP see this as a large potential for reducing global energy usage of greenhouse gas emissions. In their 2009 report Buildings and Climate Change, they set out five Policy Options for reducing emissions from buildings:

Target 1. Increase the energy efficiency of new & existing buildings (both the physical envelope, and the operational aspects such as energy systems for heating, ventilation and other appliances);

Target 2. Increase the energy efficiency of appliances (white goods, entertainment, personal computers and telecommunication equipment);

Target 3. Encourage energy and distribution companies to support emission reductions in the Building Sector;

Target 4. Change attitudes and behaviour;


It is important to mention, at this stage, the distinction between ‘buildings’ and ‘homes’ or ‘residential housing’; the numbers identified by the UNEP and these targets are aimed at buildings that also includes residential housing - the focus of this thesis.

With all the good intentions of the UNEP in identifying the built environment as a major contributor to climate change, they seem to have glossed over the designs of new buildings taken from a standpoint of material production and construction methods of buildings. With that said, a study of Life Cycle Assessments (LCAs) of buildings conducted from 2000-2007 concluded that the operational phase of a building’s life is the most critical in European scenarios and less so in tropical climates (Ortiz et al., 2009, p 36). With the global scale that the UNEP works with, those targets are possibly most in reach and applicable on a global scale.

To add further evidence that the UNEP are on the right track with tackling the ‘easy-to-reach- fruit’ of reducing energy efficiency, recent research into LCAs of buildings have revealed the difficulty in analysing every impact of every aspect and component that makes up the built environment particularly given the long life-span of a building. (Khasreen et al., 2009, p 695)

However, one of the results of focusing on improving energy efficiency has seen an increase in materials used in the design and construction; effectively shifting the energy used in the building’s lifetime from the operational phase to the construction phase. Operational efficiency can no longer guaranteed to be the majority polluter of buildings; there has been a shift in energy used during a buildings lifetime from operational to production and construction. (Gustavsson & Joelsson, 2010, p 210)
After a study of residential homes built with various construction materials, to energy efficient standards and with various space heating options in Sweden, Leif Gustavsson and Anna Joelsson concluded that “it is essential to consider both the production and operation phases when minimizing the life cycle primary energy use of buildings.” (Gustavsson & Joelsson, 2010, p 219) They go on to further suggest that “demolition and recycling, should also be included in optimization aimed at minimizing the life cycle energy use in buildings.” (Gustavsson & Joelsson, 2010, p 220)

We are clearly in a transitional phase when it comes to understanding the LCA process and how it applies to the building sector. What is clear is that buildings at all stages of building: from material selection, through construction to their occupational use and demolition are a major contributor to the greenhouse gases.

2.3 Sustainable Housing
In the short term, building is a destructive act (Snell & Callahan, 2005, p 48) and sustainable housing could be considered an oxymoron unless, as just mentioned, the whole lifecycle of the building, however difficult to quantify and evaluate, be taken into account.

In this section I will discuss the virtues of building sustainably starting with the most recognised way of obtaining ‘sustainable buildings’: through standards and awards.

2.3.1 Green Building Standards
Originally founded on concerns of toxicity levels within building materials and their impact on children’s health in the 1980’s, organisations both governmental and non-governmental have set a number of benchmarks and standards for buildings. Buildings, designed to these standards are then graded and certified. There are now a number of widely accepted standards that can be chosen by the builder depending on the location of the building and their goals. The focus of these standards has shifted in the 21st Century to the wider goals of reducing climate change and limiting resource depletion as well as expanding the standards to include a broader range of environmental issues and the impacts of products during their manufacture, use, and reuse (Vierra, 2011).

2.3.1.1 World Green Building Council
Established in 2002 as a non-profit member based organisation, the World Green Building Council is the umbrella organisation for 80 national Green Building Councils. Its aim is to further the discussion of building more sustainably while providing a platform for the building industry to develop its practices and material choices (WorldGBC, n.d.).

In the United States, the US Green Building Council (USGBC) has a defined set of standards called Leadership in Energy and Environmental Design (LEED). Buildings are designed to “satisfy prerequisites to earn points and achieve different levels of certification” (USGBC, 2004). The LEED standards have become very popular in guiding architects and designers to create more sustainable buildings around the world with projects certified in 135 countries. In 2010, the US Federal Government adopted the LEED Gold standards for all new federal building and renovation projects (USGBC, 2014).

The Building Research Establishment Environmental Assessment Methodology (BREEAM) was founded in 1990 as a pioneer of green building standards and was influential in creating the UK Green Building Council. “It encourages designers, clients and others to think about
low carbon and low impact design, minimising the energy demands created by a building before considering energy efficiency and low carbon technologies.” (BREEAM, 2014)

When the Swedish Green Building Council (SGBC) was formed in 2010 they adopted the BREEAM standards and principles. Their aim is to develop and market the BREEAM certification system, educate the members of the industry, the public and influence legislation to promote more sustainable construction in Sweden (SGBC, 2014).

Although BREEAM and LEED are going for the same effect – increase in the awareness and promotion of constructing ‘green’ buildings in the UK and the US respectively, there is stiff competition between the two standards internationally with LEED ‘winning’ the race to become the international standard (Mark, 2013). Nevertheless these two are not the only standards that are used with Green Star widely used in Australia and New Zealand, NABERS in Japan and Green Globes also in North America.

The question therefore is: can there be an international standard? Or more precisely, should there be an international standard for ‘green’ building? Surely there should be standards based on the location of the building taking into account the context in which it sits. An all-encompassing international standard would not allow for country specific guidelines, therefore these competing standards and certifications should only be used as guides to lead the designer and/or builder to make better choices based on the location and circumstances of the project.

2.3.2 Impacts of Standards
Criticisms of the standards have been widespread, the construction industry is big business and large corporations, who are threatened by the changes brought about by the Green Building Standards by challenging the status quo, has resulted in actions groups such as LEED Exposed. However, that exposure was backed by The Center for Consumer Freedom (Alter, 2014) who themselves are heavily criticised for being financially supported by tobacco companies as well as restaurant, alcohol and agribusinesses (Humane Society, n.d.); therefore any criticism must be taken with a hint of skepticism.

The positive impacts of these standards have been to increase the availability of technology used with buildings and in the industry of developing the technology – hi-tech or lo-tech. An example of this is in Israel, where there is now a regulation that requires all new homes to be built with solar water heaters, the result of this has been a burgeoning of a solar water heater manufacturing industry and, in a competitive market, the prices have been driven down to a level where solar water heaters are now considered a reasonable cost to be used for retrofitting existing houses (Vale & Vale, 2002a). This can be seen as a win for greener building standards and the free markets.

An analysis of all the various Green Building Standards along with their benefits and criticisms would be a thesis of its own. This section was to highlight the ‘top-down’ aspect of the building industry in counter to the more ‘bottom-up’ angle that this thesis will approach, with the do-it-yourself spirit of Walter Segal.

2.3.3 Beyond the standards
Standards identified above are all focused on the construction, occupation and in some cases the demolition of a building, but maybe there is more to sustainable housing? Green Building Standards are also starting to look beyond the building as a single unit towards the building as an element within a community. BREEAM, in 2012, have introduced
an assessment method called *BREEAM Communities* to be implemented in the ‘masterplanning’ process of large scale development projects with the aim of including social, environmental and economic sustainability in the larger housing projects (BREEAM, n.d.).

This can be seen as catching up with popular academic thought. In their book, *The Whole Building Handbook*, Varis Bokalders and Maria Block state that sustainable buildings must have a broader approach to include the environment, people’s health and social well-being throughout the lifetime of the building. Figure 7 shows a tree that describes their idea of *Building Ecology*, a check list that provides a designer with a holistic perspective when planning and building arguing that with an understanding of the different parts and interconnections, the designer will have a comprehensive and integrated approach to the design (Bokalders & Block, 2010, p xi).

Architects, Brenda and Robert Vale argue that sustainable housing should also be flexible and adaptable to meet the needs beyond the time of its construction (Vale & Vale, 2002b, p 55) and Peter Graham, a Doctor at the University of New South Wales identifies a “sustainable building is not one that must last forever, but one that can easily adapt to change” (Graham, 2002, p 7). To last and function as a building, housing of today should be constructed with flexibility built into the design; to allow the users of today and users in the future to modify the building to meet their needs beyond the first level of Maslow’s pyramid.

As mentioned before with the *Miljonprogrammet*, aesthetics are important to any building.
Creating buildings that are beautiful is an important factor in long-term desirability and therefore sustainability.

Sustainable buildings must also have a hand in shaping a more sustainable life, this is meant by living more sustainably and within ones means, but also by providing a healthy environment in which to live. For a building to be designed to draw upon the local resources available for power, water and warmth and the occupants be restricted to these, then could a building be considered no longer destructive but sustainable? As Barbara Jones, a home builder in the UK puts it: “The essence of sustainability is to use what is enough, and no more.” (Jones, 2009, p 20)

Sustainable buildings have been called “an ever evolving target” (Dutil et al., 2011), autonomous housing could be the step beyond the current building standards and take buildings from ‘green’ to the ‘essence of sustainability’.

2.4 Autonomous Housing

The word autonomous has many connotations and it can be hard to define in relation to housing; where do the boundaries of autonomy lie? John Christman, a Professor of Philosophy at Penn State University discusses autonomy in the traditional sense of individual autonomy saying that “the capacity to be one's own person, to live one's life according to reasons and motives that are taken as one's own and not the product of manipulative or distorting external forces.” (Christman, 2011) When reflected upon and applied to buildings, a single autonomous house by this definition, would satisfy the buildings functions and those of the user(s) suggesting an off-grid building with no relation to it’s neighbours or external connections to it’s surroundings.

The idea of the ‘autonomous house’ was first suggested by architect Alexander Pike in 1974 (Chen et al., 2009) and the choice of the word ‘autonomous’ when talking about housing is discussed in the book The New Autonomous House written by architects Robert and Brenda Vale; their conclusion is that although it may not be the best word to describe the homes that we are after, offering ‘self-sufficient’ or ‘self-governing’ as alternatives; however the word ‘autonomous’ has caught on and become “common parlance” when discussing buildings that have no inputs other than those gained from the environment in the immediate surroundings (Vale & Vale, 2002b, p 10).

For the purposes of this thesis I will defer to the definition of Robert and Brenda Vale, when it comes to discussing an autonomous house, who say that:

“An autonomous house has to depend on the resources that can be collected on its site, and the technology that it uses to harvest these resources needs to be simple, robust and controllable by the occupants. Only in this way will the inhabitants of the house gain that sense of control which will allow them to use their share of the Earth’s resources sensibly.” (Vale & Vale, 2002b, p 41)

This definition correlates well to the ‘essence of sustainability’ suggested by Jones and brings up an interesting point. The behaviour of how we live in the modern world is based upon infinite resources perpetuated by the homes we live in. Modern homes are designed so that we distance ourselves from the services we require to support a comfortable home. As the Vales put it: “In the autonomous house, resource depletion begins at home” (Vale & Vale, 2002b, p 39)
2.4.1 Versus Standard Housing
What separates an autonomous house from the ‘standard’ house is:
- Maintaining a level of independence from the centralised systems of electricity, water and sanitation by using the available resources on site.
- Allow occupants to control the level of resources required to provide a comfortable way of life whilst using their share of the Earth’s resources sensibly.

The limits set by the environment in which an autonomous house sits “will not be able to provide the same level of service provision as a conventional house” (Vale & Vale, 2002b, p 38). For a sustainable future, houses must be designed for their location and people must be willing to live within the limits provided by the natural environment. It is pointless to design a home with technology that meets the level of services currently provided in a ‘standard house’ as these are not sustainable in the long-term future.

2.4.2 Earthships
In their book the Vales conclude that they have designed and built an autonomous house not the autonomous house (Vale & Vale, 2002b, p 190) this is in contrast to Michael Reynolds who has developed, over nearly 40 years, what he deems to consider as the autonomous house – an Earthship. On their website Michael Reynolds and the team behind Earthships believe that they have “developed a fully independent home that provide[s] shelter, utilities and food, that could be built with recycled materials found anywhere in the world and costs much the same as a conventional home” calling their generic model the ‘Global Model Earthship’ “[t]he most versatile and economical building design in the world.” (Earthship Biotecture, n.d.)

Having been to a 3-day conference with Michael Reynolds I can say that he is not one to mince his words and will use hyperbole to promote the benefits of the Earthship concept. In his first book Earthship: Volume 1 published in 1993, there are more humbler words when he talks about the concept of the Earthship as a step in the direction of a vision of “realigning ourselves with the processes of the planet and re-evaluate our concept of living.” (Reynolds, 1993, p 21) Again the idea of changing our behaviours and habits towards the resources available resulting in living ‘lean lifestyles’ is key to the concept of more sustainable living with autonomous housing, concluding that “As we “lean” our lifestyles toward what the Earthship can provide, we evolve the Earthship toward what we need. Someday we will meet.” (Reynolds, 1993, p 24)

Although influential in developing my own thinking of how we live and alternatives to the systems we need to provide us with a level of comfort needed in the modern world my problem with Earthships are the materials that they use. I am not against the fact that they are a buried structure, or that they are primarily built with used car tyres, but there is a lot of foam insulation required to wrap the whole house and insulate it from leaking the heat gained using passive solar into the earth berm that surrounds it. There is also a huge amount of concrete and cement used as well as aluminium cans to fill in the gaps created by the car tyre walls and to build internal walls. Since the conception of Earthships, there is now more access to recycling of aluminium cans, there are now better grades of concrete available in certain locations but there is still no natural insulting material that provides adequate insulation from the earth berm without degrading over time.

In principle and scientifically I do not doubt that an Earthship could provide a comfortable home with minimal or no reliance on infrastructure anywhere in the world but the cookie-cutter ‘Global Model Earthship’ is missing the point. Throughout the world there is variety;
the context in which a house sits is missing from the Earthship concept, the local cultural elements: aesthetics, ceremonial and social that would need to be taken into account in any house that should be considered when designing any building.

“If we are to design [housing] which won’t backfire in the future, it must be looked at on a mass scale.” (Reynolds, 1993, p 23) However, the most crucial aspect of designing a house, particularly an autonomous or near autonomous house, context is the biggest factor. Creating standardised housing reliant on centralised systems and placing them wherever we want is part of the problem with today’s housing stock.

2.4.3 Limitations of Autonomous Housing
As discussed the context in which any building sits is vital to the design. More often than not, and with all examples of Earthships that I have seen is that they are remotely located away from centralised distribution places for water, electricity and waste collection. While placing an autonomous house in the middle of the city may not be the right choice, there are existing electrical grids to tie into, existing water and sanitation systems. There could also be issues with generating enough electricity; there is also the consideration of scale: can an autonomous building provide enough water, generate enough electricity and deal with the waste of more people than a small family?

Also called into question of ‘green’ homes is the ‘rebound effect’: the financial saving due to energy efficiency of buildings could lead to that money being spent elsewhere negating the effects of reduced carbon emissions at home. (Bourrelle, 2014)

2.5 Concluding Remarks
This background research could have gone in many different directions and delved deeper into certain aspects, particularly the Green Building Standards, however the aim of this section is to give the reader an understanding of the importance of shelter and the need for our buildings to become more sustainable. It calls into question the current thinking of ‘green’ buildings bringing in the idea that autonomous housing could be a step beyond the improving standards and to look at the building in its context in terms of resource availability.

The next section of this thesis will look at the methodology used to build upon this background knowledge and help answer the papers research questions:

- Is an autonomous house possible in Sweden?
- And can one design build an autonomous home in the spirit Walter Segal?
3 Methodology
In this section I will outline the methodology used for this thesis.

3.1 Case Study Methodology
Case study methodology bridges the gap in the social sciences between qualitative and quantitative methods (Johansson, 2005, p 38). In general, case studies are the preferred strategy when it comes to asking the ‘how’ or ‘why’ research questions with a focus on ‘real-life’ in a defined context (Yin, 1994, p 1) or a bounded system that may be a physical setting, or a social, historical and/or economical setting for the case (Creswell, 1998, p 61).

These ‘how’ and ‘why’ questions deal with operational links needing to be traced over time, than mere frequencies or incidences (Yin, 1994, p 6) allowing for case study research to be completed over an expansive amount of time and taking in more than a singular methodology. Therefore, the essence of a case study, as described by Rolf Johansson a professor at KTH, is “the triangulation, the combination on different levels of techniques, methods, strategies, or theories” (Johansson, 2005, p 38).

Case studies are often said to take too long and produce overly long reports (Yin, 1994, p 10), Johansson argues in his paper On Case Study Methodologies that the “context of design and the context of use may be separated in time, but are often equally important to understanding the case of an artefact.” (Johansson, 2005, p 33)

Therefore any understanding of the case requires longer periods of research, meaning that the design for this case study will only be understood after three or four years of study and research of the performance of the finalised design. From this, we can say, that this thesis is the starting point for a longer study of understanding the final design in context to its surroundings and through its use with potential for further reporting.

Maybe this extensive period of time, over which a case study takes places gives rise to the thoughts promoted by Creswell in his book Qualitative Inquiry and Research Design, of a ‘Rhetorical Structure’ where a case study should have a more personal feel to it including a background of the researcher and how he/she identifies to the research ending with a more personal conclusion of “reminding the reader that this report is one person’s encounter with a complex case” (Creswell, 1998, p 187). Creswell also recalls Stake’s 20 criteria for assessing a good case study report with criterion number 16 as “Is the role and the point of the view of the researcher nicely apparent?” and criterion number 19: “Are personal intentions examined?” (Creswell, 1998, p 214). This strategy could be to counter the argument by Yin that a case study can be too easily influenced by the researcher(s) (Yin, 1994, p 9). By providing the reader with the position of the researcher they are allowed a more transparent view when it comes to any potential bias drawn in the conclusions.

Another common concern regarding case studies is the ability to draw scientific generalisations however Johansson argues that generalisations from case studies are “not statistical, they are analytical. They are based on reasoning” (Johansson, 2005, p 36). Having more than one case within a case study could help with generalising but as Creswell points out “…the more cases an individual studies, the greater the lack of depth of any single case” (Creswell, 1998, p 63). By allowing multiple cases within a case study you are diluting the results with a lack of understanding and over generalising before you reach a conclusion.
As Yin describes it, a case study methodology is an “all-encompassing method” (Yin, 1994, p 13) and is one suited to subjects linked to sustainable development an area that requires more holistic, multi and trans disciplinary thinking rather than methodologies suited to single discipline research.

This thesis, using the Case Study methodology is to explore the idea of building a house, a home for a small family who are able to live comfortably and sustainably in the house around the year, with minimal negative impact on the environment. The house should be designed to be as near autonomous as possible with minimal reliance on large infrastructure and designed with materials that can be bought from local retailers and can be re-used or recycled when/if the building’s life comes to an end.

For this particular thesis, the subject lends itself to the case study methodology as argued by Johansson that in the “practice-orientated fields of research, such as architecture and planning, the case study has a special importance. The ability to act within professional practice is based on knowledge of a repertoire of cases. These cases are based either on personal experience or are model cases established within the profession. Case studies contribute to the building of a professional repertoire” (Johansson, 2005, p 32).

3.2 Concluding Remarks
Although there is no standard format to case studies (Creswell, 1998, p 186) I have hopefully given the reader a background on the thesis topic, motivated why such research needs to be done and provided a clear aim and purpose of the thesis. The following sections will set out the context of the case study and apply a personal story to the research. Later, in the summary of the thesis, I will provide some generalisations from the findings and define scenarios for future research to expand and round out the case study to provide the ‘operational links’ of the usage and maintenance of the final design.
4 Case Study Description
As I have established, there is not one solution for a building design that fits all locations and climates; all buildings should be designed within the context in which they sit. Taking that and leading on from the Case Study Methodology I will define the context of the Case Study, outlining the location and geographic influences on the case, what existing systems are available and finally, describing which new systems are required to support a comfortable and sustainable lifestyle year round.

4.1 Purpose
This case study is based on a personal need. I will be finishing my studies soon and have already started to transition into the workplace. My girlfriend and I would like to stay in Uppsala for the foreseeable future. However, the issues highlighted at the beginning of this thesis – lack of affordable housing due to high demand based on the ‘Monstrous Hybrid’ of regulation and free markets has reduced our financially viable options. We’ve lived in Uppsala for three years and have always had a second-hand contract. We are still significantly low on the queue list for houses provided by Uppsala Kommun (the local municipality) and with the loss of our student status at the end of the semester our queue position for student housing is no longer relevant.

Reflecting back over the past few years, I have developed a strong interest in sustainable homes and have come to realise the importance of creating places to live that have a limited impact on the environment – both local and global. This was an opportunity for us to explore some of the ideas I had been researching and to create a showcase home that could be used as an example that hopefully inspires others into taking action themselves.

Before describing the case I would like to remind the reader of the requirements set out at the end of the Methodology section, I stated that this thesis was to:

“...explore the idea of building a house, a home for a small family who are able to live in the house around the year, with minimal negative impact on the environment. The house should be designed to be as near autonomous as possible with minimal reliance on large infrastructure and designed with materials that can be bought from local retailers, that can be re-used or recycled when/if the building’s life comes to an end.”

This, in effect, is the design brief or framework for this thesis and the basis for the case study.

4.2 Site Description
Located at the southern edge of Uppsala on the east side of the Fyrisån river and opposite the Ultuna campus of the Swedish Agricultural University (SLU) (see Figure 8), Nåntuna-Lund is an old grove that botanist Carl von Linnaeus is said to have described as beautiful and unlike any other groves in the Uppsala region. The area is scattered with dense hazel bushes, old growth oak trees and to the north-east corner graves dating back nearly 2,000 years (Länsstyrelsen Uppsala Län). The area is now a nature reserve and part of the ‘Linnéstigar’, a walk in the

Fig 8: Location of case study in relation to the city of Uppsala (Original image taken from eniro.se). Approx. scale: 1cm = 2.5km
footsteps of Uppsala’s iconic botanist Carl von Linnaeus. To the south of the grove is a group of 7 plots each with a ‘Fritidshus’ – a vacation home or ‘Summer Stuga’.

These plots of land in Nåntuna-Lund are owned by SLU, therefore the contract holders of each plot only maintain control over the buildings on the land but not the land itself. Contracts are agreed between SLU and each owner individually and are on a 5-year rolling basis.

Seeking to explore the alternative option of building ones own home, my girlfriend and I have gained access to one of these plots of land. We were fortunate to hear of this opportunity through a friend and spoke to the current owner before he had placed it on the market. We bought the contract rights in April 2014. The contract for the location of the plot of land within this thesis stipulates that there is a rental fee for the use of the land per year.

The plot that the basis for this case study is the third plot you come to as you come along the access road that lies off of the main road Hemslöjdsvägen (see Figure 9). The plot is approximately 900m² in total, sloping from an elevation to the east of 21m above sea level down to 15m above sea level at the western edge of the plot (see Figure 11). A public access road continues to run along the western side of the plot and is primarily used by horse riders, dog walkers and those out to enjoy the scenery. This access road is also suitable for vehicle access and is the main access route to most of the plots, it is a dirt road that is to be maintained by all who own and use it – it is not the responsibility of SLU to maintain the access road. To the east the plot backs up to woodland dominated by willow and hazel, to the south and to the north lie the neighbouring plots with trees and bushes marking the borderlines.

The view to the west is across agricultural land, to the Fyrisån River and the buildings in Ultuna. The river, the nearby wetlands and the grove create an important habitat for migratory birds (Upplands Ornitollogiska Förening, 2012), with the area along the river considered a protected nature reserve. See Appendix A for pictures of the area.
4.2.1 Existing Buildings

There are a total of four buildings on the plot. Central to the plot is the Main Stuga. Built in the 1950’s it measures 5m by 5m. A small toilet cubical (less than 1m2), included in the 25m² but outside of the main building has been added at a later stage, a floor plan for the existing Main Stuga is shown in Figure 10. The existing Main Stuga is built upon concrete filled metal tubes at the west with large rocks forming the foundations for the north, east and south walls. A large veranda measuring a further 5m by 5m has been recently added. Steps wrap around the veranda to provide access to the veranda and the main building (not shown in Figures 10 and 11).

To the east and up the gentle slope of the main building are two buildings 2.5m by 5m. The older of the two is a storage room and sauna, however the roof has not been maintained and has deteriorated to the level where it no longer provides a suitable weatherproof shield for the walls and floor. The newer building of the two is a small guest room, that lies closest to the woodland is structurally sound and weather tight. Both buildings sit on concrete blocks.

The newest building lies closer to the main building and is the southernmost building. It is a playhouse of 2m by 2m and simple construction (see Figure 11).

See Appendix B for pictures and more diagrams of the plot.
4.2.2 Existing systems

At the moment the buildings could be seen as semi-autonomous as there are connections to the electrical grid while the Playhouse is the only building having no electrical connection. There is no water available on the plot, heat to the buildings is supplied using electrical heaters and greywater is disposed of on site. The waste from the small chemical toilet is taken away and disposed of at an appropriate site. General waste from food packaging or compostable waste is removed from site and disposed appropriately (see Figure 12).

Figure 12: Existing Main Stuga Services. The supply of services is near autonomous, but the waste products generated are heavily reliant on communal sites far from the case study plot.

These water, power and waste systems currently there are typical for the buildings used as a summer house for the area and suit a certain minimal usage lifestyle, however this thesis is looking at changing how the buildings will be used and appropriate water, power and waste systems will be needed to meet the requirements of the new lifestyle.

4.2.3 Cultural Qualities

As previously mentioned, there are strong connections between the plot and the environment around; with the woodland surroundings, birdlife sanctuary and nature park all having an impact on the visitor to the area. Two graves dating back 2,000 years are situated north east of the plot in this case study, are represented by an unbroken circle of small stones similar in size to those found elsewhere related to this period of time.

Minimising the negative environmental impact whilst maintaining the cultural aesthetic of the area will be important when re-designed the Main Stuga.
4.2.4 Climate Qualities
With basis of this thesis looking at the site holistically we must take into account the impact that the climate will have on the design but also what resources are readily available.

4.2.4.1 Water
As part of the Nåntuna-Lund area there is a well that supplies fresh drinking water from a local source. This is accessed 10m north along the access path of the case study plot via a hand pump. However this supply is only available during the warmer months with the hand pump removed during the time when it is likely to be below freezing – typically from October to April.

The alternative option of gaining water for the site is by harvesting rainwater. Although there is no official precipitation statistics for the exact plot in the case study there is a weather station located at Geocentrum, part of Uppsala University that has maintained precipitation records for the area since the 17th Century (Bergström, n.d.). For this case study, I will be using these statistics for the case study plot, and Figure 13 shows the average precipitation in Uppsala for a 30 year period (Institutionen för Geovetenskaper, n.d.).

Apart from precipitation and any water gained from this, there is also an alternative source of water. The plot that lies directly to the south of the case study plot has its own well that supplies the main building on this plot with water all year round and is suitable for drinking.

![Average precipitation in Uppsala between 1981-2010](image)

4.2.4.2 Temperatures
Similar with the precipitation statistics, the average temperature in Uppsala can be found at the weather station at Geocentrum. Figure 14 shows the average temperature in Uppsala from 1981-2010.

![Average temperature in Uppsala between 1981-2010](image)
The site itself is quite shaded; there are large spruce trees on the edges of the plot as well as oak that could reduce the amount of sun available for solar harvesting.

Given its global location, the movement and positioning of the sun position changes dramatically in Sweden from summer to winter and this movement will have an effect on the design of the building to ensure that the building remains cool during the summer but still takes advantage of the sun during the winter months. Figure 15 shows the solar path for 21st June (yellow line) and 21st December (black line). More images of the solar movement for the site can be found in Appendix C.

![Fig 15: The suns movements over Nåntuna-Lund. The yellow line is the movement of the sun on 21 June, the longest day of the year. With the black line the movement of the sun on 21 December, the shortest day of the year. Not shown here is the elevation (see Appendix C) that further illustrates the stark contrast in the suns movements and therefore daylight hours from June to December. (Solar positions and image from SunEarthTools.com (SunEarthTools))](image)

### 4.2.4.3 Wind

More exposed towards the south and west the site is particularly susceptible to windy weather during the winter months when the shelter offered by the deciduous trees is reduced.

### 4.2.5 Social Qualities

With the more physical aspects of the climate and the existing buildings described, some of the ‘softer’ aspects of living should be considered, those that appear higher up in the Maslow Pyramid.

One of the best aspects of this plot for us was the location: close enough to the city of Uppsala but far enough away that, particularly given the surroundings, feels like living in the countryside. With the cities’ increasing population and the housing demand mentioned at the start there is pressure for Uppsala Kommun to expand the city limits.

The Fyrisån River cuts southern Uppsala in two with bridged connections at the very southern tip of Flotsund and industrial area of Kungsängsgatan creating an air of calm and peacefulness at the location, away from noises and distractions of automobile traffic. However, there are
ongoing discussions about connecting the two sides of the river together with either one or two bridges very close to the case study location. This is to facilitate traffic from the suburbs of Gottsunda and Sunersta on the west side of the river to the proposed new train station south of Uppsala in the nearby suburb of Bergsbrunna on the south-eastern side of Uppsala.

There are some social implications to us moving to this area, we are younger than most of the other residents who live and use and maintain the private areas, however the public area of the woodland attract people of all ages and we hope that by living there all year round we will improve the community feel and add a sense of security to those who don’t visit their plots regularly. This could have negative effects as it may open up the area for potential development; at the moment this area is outside the Detailed Plan of Uppsala Kommun meaning that there is no plan to expand the nearby suburb of Nåntuna towards Nåntuna-Lund.

4.2.5.1 Transport
As mentioned, the main access to the plot is using the dirt road that runs alongside the western edge of the plot. There is also a private footpath that leads from the south-eastern corner up to the woodland that is shared with the neighbour to the south giving good access to the public transport links to Uppsala with buses leaving every 20 minutes from a bus stop that is a short walk from the plot. However, our main transportation within the city is by bicycle and there are good bicycle paths that lead all the way into town. A journey from the plot to the center of Uppsala by bicycle usually takes around 25-30 minutes.

4.2.5.2 Local Amenities
The nearest local amenities are an ICA Supermarket that can supply everyday needs. A little further away in the suburb of Sävja there is a smaller local convenience store, health clinic and library (see Figure 16). Also close by are vegetable allotments that act as social hub for a wide variety of people living in the surrounding area.

![Fig 16: Location of case study plot (red star) in relation to the nearest regular bus stop and local amenities. (Original image taken from eniro.se) Approx. scale: 1cm = 300m](image-url)
4.3 New Systems required
Returning to the ‘harder’ aspects of the physical world the next section will look at the systems required to fulfil the design brief: comfortable year-round living.

By identifying what is not available and what is considered basic human needs we can say that there is a need for the following at site:

Requirements for comfortable living:

<table>
<thead>
<tr>
<th>Existing Systems</th>
<th>New Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Electricity</td>
<td>• Regular water supply</td>
</tr>
<tr>
<td></td>
<td>• Heat Generation</td>
</tr>
<tr>
<td></td>
<td>• Wastewater disposal</td>
</tr>
<tr>
<td></td>
<td>• General waste disposal</td>
</tr>
</tbody>
</table>

Requirements for additional comfort:

<table>
<thead>
<tr>
<th>Existing Systems</th>
<th>New Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Telecommunications</td>
</tr>
</tbody>
</table>

4.4 Concluding Remarks
Through this section I hope to have provided the reader with a good understanding of the case study location, the challenges of building an autonomous house here as well as the importance of reinforcing the purpose of the thesis.
5 Analysis and Design Method - A Pattern Language

This section will look at the main design methodology used for the re-design of the buildings on the plot.

Released in 1977 by Christopher Alexander, Sara Ishikawa and Murray Silverstein from the Center for Environmental Structure of Berkeley, California, A Pattern Language was seen as a groundbreaking book in architectural design and has influenced the field of computer software design. Today A Pattern Language is seen as “probably the most informative book on architecture ever written”. (Kohn, 2002, p 31)

A Pattern Language is the second volume in a series of books written by Christopher Alexander during the 1970’s. The middle volume that is A Pattern Language comes between the body of work that includes The Timeless Way of Building and The Oregon Project. Although released out of sequence and over the space of four years this series of books were developed as a whole over an eight year period (Alexander et al., 1977, p ix) starting with the project work of participant-designed planning process at the University of Oregon. (University of Oregon, 2014)

Where The Timeless Way of Building is a theoretical book laying the foundation and understanding behind the pattern process and The Oregon Experiment shows how the theory could be implemented A Pattern Language is a more practical book that looks at the building blocks of the architectural language.

When the authors liken the use of the word ‘language’ as that used by poets “… is not that different languages are used, but that the same language is used, differently” (Alexander et al., 1977, p xli). Meaning that the building blocks required to build a community, to build a house are the same, but by using and overlapping these blocks in a complimentary manor develops a language of spaces. The building blocks become patterns, with patterns based upon an understanding of human and natural requirements. A pattern expresses a relation between a certain context, a problem, and a solution. (Kohn, 2002, p 26)

Never when reading the book will you end up with a single pattern to work with. The book demonstrates that you cannot build anything in isolation, you must take into account its role in the larger environment – does it improve or ‘repair’ the environment in which it sits? (Alexander et al., 1977, p xiii)

When it was published, A Pattern Language, as suggested by the authors, was an antagonist to the brutal and fragmented way in which we live (Alexander et al., 1977, p xvi). Each pattern is “alive and evolving”. (Alexander et al., 1977, p xv) The book implores the reader to make his or her own choices and not to follow the book like a how-to manual of good architecture and community development. The authors admit that the patterns are still hypotheses and are free for the reader to evolve the patterns in the book “under the impact of new experience and observation.” (Alexander et al., 1977, p xv) The authors believe that reading A Pattern Language is the first step in embarking on the construction and development of his/her own language. (Alexander et al., 1977, p xvii)

5.1 Description of Design Method

Using the book is logical. There are 253 patterns, the early patterns start from a very high level of town organisation and planning for communities and slowly reduce their focus (as the pattern number increases) to construction details of window sizes and material choices.
At the start of each pattern is a short paragraph stating which patterns earlier identified in the book could affect the pattern in question. Each pattern description ends with a paragraph for further patterns later identified within the book that will be affected by it. This layout of the pattern perpetuates the overlapping of patterns, finding complimentary patterns, as the authors state: “Each pattern can exist in a world, only to the extent that is supported by other patterns … and the smaller patterns which are embedded in it.” (Alexander et al., 1977, p xiii) By leading the reader through the book with this pattern format, the reader gains an understanding of the interconnections and transitions of spaces, basic human behaviour and interaction between us and with nature – the reader creates their own ‘pattern language’ for the space and design they are working on.

Each pattern is based on a problem. This problem is stated in a short sentence, followed by discussion – the bulk of the text related to each pattern often with scientific research to support the arguments and concludes with a suggested solution. This simple problem-solution format intends for the readers to judge the pattern for themselves and “modify it, without losing the essence that is central to it” (Alexander et al., 1977, p xi).

To use the book, the reader finds a pattern that best describes the project they are working on. Using this as a starting point, the reader works their way through the patterns related to that starting pattern, picking up further patterns that relate to further patterns. The reader decides, after reading a pattern whether this pattern is suitable to their project. This continues until the reader goes through the book and has decided that there are no more patterns suitable to their project. The book has been organised so that the reader always moves from larger patterns to smaller patterns, “always from the ones that create structures, to the ones which then embellish those structures, and then to those which embellish the embellishments” (Alexander et al., 1977, p xviii).

For example, the pattern that best describes the design brief for this case study is the pattern ‘House for a Small family (N°.76)’. At the end of this pattern, after the conclusion, the patterns related to this pattern are:
- Your Own Home (N°.79)
- Common Areas at the Heart (N°.129)
- Couple’s Realm (N°.136)
- Children’s Realm (N°.137)
- Bed Cluster (N°.143)

After reading those patterns and agreeing which patterns to include in the project the reader is then directed to look at further patterns. Sometimes patterns refer back to previous patterns creating a web of patterns and possibilities that lead the reader forwards and backwards; the interlinking patterns direct the reader towards a better understanding of the project they are working on and gaining an understanding of the impact that the project will have on those that use it and the environment around in which it sits.

This book is not written for architects, there are no specific technical details, no scientific formulas, it can be picked up by anyone who will be involved in (or affected by) a project related to the built environment as it gives the reader a better understanding of the relationships between the built environment, human behaviour and the natural environment.
5.2 Results of Method

I used this design method for rethinking how the Main Stuga would function and relate to the buildings around it: its context. There are quite a few patterns that relate to the surrounding area within the limits of the plot, however most of the patterns used focused on the Main Stuga.

Looking down the list of patterns towards the beginning of the book I chose to start at pattern ‘House for a Small family (N°.76)’, this pattern best described the design brief stated earlier. I read through remaining Patterns of the ‘Towns’ section and most of the Patterns within the ‘Buildings’ and ‘Construction’ sections, noting down which patterns related to the Main Stuga and the surrounding buildings. Where patterns did not apply to this project, I noted down and considered these patterns a ‘dead-end’, a stopping point, in regards to this case study. In the end I had read through 160 patterns deeming 95 to be appropriate to the design brief.

<table>
<thead>
<tr>
<th>Section</th>
<th>Pattern N°.s</th>
<th>Read</th>
<th>Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Towns</td>
<td>1-94</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Buildings</td>
<td>95-204</td>
<td>102</td>
<td>59*</td>
</tr>
<tr>
<td>Construction</td>
<td>205-253</td>
<td>47</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>160</td>
<td></td>
<td>95</td>
</tr>
</tbody>
</table>

I also included one other pattern – “Radiant Heat (N°.230)’ – that was not a suggestion from a previous pattern. Having read this pattern independently from the process, I thought that this pattern suited what the case study was trying to accomplish; the Pattern talks of large masses that can absorb and store heat, later radiating it when the air temperature is less than that of the mass. This suits and compliments the heating system requirements of the home (see section 6.3). Appendix D shows the patterns that I read with my thoughts on whether they were applicable to the project with some notes and thoughts on the pattern.

With the patterns that I deemed suitable for the design brief selected, I started to implement them into the design. At first with each pattern in isolation and latterly applied it to the scope of the case study for the best possible outcome based on that particular pattern. A selection of these individual pattern designs is shown in Appendix E.

Once this was done, an amalgamation of these ideas were completed in a final design for the case study. The design results will be discussed later in the thesis (Section 7).

5.3 Critique of A Pattern Language

Christopher Alexander is one of an emerging generation of radical and innovative planners. However his work, particularly A Pattern Language has not been included in US architectural undergraduate and graduate programs for 15 years. His critics have dismissed him as “a Utopian, a messianic crank, and a contrarian who produces words instead of buildings” (Kohn, 2002, p 27). You wonder having read a short biography of Christopher Alexander by Kohn, that the man has ruined his own work. He has a reputation of “fits of anger, showers of insults, and storming from rooms when opposed” and his writing “unbearably condescending to practitioners who take pride in having invented some of their own solutions to the problems of architecture.”
His actual buildings are few and far between, for a career that has spanned over five decades there is little to show for it and due to this, as Kohn nicely puts, “his ideas will remain pristine, whole, even beautiful, and on the printed page only.” (Kohn, 2002, p 34)

In the publication, *Timeless Citylands*, Per Berg discusses that A Pattern Language “…was missing was typically a great number of physical aspects on e.g. energy, water or material management” (Berg, 2010, p 27). This could have been that it was written by traditional and landscape architects who wanted to maintain a common theme through the three books and dared not venture into the fields of resource supply and waste management.

5.4 My own experiences
Having gone through the process of identifying a starting point and following the instructions as the book intended I feel that the eventual building design is much more in tune with the human behaviours and the environment around it. However I found it easy to continue to add spaces – spaces for adults and separate spaces for children. The book did not question the use of mixed-use spaces as are popular in modern design.

Based on this experience and working with other projects its safe to say that, before starting to use this book you need to have a fixed scope, it is too easy to include all patterns within your project. Having some boundaries or definitions to the project’s limits will allow the reader to limit and simplify the final design.

Earlier I talked of a web of patterns as certain patterns reoccurred throughout the book with some patterns probably referred to by other patterns four or five times, some patterns such as Seating Spots (No.241) were referred by other patterns more partly because it comes so late in the order, but it highlights that some patterns could be more important.

Although some of the Patterns are out dated – there is a heavy reliance on concrete in the ‘Construction’ section, but most of the Patterns – problems set out by Alexander and his team - are still relevant to the design of a house designed around human needs and functions.

5.5 Concluding Remarks
Many of the other books that I have read for this thesis have mentioned *A Pattern Language* and the process that it guides you through as an ideal place to start when thinking about designing and building your own home. The ideas and patterns within the book resonate with many aspects of ‘green’ or ‘sustainable’ building practices that are heralded in modern times. I will discuss the results of this design process in the ‘Design Results’ section and touch on it again during the ‘Discussion’ section later.
6 Systems Design & Integration

The previous section looked at the design of the home, the interlinking web of patterns that provide shelter. In this section I will look at the supporting systems that will provide the level of comfort for a modern lifestyle: water, heat and thermal insulation, electrical, landscape, waste, materials, and aesthetics. A brief discussion is also given on legalities associated with the planning and permitting processes relevant to these supporting systems proposed for the home.

This section will question the viability of an autonomous house in Sweden. As discussed before, an autonomous house has to depend on the resources that can be collected on its site, and the technology that it uses to harvest these resources needs to be simple, robust and controllable by the occupants.

Having more than one supply of resources will enhance the resilience of the building, solutions that provide all or part of the required resources will be looked at in this section. The result being a multi-faceted solution, more complicated but more resilient and capable to adapt to changes. As this is a fairly experimental design, given my experience and limited knowledge of applying some of these solutions to Sweden, creating a resilient design would benefit the occupants in the long run as well as help my own personal development.

6.1 Water

Historically, the supply of water provided no incentive to limit water; creating reservoirs and inter-basin transfers have provided solutions to increased demand but, in turn, this has led to excessive abstraction from ground water, rivers and lakes (EEA, 2009, p 6). The autonomous house aims at cutting off municipal ties to water collection and treatment systems.

As previously mentioned there are a few options for supplying water to the new Main Stuga. Here I will evaluate the options identified and later provide a conclusion on which system or combination of systems would be best suited.

6.1.1 Water Requirements

There will be significant change to the water requirements given the change in building design and usage. Going from a seldom-used place in the summer to a year-round home that should cater for a small family, there will be a greater and constant demand for water.

Figure 17 is taken from the Whole Building Handbook and shows average requirement per person per day of water and where it is used within the household. These figures total 215 litres, another study in Sweden carried out in 2007 looking at water usage in eight typical homes produced an average water usage of 211 litres and this study excluded water used for flushing toilets and washing clothes (Johansson et al., 2007). From these figures we can conclude that there is a large domestic water supply requirement in Sweden.

By including waterless solutions we can significantly reduce the demand. A good example for this is by having a ‘dry’ toilet i.e. a toilet without a flush. By using a compost toilet we can eliminate the need of 40 litres per person per day, Fig 17: Average household water use from Whole Building Handbook, page 320
14,600 litres per year – a significant number and add further benefits which I will discuss later.

6.1.2 Water Supply
For such a basic need as water it is good to have many sources, bringing an inherent resilience to the overall design.

6.1.2.1 Rainwater Collection & Filtration
Rainwater is often seen as a good supply of water for purposes that don’t require drinking quality water (Villarreal & Dixon, 2005) also known as potable water. However, with a series of filters to remove fine particles and UV filters to remove bacterial particles, rainwater can be used for drinking and can be stored for a longer period of time (Naddeo et al., 2013).

Although it has been found that the measured inorganic compounds in the rainwater harvested from most rooftop catchment systems generally matched the WHO standards for drinking water (Helmreich & Horn, 2009), rainwater is rarely fit for human consumption over urban areas. On the way down the rainwater is polluted by the particles in the atmosphere and those on the roof surfaces. Once on the roof of a building, in particular at the initial stages of rainwater run-off from rooftops, the rainwater collects organic material and dust particles that contaminate the water further (Yaziz et al., 1989; Helmreich & Horn, 2009). The early filtration stages of the screen on the guttering cuts out the larger organic particles such as leaves; and the ‘First Flush Filter’ works by immediately disposing the initial rainwater run-off that collects the bulk of the organic material and dust therefore removing these contaminants from the system completely, flushing it out. After the initial rainwater, the remaining rainwater is then diverted to the first filtration stage (Yaziz et al., 1989).

Once the larger organic material has been removed, the rainwater is then filtered further often using a slow sand filtration; these sand filters are improved with vertical depth, allowing more time for the water to trickle through the sand particles. A study in Gotland, Sweden proposed sand with a 1-2mm diameter, however the results of this study called for a finer sand to improve filtration (Herbert & Erikson, 2009). Another study used a sand of 0.30mm for a successful implementation of a slow sand filter for horticultural purposes (Calvo-Bado et al., 2003). Over time a thin biological layer or biofilm, forms on the top surface of the sand filter that improves the filter by adsorbing heavy metals, organics and pathogens from the water (Villarreal & Dixon, 2005; Helmreich & Horn, 2009).

After the sand filter, any organic material should be removed and the filtered rainwater is good enough to store for a certain period of time. To avoid any stagnation it is advisable to have a circulation pump that moves water around the tanks and also to have an intermittent flow of water in the slow sand filter to maintain a level of moisture in the sand filter and keep the biofilm from dying out (Calvo-Bado et al., 2003).

To treat rainwater further for human consumption, Chlorine is typically used (Helmreich & Horn, 2009), however the use of chemicals is an unwanted and a less resilient design. Solar radiation has also been shown to remove bacterial contaminants (Helmreich & Horn, 2009), however this option may not be suitable for Sweden given the need for constant solar radiation. Membrane or Charcoal filter as well as UV filters are readily available and are low maintenance, demand a minimal amount of electricity to operate, fit into standard plumbing fittings and can provide on demand filtration if needed. There have been studies that have proved that rainwater run-off has an acidic pH value lower than expected and therefore rainwater should be check regularly and corrected to ensure quality (Yaziz et al., 1989).
Figure 18 shows a typical example of a rainwater collection, storage and filtration system.

6.1.2.2 Communal Water Pump
The communal water pump is managed by one of the residents. It is removed based on the temperatures falling below freezing over night; this varies year to year, but typically takes place in October. The pump is restored for all to use when there is no chance of negative temperatures, again this varies from year to year, but is typically around April. This basically means that the water from this source is cut off for 6 months of the year.

A pipeline could be drawn off the mainline leading to the hand pump with an electrical pump to provide the pressure required to move the water up hill (around 4m). A trench would have to be dug from the Main Stuga down the slope and under the access road to keep the pipeline and electrical cable for the electrical pump safe from accidental and weather damage.

6.1.2.3 Wells
In the contract we have signed with SLU, it stipulates that we cannot dig our own well to provide our own water supply. However the neighbour has a well that supplies their Main
Stuga with enough water for their daily needs. Part of the water is filtered to a level deemed suitable for drinking.

The well is located nearer the Main Stuga, is higher up the slope than the communal well (see Figure 19).

**Fig 19: Location of the two wells in relation to the Existing Main Stuga. The communal well is located further down the access road and lies at 4m lower elevation than the Main Stuga, this is operated by hand pump that is removed for the colder months. The other well is the one located on the neighbour’s property and supplies their house with water; this is filtered for washing and showering with some further filtered for human consumption. This well lies at approximately 1.5m lower elevation than the Main Stuga. For scale purposes: Main Stuga width is 5m.**

6.1.3 Water Storage

From reading articles, reports and books on rainwater collection systems and water storage tanks it is clear that the intended end purpose of the water, and therefore the quality, drives the quantity required for storage. For simple rainwater harvesting to be used in the garden the UK Environment Agency recommend that tank sizes should be 5% of the total annual rainfall (EA, 2010, p 8); whilst the Vales, in their autonomous house had a series of water storage tanks totaling 30,000 liters that, when full would supply 150 days of water without rainfall.

In a report on rainwater harvesting in the US, the authors concluded that there is “a diminishing return of added storage capacity” (Jones & Hunt, 2010). The sizing of the water storage tanks is a crucial factor as this is usually the most expensive item(s) in the water collection and storage system. The same report also calls into question the psychological impacts of seeing water tanks continuously depleted “may discourage overall use and negate any potential benefits as a result” particularly if there is municipal source of water available (Jones & Hunt, 2010).
As mentioned, water storage tank(s) are considered the single most expensive element of a rainwater collection and filtration system. In a study of rainwater collection systems in Barcelona, the report suggests that the chosen tank size could take 33 to 43 years to ‘pay-back’ the saving of collecting rainwater rather than paying the municipal water rate (Domènech & Saurí, 2011, p 603). This is understandable, especially as the report also discusses a survey showing that the ‘environmental benefit’ of rainwater collection systems rated higher (more positive) than the ‘economic benefit’ or the possibility of being ‘self-sufficient’. When it comes to water storage, care must be taken to provide an adequate enclosure to minimize contamination and prevent algal growth and breeding of mosquitoes (Helmreich & Horn, 2009).

6.1.4 Analysis of Water Systems

Given the findings from this section of research, a water supply is best sourced based upon its use meaning that there could be two or more water sources that supply various ‘grades’ of water depending on their use, there is no need to filter water to a purer state than needed. The negative temperatures in Sweden (see Figure 20) are also an issue for collecting and storing water without proper protection and insulation from the elements. Given the long-term negative temperatures the sand filter, along with all storage and other filtration stages, would have to be kept above freezing. A separate housing and potential heating equipment would be needed to maintain a good temperature level.

Given the issue of freezing temperatures reducing the ability to collect rainwater year round the best option would be to combine rainwater harvesting with a source of water that is already known to be reliable. Therefore the best option would be to take an underground line from our neighbours well and feed it underground in an insulated pipe to the water storage tanks. The underground line would require significant excavation and care would need to be taken near root systems of trees and bushes that denote the border between plots.

6.2 Electrical

The plot in this case study has an electrical supply from Vattenfall, the large part-government owned electricity supplier. Every quarter we receive a bill from Vattenfall that includes line rental and electricity supply based on our usage.

Although the point of an autonomous house is to be independent from non-renewable resources, particularly those produced in supplying electricity, this thesis will not look at the option of disconnecting from the electrical grid and generating our own electricity. Although the technology of photo-voltaics (PV) is improving every year; solar panels are becoming more efficient at converting the sun’s radiation to usable electricity however there is a

Fig. 20: Precipitation and Average Temperature in Uppsala, note that Nov-Mar the average temperature is near or below freezing meaning that rainwater collection would be difficult for the months either side i.e. October and
comparative lack of improvement in technology when it comes to storing electricity.

To rationalise this decision, I took inspiration from Vales, who in their book *The New Autonomous House* also justify their choice of maintaining a connection to the grid with the realisation that batteries are large, expensive and made of materials that are not considered sustainable (Vale & Vale, 2002b, p 124). Until the storage of electricity becomes a viable economic and environmental option the scope of this case study and the overall design will rely upon a connection to the grid to supply the Main Stuga as well as the other buildings on the plot. A later study can be made that looks at the options of PV and possibly combining this with generating energy through small scale-wind turbines once suitable solutions for electrical energy storage emerge.

With maintaining the grid connection one can start to consider the source of the electrical power, for this case study the electrical provider is *Vattenfall*. There are alternative energy providers that can supply the electrical energy that doesn’t use, or uses less fossil fuels: *MälarEnergi* and *Sala-Heby Energi* are two local energy providers that offer energy generated through PV. These two companies also offer services to buy energy from other smaller producers and there still remains the possibility to include alternative forms of on-site electrical generation and storage as well as the possibility of feeding back into the grid in the future (SHE, n.d.; Mälarenergi, 2015).

On a more practical note, when it comes to the work associated with designing the electrical and installing the system, we will have a qualified contractor to come in and carry out the work based upon the requirements that will be obtained when the design becomes more detailed (beyond the scope of this thesis).

### 6.3 Heat Generation & Thermal Insulation

The Vales argue that the buildings we build today, given their expected long life, should not be designed to be heated with a reliance on fuels that may not be available or cheap in the future (Vale & Vale, 2002b, p 16). This longer-term viewpoint complements the short literary review on the LCAs of buildings and the UNEP targets mentioned earlier in this thesis. It was apparent that improving the efficiency of heating or cooling the living space would be a major benefit to the overall environmental impact of a building, and by extension, it’s users. The airtightness can lead to issues with moisture and ventilation, this is usually dealt with a Mechanical Ventilation Heat Recovery (MVHR) unit that takes cold air from outside and preheats it with warm air already in the building, the result is warm fresh air coming into the building and cold stale air leaving the building.

The thermal insulation of a home – the envelope which wraps the building from the environmental elements is a “key factor” in building an autonomous house (Vale & Vale, 2002b, p 86). Maintaining a comfortable temperature inside the home throughout the year can be difficult with the extreme temperatures that are prevalent in Sweden.

#### 6.3.1 Passive Solar

Removing the requirement of heating or cooling the space altogether is one way to significantly reduce the energy consumption of a building. This approach is promoted by the *Passive House Institute* who have set building design standards that, once applied, create buildings that use below one tenth the ‘standard buildings’. In their strict standards they promote high insulation values and air-tightness in the design of the building that eliminates the need for traditional heating or cooling systems (Passive House Institute, 2012).
Other key principles of passive solar are to orient the building towards the optimal angle to take advantage of the sun’s warming energy and using large quantities of dense materials (such as clay or concrete) to absorb the solar radiation (see Figure 21). The idea is that the sun’s energy will be stored within the mass of the building and will be slowly released when internal temperatures fall, thus maintaining a comfortable level of air temperature throughout the day and throughout the year with little or no additional heating (Snell & Callahan, 2005, p 52).

Fig 21: In the northern hemisphere a building should be angled towards the south (north in the southern hemisphere), with the building running east to west. The south side should contain enough glass to allow the sun to reach the materials of the walls and floors – the mass that will soak up the solar radiation and slowly release the absorbed energy in cooler temperatures. Care must be taken in the design with the right amount of south facing glass to avoid overheating and the correct shading in the summer months (Snell & Callahan, 2005, pp 52–56).

6.3.2 Wood Stove
Although eliminating space heating would be an ideal scenario, building designers should include at least one source of heating just in case there is a change in environment or a freak weather period that requires some form of space heating, particularly in Sweden. Although Uppsala doesn’t receive the harsher winters of northern Sweden, it can remain below freezing for four months (as experienced by the author during the periods 2012/13 and 2013/14).

Ideal heating for the case study location would be one based on wood given the environment that surrounds it. The availability of wood on or near the site could be sufficient if there is an efficient way of burning and storing the heat.

A Rocket Mass Heater (RMH) does just that. It is a simple wood burner that uses small diameter wood and a sideways burning to generate very high temperatures that removes the soot and black smoke associated with burning wood. Rather than sending the smoke and heat vertically up a chimney, the flue from the RMH is sent horizontally warming up a ‘mass’, a clay bench that absorbs and stores the heat that slowly radiates the stored heat long after the original fire has died out (see Figure 22). There is little scientific data on the efficiencies of this type of heater, but there are abundant sources on the Internet promoting the benefits of the RMH. This maybe because the RMH is a low technology wood burner that uses natural
materials, can be designed with knowledge gained from the internet or books and be built by amateurs. In Sweden, the traditional *kakelugn* (Bokalders & Block, 2010, p 394) uses the same approach to heating up and storing the heat in a mass and modern versions are available but expensive, the RMH provides a cheap alternative to a traditional heating method.

![Rocket Mass Heater](Nicodemus, n.d.). The RMH can have many functions in a building, there are variations online that also have copper pipes that run around the main barrel to heat water, also note that this diagram shows the top of the main barrel exposed leaving a ‘cooking surface’.

### 6.3.3 Solar Water heaters

Solar water heaters harness the warmth of the sun to heat water or, in the case of Sweden, an anti-freeze liquid then transfer the heat to a storage tank. This can be used either to warm up water to be used within the home or to supply a heat exchanger, similar to a radiator, to transfer the heat from the water to the air in the living spaces. Solar heaters could function as both the heat source and source of hot water however different water systems should be in place. Figure 23 is a simple diagram showing the basic elements of a solar water heater.

![Solar Water Heater](Fig. 23: A simple diagram for a Solar Water Heater. For a system for space heating, a radiator would be attached in series that takes the hot water and loops the pipeline back to the Water tank via ‘Cold Water In’ – in effect the system would be a ‘closed-loop’ system. For a system applied to supplying hot water to kitchens and bathrooms there would be a need for incoming water from another source (Bokalders & Block, 2010, p 398-403))

### 6.3.4 Electrical Heaters

Electrical heaters have a bad reputation, but given advances in efficiency and the possibility of electrical supply from renewable energy the option of using electricity to heat electrical heaters should not be overlooked.

Popular in Sweden right now for space heating is the *Air Source Heat Pump* (Swedish: *Luftvarmepump*). Boasting a 150% to 300% efficiency meaning that the heat energy output is
at least twice that of the electrical energy put into generating the heat. This is achieved by air source heat pumps *moving heat* rather than *converting heat* from a fuel like combustion heating system. (US Department of Energy, 2015)

In-line on demand electrical water heaters as well as emersion electrical heaters for water tanks are also becoming more efficient. With the small volume use expected in this case study the on demand electrical heaters would be good choice for this case study (Bokalders & Block, 2010, p 330).

### 6.3.5 Analysis of Heat Generation

Based on the above sections and the idea of resilience design being one that encompasses different options for sources of heat, then the finalised design should use as many principles and techniques applied to create a passive solar building – thick insulation, air tightness and summer shading. A RMH should provide additional heating with backup or further additional space heating provided by a Luftvarmepump.

For this particular case I can conclude that the option for a Solar Water Heater should be abandoned. The case study plot at the moment is too shaded and warming enough water could be difficult in the winter months. Solar Water Heaters’ technology is already out of date with the advances in efficiencies in photovoltaics to power electrical heaters; thus, saving the cost of electrical pumps as well as the maintenance and wear and tear of moving parts and water tight seals required in Solar Water Heaters.

### 6.4 Landscape

To design the building as a stand alone object would go against the whole ideas discussed so far. Designing the building or collection of buildings that settle within the landscape and brings the context in which it sits as a defining element that must be taken into account. The Pattern *Site Repair* (No.104) says that buildings should be built on the ‘worst’ piece of land to limit the impact of the building on the environment (Alexander *et al.*, 1977, pp 509–511).

With this in mind and with this particular case the newly designed Main Stuga would need to be built on the same footprint of the existing Main Stuga and adjacent veranda.

#### 6.4.1 Redirect water run-off around main building

With the slope of the land running from east to west, dropping 6m as it does so, means that rainwater run-off needs to be taken into account when designing the foundations. Care needs to be taken to redirect surface water away from the Main Stuga.

Capturing the water and reducing the speed of the rainwater run-off is one solution. Terracing to level out the landscape around the plot, creates steps of level land that will soak up the rainwater, reducing soil erosion and helping with storing water below surface level and replenish the ground water for the well.

#### 6.4.2 Permaculture - fruit & nut trees

Out of the scope of this thesis but an important aspect closely related to reducing the environmental impact of the users and residents of the Main Stuga is an aspect not mentioned so far: food. Given the 900m2 area of the plot, there is scope to cultivate plants and trees on the plot to further reduce the impact of the residents by supplying some of the fruit, vegetables and nuts required for a healthy and balanced diet.
6.5 Waste Systems

Using the land around the Main Stuga is vital to dealing with the ‘waste’ created by the users and keeping up the ideals of an autonomous house. One of the biggest mistakes with the modern world is seeing wastewater and compostable products as a waste but should rather be seen as a resource (see Figure 24). This is a sensitive subject and I agree with the Vales that when unconventional systems are proposed it is important to ensure that they function better than a conventional system (Vale & Vale, 2002b, p 177). Therefore any waste systems put in place here should be included in future studies associated with this case study and to further research in providing simple and robust solutions to household waste.

6.5.1 Wastewater

Wastewater can be split into two categories: Blackwater and Greywater. Blackwater is the wastewater related to the toilet and contains the health risks associated with wastewater (WHO, 2006, p 9). Greywater is the wastewater typically connected with washing machines, kitchen sinks, bathroom sinks and showers. Wastewater contains a large amount of nutrients that are discarded with standard systems we see in today’s homes. Currently all forms of wastewater are collected and transported to a central treatment facility in Uppsala, but by separating the different forms of waste at source i.e. at the individual household level, then we can treat each ‘waste’ to become a resource (see Figure 24).

Leading on from this, as Figure 25 shows, there are a great number of nutrients that we throw away in wastewater. Given the remote location of the Main Stuga and the ideals of an autonomous house, wastewater systems should be designed to treat the wastewater separately and bring out the nutrients in a safe and controlled manor.

Fig 24: This diagram neatly shows how, through separation at source we can keep the ‘Water Loop’ (greywater from sinks, showers, washing) and the ‘Nutrient & Energy Loop’ (blackwater from toilets, supplied with organic kitchen waste) separate and manage the imbedded resources in both grey and blackwater more efficiently (Alsén & Jenssen, 2005, pp 14–15).
Fig 25: Nutrient suitable for agriculture found of wastewater (Vinnerås, 2002); ‘Biod. Solid’ = Biodegradable Solids – the small organic material found in greywater. As you can clearly see, urine contains a significant amount of nutrients.

Pathogens on the other hand are a significant problem with wastewater. Figure 26 shows the results of research in Vibyäsen, Sweden on the level of pathogens in various forms of wastewater. As can be seen, the pathogens in mixture of blackwater and greywater even after treatment from large scale Waste Waster Treatment Plant (WWTP) is significantly higher than the levels of pathogens in greywater. This study clearly identifies blackwater as the major carrier of pathogens.

Fig 26: Pathogen levels of various wastewater mixes before and after treatment (Ridderstolpe, 2004).
6.5.1.1 Blackwater
Eliminating blackwater from the home is as simple as not creating it. As Carol Steinfeld points out in her book *Liquid Gold: The Lore and Logic of Using Urine to Grow Plants*, urine is kept separate from the faeces in the body and why should not we do this when it leaves our body? Mixing faeces and urine creates a more dangerous product than when separate and therefore they should remain separate (Steinfeld, 2010, pp 38–39).

A dry compost urine-separating toilet will keep the urine and faeces separate and, as highlighted earlier, doesn’t require water therefore reducing the water demands on the autonomous house; a compost toilet is one of the things that can *radically* improve the environmental impacts of our homes (Magwood, 2104, p 366).

6.5.1.2 Greywater
Given the water demands of an average household being 215 litres per person per day identified earlier; and given the introduction of a dry compost urine-separating toilet, the expected greywater should be at least 150 litres per person per day. As identified above greywater is considered harmless in regards to pathogens and can be reduced by a factor of 100 with simple treatment. Most of the harmful aspects of greywater are from household and hygiene chemicals; traces of heavy metals can be found in greywater from the pipes used in transferring water from centralised treatment facilities as well as dust, cutlery, dyes and household items (Ridderstolpe, 2004).

In a report by the Stockholm Environment Institute, the author Peter Ridderstolpe has broken down the greywater treatment process into five main components that one must consider when thinking about greywater management:

- **Source control:** Preventing the need for treatment, by measures at household level that reduce and control hydraulic and pollution loads, should be seen as a vital part in all greywater management.
- **Plumbing and pipe system:** The collection of pipework that collects and distributes the greywater can be smaller than normal wastewater pipework as there should be smaller solids i.e. no faeces. Care should be taken with oil and to minimise flow reducing splits in piping.
- **Pre-treatment:** Before the greywater is sent to the main treatment phase, there needs to be time to allow for the small organic particles and oil to separate. This can be done with a simple septic tank that acts as a surge tank – collecting the large intake of water after a shower for example – and then giving time for the solids to sink to the bottom and the oil to float to the top. Within the tank is another chamber that takes water from the middle of this collection that should be solids and oil free and passes it on to the next phase.
- **Treatment:** Figure 27 shows a simple diagram of a greywater system and lists a variety of greywater treatment options. As the list descends the complexity, energy requirements and cost of the options increases. Choosing the right solution for the greywater treatment is highly dependent on the context.
- **End uses and post-treatment:** Once the greywater has been treated it should be used for either irrigation or returning back to nature. (Ridderstolpe, 2004)
However greywater is treated the main problem is the large volume created by occupants (Günther, 2000) and the ‘soft’ aspects of the system “such as user participation in running and maintaining the system” are rightly highlighted by Ridderstolpe (Ridderstolpe, 2004, p 4). More efficient use of water will be encouraged by a greywater solution that has limiting flows – therefore an autonomous house could not only restrict the occupants with the water supplied, but also by restricting the ability of the sanitary systems.

With an occupant’s understanding of the greywater system and a system that uses natural elements to filter the greywater there should come the understanding that ‘what goes in is what comes out’. Armed with this knowledge, there could be a change in behaviour that leads the occupants buying ‘eco-friendly’ detergents and start to think about removing small organic materials that could block or slow the system.

### 6.5.2 Compost systems

Food waste and household compostable waste can be split into ‘brown’ and ‘green’ compost. Brown compost is high in carbon, such as newspapers and leaves while green materials such as food scraps are high in nitrogen and other nutrients required for healthy compost. It is good to get a brown to green ratio mixture of 25:1 for a fast and effective compost (Bokalders & Block, 2010, p 359).
Other than the compostable waste generated from household waste, there will be a significant brown compost material generated every year on the plot with the fall of the leaves. This will be a great source of brown material to be used to mix with the mainly green organic material from the Main Stuga. Due to the expected quantity, a dedicated Leaf Compost pile should also be created, this will take much longer to compost, however it has been proven that by adding urine, a liquid high in nitrogen, the composting process will rapidly increase and the resulting organic material will be high in carbon and rich in nutrients (Steinfeld, 2010, p 51).

Due to the high temperatures generated during the composting process there are techniques that can harness this energy and transfer it to places that can use the warmth to heat spaces or water. One such technique is the Jean Pain Mound, however this has only been tested and proven to work on large quantities of compostable material (Compost Power, n.d.).

6.5.2.1 Vermiculture
Vermiculture or Worm Compost is a simple system that requires no inputs other than regular organic household food waste and a source of carbon such as newspapers or leaves. The system is a series of boxes containing worms that recreates a habitat perfect for worms to flourish. The worms and the micro-organisms are the real workers in this system, they eat the mould and bacteria that starts to grow on the organic material, the worm excreta is high in nutrients and beneficial bacteria that is great for fertilising plants (Sinha et al., 2009). There is also a liquid, vermicomposting leachate commonly referred to as ‘Worm Tea’ – that is also highly nutritious and should be diluted with water before applying as fertiliser (Garcia-Gomez et al., 2008).

Vermiculture provides a solution to concentrating the nutrients from organic household waste and a faster way to reduce the bulk associated with household compostable waste. It uses no electricity, no water and only requires the owner to maintain a healthy environment for the ‘workers’.

One final positive outcome from vermiculture is the growth in worm population, which when it reaches a point where there are too many worms in the system, the user can remove a large proportion of the population and use them on the outside compost pile. Worms are an important element in creating healthy soil as they breakdown organic matter and aerate the soil, increasing the worm population on and around the plot will be beneficial to the natural surroundings and local wildlife – their predators will be very grateful.

6.5.3 Household Waste
Uppsala has a very well established recycling system. At the local ICA Supermarket (see Figure 16 for proximity to case study plot) household waste can be sorted into:

- Paper
- Cardboard
- Plastic packaging
- Metal packaging
- Glass (Coloured and Clear)
- Batteries
- Lightbulbs
For items that cannot be recycled locally there are three recycling centres in Uppsala. The nearest is 5km from the case study plot. At this larger facility there are the same options shown above plus:

- Gypsum, insulation and other glass items
- Wood and garden waste
- Bricks, concrete and tiles
- Large metal items
- Electrical items
- Hazardous material such as paints and solvents

There is also a drop off point for items which are deemed ‘too good to throw away’, these can be left for a team to go through and later transport resalable items at the second hand store nearby (Uppsala Vatten, 2015).

There is always waste that cannot be sorted to be reused or recycled, for this Uppsala has a Combined Heat and Power Plant that burns all combustible waste. The energy gained from this creates steam that is sent around the underground piping system and into the buildings of Uppsala, 95% of Uppsala’s buildings are heated this way (Vattenfall, n.d.). This steam can also run steam turbines to generate electricity, through this Vattenfall produces 225 GWh/year for the electrical grid (Vattenfall, n.d.).

6.5.4 Analysis of Waste Systems

Re-visualising waste as a resource is one of the main aims of an autonomous house. The occupiers, through an understanding of the processes can decide what goes into their waste and how much of it. Being involved in the process of turning waste into a resource, the occupiers will benefit from a connection to nature and the processes involved. The choices for the waste systems of the autonomous house in this case study must reflect these ideals, to fulfil the criteria set out earlier of having a minimal negative impact on the environment.

6.6 Materials

As discussed earlier, the demand for energy efficient buildings has increased the quantity of insulation in these buildings to a point where the energy used in producing the insulation material is overtaking the occupational energy used/consumed within a building’s lifetime. Therefore, the choice of materials chosen in the design phase will have a large impact on the embodied energy within a building. The production, transportation and construction processes are becoming a vital element of reducing the embodied carbon within a building.

The architects Brenda and Robert Vale warn against embracing modern building materials and techniques arguing that “[t]he idea of modernity, in which a building responds to a theory that is current at the time of its construction, fits poorly with the idea of a building that might be designed to last for 500 years.” (Vale & Vale, 2002b, p 55) Author Chris Magwood in his book Making Better Buildings offers a counter point describing the ‘paradox’ of expecting unrealistically high standards of new ideas or technology whilst accepting the flawed existing ideas or technology. He concludes that the challenge to building better buildings is realising where we are on the learning curve with new ideas and technology. He urges his readers to focus on making decisions on the ‘macro level’, the big advantages and benefits and work with minimising the ‘micro level’ flaws that materials offer (Magwood, 2104, pp xvii–xviii).

Sustainable buildings therefore should look carefully where the material is coming from, the embodied energy in the construction process and given the Walter Segal spirit of this thesis,
how easy the material is to use and manipulate. In the rest of this sub-section I will highlight the ‘macro level’ material choices when creating a sustainable house.

6.6.1 Natural Materials

Natural or organic materials are seen as the only true environmental choices when it comes to ‘green buildings’. The process in production of non-natural building materials is often energy intensive further decreasing any potential they might have had of being environmentally friendly building materials. A common material used is concrete, too common in fact. In their review of sustainable buildings, Dutil et al stress the need to avoid concrete as much as possible, saying that concrete production is responsible for 7% of the global CO2 emissions, and that in some cases concrete accounts for 99% of the building’s total embodied energy (Dutil et al., 2011). By contrast some natural materials are seen as carbon sinks. Figure 28 shows a comparison graph of 24 materials and their carbon emissions during production. As you can see the natural materials are more likely to remove carbon dioxide from the atmosphere than those created by mining one or many components from the ground.

![Graph of 24 common building materials with their overall CO2 emissions by weight (kg) released by production of 1kg.](Jones, 2009, p 23)

In the Whole Building Handbook the authors rate a variety of materials available based upon the materials effect on health and the ecosystem, what resources are used and the environmental damage (Bokalders & Block, 2010, p 9). They provide short descriptions and summarise sections with tables listing construction materials that they would recommend and those that they would avoid; all natural materials that appear in the book are recommended (see Figure 29).

6.6.2 Insulation

When I discussed the principles of Passive Solar, insulation was a major factor in maintaining a year round comfortable temperature, particularly in Sweden with the cold winter months a good level of insulation is required for energy efficient homes. Insulation also has to be able to control moisture movements that can develop from differences of temperatures on either
side of the outer walls as well as be air tight, further improving efficiency (Bokalders & Block, 2010, p 248).

Insulation has an insulating capacity and is given a 'U-Value' with the units of watt per square meter and degree kelvin (W/m²K). The lower the U-Value the better the insulation.

<table>
<thead>
<tr>
<th>Insulation: Environmental Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended</strong></td>
</tr>
<tr>
<td>Cellulose fibre*</td>
</tr>
<tr>
<td>Hemp fibre</td>
</tr>
<tr>
<td>Coconut fibre</td>
</tr>
<tr>
<td>Cork</td>
</tr>
<tr>
<td>Wood chips</td>
</tr>
<tr>
<td>Flax fibre*</td>
</tr>
<tr>
<td>Straw</td>
</tr>
<tr>
<td>Wood fibre insulation board</td>
</tr>
<tr>
<td>Wood-wool cement boards</td>
</tr>
<tr>
<td>Peat</td>
</tr>
<tr>
<td>Corrugated cardboard</td>
</tr>
<tr>
<td>Foam glass gravel</td>
</tr>
<tr>
<td>Shells</td>
</tr>
</tbody>
</table>

Fig. 29: The list of insulation materials based on the requirements set out by the authors – health and the environment (Bokalders & Block, 2010, p 45). Note that natural materials are usually recommended, interestingly Sheep’s wool is not recommended as this is often treated with a flame retarding chemicals and mixed in with polyester (Bokalders & Block, 2010, p 39).

6.6.3 Strawbales

One of the ideas that has developed over the course of the research into the designing the autonomous house has been to build the house out of strawbales. The history of building with strawbales dates back to the Midwest United States in the 1800s and is the classical example of people building homes (shelters) with what building materials they had available (Jones, 2009, p 12). In modern terms, strawbales seem to tick every box when it comes to sustainable building in Sweden:

- They are a carbon sink (see figure 28).
- Have good insulation values – as low as 0.013-0.020 W/m²K (Jones, 2009, p 121).
- Is a by product of farming (Snell & Callahan, 2005, p 346) and is available locally in Uppsala.
- Is competitively priced; we have had quotes of 20SEK for a straw bale 300x500x750mm from a local farmer. Natural builder Barabara Jones argues that it is now possible to build a “thermally efficient 3-bedroomed strawbale house for £100,000” (Jones, 2009, p 17), which falls in the middle of the range suggested by ‘conventional property developer’ Mark Brinkley (Brinkley, 2013, p 17).
- Are fire less of a fire risk compared to timber (Jones, 2009, p 14).
- Offer a good level of acoustic insulation (Jones, 2009, p 14).
• With a natural plaster finish such as clay or lime on both the inside and out walls, strawbales create a breathable house that can deal with the flows of moisture and air (Jones, 2009, p 93).
• With the protective coats there won’t be any problems with decay as straw does not wick (suck) water into itself like concrete does. It simply gets wet as far as the force of wind can drive the rain into it” (Jones, pp.38)

6.7 The Look of the house

Again, in their book The New Autonomous House, the Vales have a take on the visuals of a house, their suggestion is that a “design should not represent an international style but should respond to its immediate environment” and not be at odds with the genius loci of the place (Vale & Vale, 2002b, p 49).

The genius loci, or the distinctive atmosphere of Nåntuna Lund is one of remote small red cabins. There it little noise from the road traffic, which seems to have an effect on the pace of life here. This relaxed pace is reflected in the activities of dog walking and horse riding, helped more by the noises of the local wildlife.

Culturally, and to fit in with the aesthetic value of the buildings around the plot and the buildings in Nåntuna Lund, the building should have a wooden cladding painted with Flauröd a traditional wood staining made from the waste product of the iron mines (Hult, n.d.).

6.8 Legalities

As we are building over 25m2 we need to apply for Planning Permission (Swedish: Bygglov) with Uppsala Kommun. The process for getting approval for building is described on their website as follows:

• The application: Depending on what kind of building permission is being sort certain documents and drawings have to be submitted.
• Verification: Uppsala Kommun verifies that an application is complete.
• Start Time: processing time starts when an application is complete.
• Feedback: in some cases, neighbours and other stakeholders are give the opportunity to comment.
• Decisions: Planning and Building Committee decides on the matter. The decision is based inter alia on the Planning and Building Team. The Board shall always take into account both public and private interests (Uppsala Kommun, 2015).

Obtaining approval in the planning process with Uppsala Kommun can take up to 10 weeks. They have a free consultation session every Thursday evening between 18:00 and 20:00. These are on a first-come-first-served basis, in our experience; this has been a useful way of getting answers to questions as well as having a pre-check before submitting the application.

Other applications that may need to be made are associated with the wood burning stove, greywater system and compost toilet (Uppsala Kommun, 2015). Here, I would like to reiterate that when dealing with or designing unconventional systems, it is important or vital to ensure that they function better than a conventional system. More research is needed as part of the ongoing case study, into the technicalities, pitfalls and benefits of the systems that require approval by the council.
The planning application form and supporting documents for the design discussed in the next section are shown in Appendix F.

6.9 Concluding Remarks
In this section I have outlined the services that can make a house an autonomous house. Aside from the electrical supply, the services such as water supply, and particularly systems that deal with the waste, are disconnected from communal services; proving that an autonomous home for a small family could be built on the plot of land associated with this case study.

Towards the end of this section, I looked beyond the services emphasising the importance of the material choices and overall look of the finished home in achieving long term sustainability. Many parts of this section could have been a thesis in themselves and I have glossed over some aspects of an autonomous house. In the following section I will present the results of the Pattern Language design as well as dip into elements of the systems design that I feel are important to highlight.
7 Design Results

In this section I will show the results from the design for the Main Stuga using the Pattern Language method. The decisions taken in the previous section regarding the supporting systems chosen for the case study plot (water supply, electrical supply, heat generation and waste systems), will also be commented on briefly and highlighted when affecting the overall design of the New Main Stuga.

7.1 New Main Stuga

Although the case study looked at the whole of the plot, the focus of using the Pattern Language process was on the design of the New Main Stuga. Other aspects of the plot have been taken into account in relation to the how the New Main Stuga interacts with the other buildings.

The design for the New Main Stuga was done using Sketchup, a freely available 3D modelling tool. Each image on the following pages will have some commentary to provide the reader with a better understanding of the building and the thought process that went into the final design. The building is a two story wooden structure built around the site of the existing Main Stuga and attached veranda. It will be roughly 50m² on lower level with roughly 36m² of useful area on upper level plus a balcony to the south.

The New Main Stuga is a timber frame structure with straw bale in fill to provide the main insulation for the building. Clay plaster on both the inside and outside to provide wind proofing, with timber cladding on the outside to stop water from entering and damaging the outer layer of clay plaster. The roof shape is called a Gambrel roof, this design aspect was inspired by many buildings around Uppsala and Sweden (see Figure 30).

Apart from the glass wall to the southern side that forms a greenhouse and the main entrance porch the house doesn’t take up any more of the ground area than the existing Main Stuga. However, additional foundations will have to be completed first, these will be concrete pillars and are yet to be specified by a Structural Engineer. On the south west corner is the greywater filtration bed (shown in white).

Fig 30: An isometric view of the New Main Stuga design looking from south-west.
7.1.1 Floor Plans

Fig. 31: New Main Stuga lower floor plan. Entrance is from the west, up some stairs and into the hall (Entrance Transition Pattern No.112; Entrance Room Pattern No.130). As you enter the home there will be a double height ceiling with space saving stairs leading up to the upper level (Intimacy Gradient No.127). The bathroom is straight ahead with shower, toilet and sink (Bathing Room Pattern No.145). To the left will be the living space (vardasrum) with a Rocket Mass Heater (Window Place Pattern No.180; The Fire Pattern No.181; Windows Overlooking Life No.192). To the right is the large kitchen (kök; Farmhouse Kitchen No.139; Communal Eating No.147; Sunny Counter No.199). The exit to the through the kitchen to the south leads to a greenhouse (South Facing Outdoors No.105; Greenhouse No.175). Where possible there are windows to allow morning and afternoon light into the spaces (Light on Two Sides of Every Room No.159) and the same is achieve on the upper level. The strawbale construction satisfies the Thick Walls (No. 197), but details like Half Open Wall (No.193) and Open Shelves (No.200) are not shown.
Fig 32: New Main Stuga design upper floor plan. Due to the gambrel roof, the upper level has a restricted floor area, anywhere that is lower than 1.5m in height is not considered useable space. The stairs from the lower level lead you the middle of the floor, to the left is the study (arbetsrum) that will also become a second bedroom if/when needed. To the right is the main bedroom (sovrum) which leads out to the balcony (balkong; South Facing Outdoors No.105; Couple’s Realm No.136; Six-Foot Balcony No.167). Small windows will bring in natural light with larger windows to the southern balcony.
7.1.2 New Main Stuga’s Relationship to Existing Buildings

The building has been designed to fit within the requirements Site Repair (No.104) and Long Thin House (No.109). The aim with future landscaping of the area would include Patterns: Positive Outdoor Space (No.106), Entrance Transition (No.112), Car Connection (No.113), Sunny Space (No.161), Outdoor Room (No.163), Connection to the Earth (No.168), Terraced Slope (No.169), Fruit Trees (No.170), Tree Places (No.171), Garden Growing Wild (No.172), Trellised Walkway (No.174), Garden Seat (No.176), Vegetable Garden (No.177), Compost (No.178)

7.2 Rainwater Collecting and Filtration

The rainwater collecting and filtration system closely follows that described in dedicated section 6.1.2.1 earlier in this thesis.

I did some calculations based upon the average rainfall in Uppsala and an assumption of water demand for a family of four based upon those numbers taken from the Whole Building Handbook (see Figure 17), which were 215 litres per person per day. Then I took away the 40 litres used for flushing the toilet and then adjusted the other numbers based on assumptions about changes in behaviour and water saving devices. Figure 34 shows the revised water demand is now at 92 litres per person per day for the New Main Stuga, and 368 litres for a family of four. These are best guesses and are done for the purpose of discussion.
Where we use water | WBH | Eco-Factor | Eco-Use | Eco-Factor Reasons
--- | --- | --- | --- | ---
Kitchen Sink / Food use | 50 | 0.7 | 35 | Low-flow taps
Hand Basin | 30 | 0.5 | 15 | Low-flow taps, low use
Shower / Bath | 40 | 0.5 | 20 | half as many baths/showers
Toilet | 40 | 0.0 | 0 | Dry Compost Toilet
Washing Machine | 30 | 0.7 | 21 | Efficient Machine
Other | 25 | 0.05 | 1.25 | Garden water obtained elsewhere

Total | **215.00** | | **92.00** |

Figure 34: Revised water demand on the New Main Stuga. The ‘Eco-Factors’ are up for debate, but this has been done solely as an exercise for furthering the discussion.

Then I took the average precipitation figures for Uppsala (Figure 13) and removing the possibility of collecting any rainwater during the months of December, January and February based on the average temperature being below freezing (Figure 14). With these two sets of data, I calculated the amount of rainfall the New Main Stuga could collect based upon its roof surface area of 50m² and with evaporation coefficient of 0.7 and a filter coefficient of 0.9. The results over a 4 year period are shown below in Figure 35.

Housing 40,000 litres of water tank space is a significant undertaking. Not only that, as mentioned earlier, the cost of rainwater storage tanks is significant meaning that the whole system would be a sizeable part of the whole building cost and could make the building financially impossible. The Vales in their autonomous house used second hand containers that had transported orange juice from Israel to the UK and were no longer required (Vale & Vale, 2002b, p 181).
From this quick exercise, a building reliant on rainwater as the only source of water would not be possible in this location unless the building was designed around 40m³ of water storage. This in itself has knock-on effects when dealing with foundations, as the weight of the all tanks full of water would be considerable. Therefore a decision was taken to downscale the rainwater system to 3-4m³ storage capacity. These storage tanks will be located in their own building attached to the north face of the New Main Stuga (North Face No.162). See Figure 36.

Fig 36: Rainwater Tank Room on northern edge of New Main Stuga.

7.3 Greywater System
Following the format set out by Peter Ridderstolpe in the previous section regarding greywater phases, below is the chosen greywater system broken down into these components with more details on function, materials, capacities and expected flow rates.

7.3.1 Source Control
Very large particles will not be allowed to enter the greywater system as they will be filtered out at an early stage using standard plastic and metal covers over the plug holes. These large organic particles will be disposed of correctly.

7.3.2 Plumbing and pipe system
Art Ludwig in his book Create an Oasis with Greywater recommends using 50mm PVC pipework for greywater. This pipe diameter allows for solids to float freely in greywater without reducing the flow. All collection pipework will have a fall of 2% to use gravity to direct the greywater to the Primary Filter Stage (Ludwig, 2012, p 31).

7.3.3 Pre-treatment
The incoming greywater will first go into a 300 liter storage tank. This storage tank has two functions, first is to act as a Surge Tank (Swedish: Slamavskiljare) that regulates the flow to a constant level of water to the second stage, the Infiltration Bed, and reduces the chances of a bottleneck further down the system. The second function of this storage tank is to filter out large particles and grease/oil from the kitchen and bathroom. This is done by giving particles in the greywater time to settle and also time for the grease/oil to separate from the water and float to the surface.

Two vents, one at the input and one at the output of the tank, will be used to vent off any gas and also to equalise the pressure of the system.

A large hole on the top will allow access to the internals for periodic maintenance, cleaning and sample recovery for research on the performance. This access hole will be sealed shut with a rubber gasket and latch.

The tank, including all internals, will be made of hard plastic as greywater corrodes metal over time whilst doing minimal damage to plastic (Ludwig, 2012). The tank will be sat on a
concrete foundation surrounded in 95mm of insulation to prevent outside temperatures from affecting the performance of the tank.

7.3.4 Treatment
From the Pre-treatment Stage the water, now removed of grease and large particles, will flow to a Filtration Bed - a series of layers that will capture the nutrients, kill pathogens and trap any heavy metals. For this stage, the option chosen is the fourth option on Petter Jensson’s list of possible greywater treatment options (see Figure 27), the ‘sand filter’ also known as a Vertical-Flow Planted Filter (VFPF). This stage is located in a greenhouse to improve all-year round performance of the system and to encourage evapotranspiration and moisture content in the air required for the micro climate favoured by the plants that we will use.

The inlet pipe from the Pre-Treatment Stage will branch off into three perforated pipes (50mm diameter) that run the entire length of the filtration bed to displace the water over the whole area. The pipes from the Pre-treatment stage will maintain a fall of 2% to keep the water moving down the pipes and this fall will reduce as the pipes enter the bed to ensure that water is dispersed evenly.

The filtration bed will be approximately 1m wide by 5m long and 1.2m deep. The bed will be built of concrete on a concrete foundation and lined with an impermeable layer. The bottom of the bed will be constructed with sloping edges to improve collection and drainage at the bottom of the bed.

This filtration system uses natural absorption qualities of plants and releases the incoming greywater into the biologically active, aerobic layer of the soil (the top 20-30cm) in order to fully stabilise the liquid (Clivus Multrum, 2010). This first layer of the filtration system will be 40cm deep with the inlet pipes within the layer mentioned above. Plants with nitrogen fixing root nodules such as Alnus will be used because of their capacity to extract phosphorus from waters with a low N:P ratio (Günther, 2000).

Below this soil layer is a layer of sand, 50cm deep. For a better phosphorous removal, sand with a higher Fe content will be used. Crushed limestone will be mixed in with the lower section of the sand layer at a ratio of around 1:1. This is to maintain a neutral pH - this is recommended due to the fact that we are treating wastewater from the kitchen (Morel & Diener, 2006). Perforated and unobstructed pipes will be inserted vertically through the bed to enable us to check and monitor the water level of the bed at various points.

7.3.5 End uses and post-treatment:
Water collected at the bottom of the Filtration Bed will be fed, via pipes that maintain a minimal 2% fall, to an Absorption Bed where plants, trees and bushes will absorb this water year round.

Any water that goes through the system and is not absorbed by the plants in the Filtration Bed and Absorption Bed will be collected and stored in an open pond. This will provide a visual and audible indication of the system’s performance.

Maintenance of the system will be conducted periodically. The system will be checked for leaks, pools of standing water, build up of solids, obstructions and any dry areas where we are expecting moisture. Filters will be checked regularly and changed/cleaned when required.
To help with cleaning the system we will incorporate a ‘rainwater flush’ option that will be used periodically and when needed. This is to flush the pipes with fast flowing water to remove any solids and/or standing water in the system. This flush can be done manually but a connection to the rainwater collection system is included. This connection can be open/closed when desired by opening/closing a valve manually.

Overflow pipes have been included in the design. If the system overflows, we have included visual and audio warnings to alert the users to carry out a thorough check of the system and find the reason for the overflow problem. Overflow water will be collected and measured as part of the research documentation.

### 7.4 Concluding remarks
A large part of this section was given over to the rainwater collection and the greywater system designs; I thought this was important to exemplify, as these could be seen as the major aspects of the autonomous house – the ‘macro levels’ of autonomy. High level information about the other services chosen in the short summaries above and are shown in Figure 38 below. This block diagram indicates each system/service and their relationship to one another and to their location/source or ‘level of autonomy’.

The actual design of the house – the ‘realms’ and functions of spaces were not explained in too much detail as these are assumed to be obvious to the reader. The timber frame and strawbale construction method are given more space in Appendix G with notes and pictures.

Another major factor that is missing in this thesis is the costs associated with the New Main Stuga design. The design as shown was completed in April 2014 and the story, my journey, with this case study had developed with major changes with the design and any cost estimates had been produced.
Fig 38: The systems diagram based on the research carried out in this section. Aside from the connection to Electrical Grid, all resources for the home are provided on-site or in the neighbouring area of Nåntuna Lund. Apart from the small amount of household waste a waste generated on-site is dealt with on-site and the waste itself becomes a resource for improving the land around the buildings. The PV panels are included as a dotted box as this is an option for the future if/when the appropriate technology is developed for storage of electrical energy. Also not discussed is the telecommunications, there is a good 4G signal available that can be used to provide Wi-Fi around the plot.
8 Discussion

This thesis is a series of ‘snapshots’ in time. The first snapshot was of the existing buildings at the start of 2014 and formed the basis of the Case Study. The second snapshot was of the New Main Stuga design that was done in April/May 2014. Given that this thesis has been written over 18 months, work has continued beyond the initial Main Stuga design presented in the previous section. This section will continue the narrative focusing on a third snapshot in time, the revised design for the Main Stuga. I will also refer back to the ideals of autonomous housing, green building standards and the need for accessibility to affordable housing.

8.1 Methodology

I feel the Case Study methodology chosen for this thesis was the correct one given the starting premise. The ‘how’ and ‘why’ of Autonomous Housing has been researched and the Case Study framework gave me enough freedom to study something practical rather than overly theoretical.

The rhetorical nature of the Case Study methodology has allowed me to include personal experiences of working with this case throughout, permitting me to give the reader a better understanding of my own position as the researcher that provides a level of transparency when it comes to any potential bias drawn in this and subsequent sections. This rhetorical freedom has suited my own personal style of writing that is less formal and has a more conversational tone that hopefully makes reading the thesis easier.

It could be argued that the Case Study methodology is the wrong choice in the context of a Masters Thesis. Case studies should have a long term monitoring process and not be restricted to a single semester. However the topic and the methodology are a good match, which leads me to conclude that the initial scope of the thesis was too expansive. Designing a house is a long-term process, particularly for a novice; there is a lot to learn and research to develop designs that suit the needs. This thesis, a truncated case study, only scratches the surface at many elements of the design.

Limited by time in terms of hours to research and write a thesis I have had the benefit, due to circumstances, of an extra year to think about the context, the design and the functions of the home, as a result the final design presented in Section 7 and the actual house built are different – I will discuss this shortly.

I am in the early stages of my learning and developing my own ideas of how the built environment can be used to the benefit of the environment and society. The experience gained from this case study methodology - the research and the practical elements – have increased my understanding significantly and are part of my on going education into sustainable housing and development into a potential career of working with the issues brought up throughout the thesis.

8.2 Reaction to the Initial Design

The designs shown in the Design Results (Chapter 7) were developed back in April 2014. Before work could continue with the design (defining details, selecting materials and suppliers etc.) the initial design had to be approved by the landowner, SLU and the local municipality that grants planning permission, Uppsala Kommun.

The design was discussed with SLU Estate Department who approved the design and the premise of a low-impact building on this plot of land. We then submitted the design to
Uppsala Kommun for planning permission through the usual process. After a period of a couple of weeks, Uppsala Kommun called us in for further discussions about the design and the location. See Appendix G for copies of drawing submitted to Uppsala Kommun.

In general Uppsala Kommun had concerns that the building was too big for the area. Remember, this area is considered high in natural beauty and is culturally significant. The area is designated for ‘Summer Stugas’, an area to be used for small dwellings that did not disturb the surrounds and look out of place amongst the other buildings close by.

Due to these concerns and conditions, results of the Main Stuga design that we submitted were effectively designed out of context – everything I had talked about in the early stages of this thesis had been disregarded when it came to the design. On reflection, I have realised that the central reason for this was that the design remit: a home for a small family and the location were incompatible to start with – it was basically the wrong site to build a year-round small family home.

The large design could also be an outcome of using the Pattern Language method. There was a sense early in the process that each Pattern that identified a functional space was deemed to be a separate space, in the book there was little talk of overlapping spaces and it was easy, whilst reading and agreeing with the book, to include patterns and spaces so that, when it came to the design, the overall size of the Main Stuga was ‘flabby’ / ‘oversized’/ unnecessary.

The third reason is the one of externalising the building services. The rainwater tanks and the greywater treatment system were included as ‘add-ons’ to the Main Stuga rather than integrated as part of the design leading to a larger footprint. These should have been included inside the main envelope of the building particularly when it comes to the challenge of keeping the rainwater storage and filtration system above freezing; it makes sense to include them within the insulated envelope of the building. The same goes with the first stages of the greywater treatment system that require warmer temperatures to function properly year round.

However, the fact remains that the plot and the design remit were out of sync. Uppsala Kommun was right to maintain the genius loci of the area. I had gotten wrapped up in creating a language of patterns and had forgotten my earlier mantra – design within context.

In reality, with no experience of building behind us, the design was too big for my girlfriend and me to construct. We were naïve and, after some rough cost estimates proved, we were underfunded to complete the original idea. The time frame was also squeezed; by choosing to use strawbales with two coats of natural clay plaster the bulk of the construction would have to have been completed before the end of September 2014 to ensure that the clay plaster would dry properly. All this in less than four months and this assumed that planning permission would be granted by mid-June.

8.2.1 Positives to take from Initial Design

It’s not all negative, the Pattern Language book and it’s methodology gave me the chance to think about spaces and elements of a building (the patterns). This helped me reflect upon designing a building built around the human functions and integrating the human elements with the natural elements.

From a certain perspective, it was good to ‘go big’ to start with, find out what I would do if unlimited, and then come back to ‘reality’, taking parts/patterns of the design that I think
work best and/or most suited to the context. In a way, going from what we want to what we need.

There are plenty of positives to take from this initial design and the ideas from the Pattern Language process:
- Urine separation compost toilets have two benefits, they significantly reduce the water demand and produce useable resources after a period of time;
- Maximising the use of natural materials used has more benefit when thinking of the whole life cycle of the building;
- Include the natural spaces as part of all structures, look at the movements between structures;
- The importance of the transitions: from the edge of the plot to the entrance of the Main and from the outside to the inside;
- Until there is an environmentally sound option for electrical storage any building should rely upon the existing grid connection to supply electricity to the plot and buildings;

### 8.3 Revised Design and Actual Build

To maintain a narrative and discussion around the design process and the development of the case study this sub-section will include a description about the actual home built in the summer/autumn of 2014.

Again, this section is a snapshot in time. A new Guest Stuga is complete and the Revised Main Stuga is structurally complete and liveable with only minor work to complete the trimming around the windows and roof. The water supply and wastewater systems are yet to be completed.

#### 8.3.1 New Guest Stuga & Storage

The first job that we did on the site was to remove the old Sauna. As mentioned earlier, the roof had collapsed some years before leaving the walls of the Sauna to slowly deteriorate. Removing the old building gave us the opportunity to rebuild this building as a Guest Stuga. This provided us with experience in construction: the effort, materials and the time required in carrying out a design from start to finish. The finished Guest Stuga maintains the same footprint of the old Sauna (13m²); has electricity and operated as a good site office when constructing the Main Stuga.

The old Guest Stuga was repurposed as storage with future plans to turn half of that 13m² into a sauna.

#### 8.3.2 Revised Main Stuga design

Having taken on board the feedback from Uppsala Kommun and inspiration from the initial proposal we scaled back the requirements of design. Changing the requirement from designing a ‘home for a small family’ to a ‘home for a couple’. This change in direction meant that we could maintain the same footprint of the Existing Main Stuga and, with minimal changes to the overall look to the outside of the building, Uppsala Kommun confirmed that we would negate the need for planning permission. This sped up the process of starting construction and reduced costs and paperwork required.
Fig 39: Revised Main Stuga Design in relation to plot. Note, that the overall footprint of the Main Stuga and the Veranda hasn’t changed from the original. The red arrows denote access points to the plot. For scale purposes: Main Stuga width is 5m.

Fig 40: Revised Main Stuga Design with areas identified

Fig 41: Revised Main Stuga Design with overlapping patterns
The reduced functionality of the building had many knock on effects in terms of spaces meaning that we packed a kitchen, bathroom, living space and sleeping space into 25m² whilst retaining a building that was in harmony with the area’s culture and not disturbing to the natural surroundings anymore than the previous building.

The roof was extended south to provide a larger entrance, as this wall is facing south we decided to also glaze as much of this as possible to create a greenhouse ideal for extending the growing season in Uppsala and increase our success with tomatoes and other warm loving vegetables and plants.

8.3.3 Water Supply and Storage
At the moment the water supply is from the communal well during the summer months and over the winter periods, when the pump is removed, we have access to the potable water from our neighbour’s well. In the near future it has been agreed with the neighbour that we will take a line from that well, after the water has been filtered, and run an insulated pipe underground as a source of potable water for the new Main Stuga.

The only water-based activities that we do at the Stuga are washing up dishes and using the hand basin. As a result of restricted water access, our water footprint is significantly less than the average demand shown in Figure 17. We are very careful when using it within the Main Stuga; on average we use around 50 litres of water every three days. We do have some ‘water externalities’ as we shower at other locations such as the gym and facilities at work and wash our clothes at public facilities but, given additional effort and lack of access these activities are done less than previously when we lived in a standard student apartment. This is only a short-term solution as there are plans to build a sauna to replace the need for showering. This
is the traditional way of cleaning oneself in Sweden. The long-term solution for washing clothes hasn’t been decided upon at the time of writing.

Currently we have rainwater collection on the new Guest Stuga, this is currently unfiltered but there are plans to include a filter to remove organic material so we are able to store water for use in the garden. There are plans to capture, filter and store rainwater from the new Main Stuga during the warmer months for additional help with watering the garden.

8.3.4 Electrical Power
We remain connected to the grid. The new Main Stuga was wired to modern standards and a new fuse box was installed. We reduced the feed from Vattenfall from 24 ampere to 16 ampere, which reduced the financial cost of connection to the grid. However, cost of electricity remains high, plans to generate electricity on-site are distant at best.

8.3.5 Heat Generation
We have installed an Air Source Heat Pump (Swedish: luftvarmepump) described in more detail. Given the small space this has been enough over the winter to maintain a comfortable temperature in the Main Stuga.

There is still the possibility to have a wood burner in the Main Stuga. The mass of a Rocket Mass Heater would require further support to the foundations of the building. There is still some unclear legality over the RMH as an approved source of heat, however a standard wood burner would be fine with the appropriate installation and safe access to the chimney.

8.3.6 Wastewater
As we have an urine separating compost toilet we produce no blackwater on-site.

Given the small amount of greywater generated on-site we will have a small-scale greywater filtration system in place that distributes the filtered water downslope from the Main Stuga in a series of infiltration beds. This area will be planted with water, salt and nitrogen loving plants.

8.3.7 Compost systems
The urine separating compost toilet is a very simple one. The faeces are collected in a large 50 litre container, which when full is taken to a larger compost bin especially designed and approved by Uppsala Kommun for composting faeces. From our experience, it has taken 3 months to almost fill the 50 litre container with faeces. The large compost bin is 500 litres, therefore we have plenty of room for a few years worth of faeces collecting, and this is without the reduction in volume overtime that happens during the composting process.

Urine is diverted at source and collected in 20 litre containers. Once full, these containers are then stored for 6 months to remove any pathogens.

We have started collecting all organic material from the home in a dedicated compost pile as well as keeping a ‘Worm Farm’ supplied with food. There is also a leaf compost area that is used to supply the other compost areas with ‘brown’ compostable material and maintain the right brown:green ratio.

Other household waste is recycled with the very small amount of non-recyclable waste disposed off at the nearby municipal waste collection and sorting centre.
8.3.8 Materials

With the restricted floorplan and a tight schedule we had to lose the idea of building the Main Stuga in strawbales. All materials we used for the construction of the Guest Stuga and the Main Stuga were readily available in the local hardware stores. The only specialist item was the urine separating compost toilet that we ordered from the Kompost Center in Solna. We purchased a few items, such as windows and a front door, from Blocket an online selling platform for second hand items.

8.3.9 Summary

The construction of the Guest Stuga and Main Stuga was done with the help of an experienced carpenter for the first three months. We hired in some help to install the special roof windows – a luxury that we included as we want to give more daylight and ventilation for the sleeping loft.

Building a home in the ‘spirit of Water Segal’ was a great experience. All materials that we bought and collected are easily available from the local hardware stores. Even with the time constraints we managed to build one guest cabin of 13m², which replaced an old storage shed and we reconstructed the main, 25 m², cabin to satisfactory level and one that is comfortable all year round.

See Figure 43 for a diagram showing the services, compare this to Figure 38, there is not really that much change to autonomy of the idealistic requirements set out earlier in the thesis.
Fig 43: As built Main Stuga services.
8.4 Autonomous Housing

There were two striking elements to the definition of autonomous housing used for this thesis:

- Dependence on the resources that can be collected on its site;
- Simple and robust technology that offers a sense of control to the users.

When looking at that first element of this definition you have to question the physical limits to dependence, the boundaries defining what can be collected. One could argue that if the boundary of autonomy is set to the borders of a city, then the city is autonomous if the power, water and waste are all generated, supplied and contained within these borders (i.e. there are no external influences in the city’s operation).

In this case study the initial boundary was defined by the physical boundaries of the plot, however in obtaining water the solution was found beyond these boundaries, partly in the neighbouring plot but also in the communal area. This solution was based on the limiting factors of the climate in which the build was set – the cold winters reduced the collectable rainfall during the winter months to zero.

Therefore, rather than saying that each building should be autonomous, we should be looking at opportunities to share resources among the close by neighbours to create autonomous communities. Given that context is such an important factor in the design of autonomous housing maybe one building is better at collecting solar energy and another is better suited at collecting rainwater or has a site better suited for digging a well whilst another area – ideally communal – is best at collecting compostable waste from more than one home.

This sense of sharing resources and collectively disposing compostable waste could harness a sense of community. Scale is important to this, too large and the community lacks cohesion, too small and the effort required to maintain the systems could be too great or depend on a few individuals, who if leave could collapse the autonomous system(s).

A further element of autonomous housing is the level of control. The occupants must want to live autonomously/sustainably. Designing and building systems that are based upon the resources only available, resources that could be a lot less than the expected lifestyle demands could come as a surprise. Not only that, all the systems mentioned above tend to require human input, whether it’s through maintenance or through taking part in the process i.e. removing the faeces collection under the toilet to the main compost pile.

The Vales argue that conventional housing encourages the occupants to “pass the buck” when it comes to their environmental footprint as they rely on centralised services to supply water and deal with their waste (Vale & Vale, 2002b, p 38). Therefore one could argue that is the overarching idea of living in an autonomous home, understanding that resources are limited and that the waste we generate should be seen as a resource and that we should not expect others to deal with the more unpleasant aspects of dealing with the waste each of us generate. Joseph Jenkins in his book The Humanure Handbook says that composting your own personal by-product is an exercise in humility that helps maintain a ecological versus egotistical balance (Jenkins, 2005, p 70).

I think that those willing to live within the confines of what the environment provides are few and far between. Autonomous housing asks for a slightly different lifestyle of its occupants, a lifestyle that questions the social stigmas attached to human by-products of urine and faeces. For the idea of autonomous housing to appeal to the masses the systems of an autonomous
house that meet resource demands and deal with waste must be as automatic as the occupants want to be able to control the services.

Looking again that the definition, the words resources and control can be extrapolated to demand. Demand of the occupants is affected by a level of self-control that, in turn, is based upon the knowledge of the available resources. Adapting to and living within the resource limits is one of the largest challenges we face on a finite planet. Autonomous housing could be a way of providing the knowledge, the realisation that we cannot just keep taps running or flush away valuable nutrients; we must learn to live within our means, within the means set out by the environment in which we live.

Figure 44 shows the ‘Macroscopic perspective of autonomous houses’ according to Chen et al, here the authors have grouped together three areas of autonomous housing after a literature review. However, I think that there they have missed out a major area in this diagram – they have forgotten about the occupants’ perspective.

8.4.1 Can the Main Stuga as built be seen as autonomous?
Taking another look at Figures 38 and 43, those that represent the ideal and the actual services supplied to the Revised Main Stuga. Then I think we can say that the Revised Main Stuga is as autonomous as possible for this given plot. There is further work to be done in terms of potentially decoupling from the electrical grid or, probably a better option, having PV panels as part of a Feed-In-Tariff that supplies the grid with electricity when not needed on-site in any of the buildings on the plot.

The water supply from a local well could be called into question: the water is from a ground source that, over time, could be depleted. However, given the quantities of water usage from both homes and the rainfall for the area this is unlikely. If, for whatever reason there is a drop in ground water it would become quickly noticeable by the residents as the surrounding plants, trees and bushes that also rely on the groundwater will start to deteriorate. This connection to nature and the visual signs of the resident’s impact on their surroundings is one of the key factors of why autonomous housing can be seen as the next step beyond ‘green’ or ‘sustainable’ homes – it signals and calls to attention the impacts created by residents to their surroundings.

The technology and the financial costs associated with the electrical supply and distribution are the stumbling blocks for these location and owner-occupiers however the technology is improving and future innovations could help make things more available, cheaper and easier for people to use.

8.4.2 Autonomous housing technology
To live autonomously is becoming easier; helped by improvements in technology and increased knowledge in simple and robust systems such as greywater filtration systems highlighted earlier in this report. More important in helping to develop the ideals of the autonomous home is the access to the technology and the knowledge both academic and through informal experiments shared over internet sites and online forums. A good example
of this is a recent news article on the online platform Treehugger.com demonstrated how the latest in microbial fuel cell technology was being applied to urine, the result being small scale electricity production (Treacy, 2015).

Whilst researching rainwater harvesting systems I came across another innovative hydraulically configured prototype that aims to remove the following typical problems of other rainwater harvesting systems:

- Adapting to existing plumbing systems
- Reduce the energy consumption
- Minimising the maintenance requirements

This is done using standard plumbing fittings and a novel up-flow filtration system with a down-flow backwashing system (see Figure 45) (Silva Vieira et al., 2013). This is another example of the work done by researchers in sharing the knowledge and advancing the designs of simple and robust technology required for sustainable housing.

![Fig 45: A novel rainwater filtration system. (A) standby stage; (B) filtration stage; (C) backwash stage; and (D) re-set stage (Silva Vieira et al., 2013)](image)

As discussed earlier, the major stumbling block for autonomous housing is the storage of electricity generated on-site. In time, with the improvements in battery technology and materials used, the storage of electrical energy will become a viable option. Until then Feed-In-Tariffs to the existing electrical grid are a good way of distributing electrical energy produced by small scale producers and supplying it to those who need the power at the same time.
Chen et al (2009) discuss that in the near future all homes will have the opportunity to have a ‘hydrogen-generating fermentation tank’ using the anaerobic digestion process from household waste to provide bio-hydrogen based energy supply to the home and reduce the demand on central power plants. Their suggestion is that this technology is not reliant on the site location and climate and therefore readily adaptable to all households. It is also scalable and ideally suited to larger homes or apartment blocks. There is the case that, due to advances in technology, buildings of the future homes will be come semi-autonomous in terms of independent electricity generation (Chen et al., 2009).

Maybe it’s just a question of the technology becoming developed and refined for everyday use that will make buildings autonomous. Is this the right attitude to changing behaviour? Hoping that techno-fixes will enable us to live a more sustainable lifestyle?

8.4.3 Autonomous housing beyond its boundaries

The resource savings of an autonomous house have effects beyond the boundaries in which it sits. Building a new autonomous house or converting an existing building to operate autonomously effectively excludes or removes it from the large-scale services supplied by the local government or private company.

The authors of the book Toolbox for Sustainable City Living say that with the development of autonomous design, ‘radical’ sustainability promotes the development of autonomous communities that work together to not only provide members with resources, but to develop collaborative transportation systems, media, health care and education that are especially adapted to creating and maintaining a sustainable world (Kellogg & Pettigrew, 2008, p xv). Autonomous housing can be seen as playing an important role in transitioning not only individuals or families but communities, away from fossil fuels and towards more sustainable living. It is promising that BREEAM have taken this step towards looking beyond buildings in isolation and are now, through their standard, teaching others about the impact a building has on the local environment and community.

With Sweden’s increasing population there has been an increased demand for homes and, as a result, resources. If all new homes were built to be fully autonomous then the demand on the electrical grid, the water supply and the wastewater systems would not be increased. Therefore over time, due to the efficiencies and changes in usage behaviour, the communal or regional demand would decrease.

Vast amounts of water are treated to the level of potable water through the use of chemicals, energy, that all cost money (Jones & Hunt, 2010, p 623). Energy intensive desalination processes have become popular in southern Europe to cope with rising demand (EEA, 2009, p 7). Although these techniques may not be required in Sweden, all over the world resources are being effectively wasted in treating and distributing the water as well as by the use and end user (Jones & Hunt, 2010, p 623). A reduction in water usage from individual households would reduce, cumulatively the overall water usage of an area and therefore reduce the water demand and energy required plus the financial costs associated on the local government to treat and supply potable water to households as well as the energy required to treat water to be safe and drinkable. With the global demand for water doubling every 21 years (Li et al., 2010, p 3), autonomous housing could play a vital role in understanding our water usage and minimise wasting water unnecessarily. In a study looking at large scale introduction of rainwater collection system it was concluded that “... there is a considerable potential for rainwater systems to be installed in many buildings with large roof areas, which would
improve stormwater management, wastewater treatment, and appreciation of the water resource in urban environments” (Villarreal & Dixon, 2005, p 1183).

The Vales argue that autonomous houses that generate their own electricity but remain connected to the grid and use Feed-in-Tariffs (FIT) are also providing the wider community with electricity, symbolically giving something back to the community (Vale & Vale, 2002b, p 129). In Sweden they use an alternative to FIT. Since 2003 they have an electricity certificate system, that allows small scale renewable energy producers to sell their electricity on the open market as a replacement to government grants and subsidies (Energimyndigheten, 2015) and increases the overall renewable energy sector of the Sweden. With an introduction of Autonomous Housing or near autonomous housing we can greatly reduce the costs on the local governments and help provide renewable energy to our neighbours.

### 8.4.4 The autonomous apartment?

Left unsaid within this thesis is the idea of singular homes. Whether autonomous or not, singular homes may not be sustainable; there are economies of scale when building for multiple families or groups that may best use the resources that are available in terms of materials, construction and building footprint not to forget that they are probably better in terms of maintaining heat or ‘sharing’ as it radiates from one ‘building’ to the next through shared walls, floors and ceilings.

The idea of autonomous housing has generally been limited to individual homes, however the future of autonomous housing, as alluded to earlier, could be expanded to autonomous communities that share the resources and have dedicated areas for treatment of wastewater and human by-products. As we have seen, the physical area as well as the materials required to meet the demands are large for a small household. Nevertheless, the systems identified in this thesis would need to be reconsidered in an area densely populated such as a city centre.

In a report, the World Health Organisation (WHO) stress the growing demand on water supply and the need to deal with the increasing production of wastewater properly as a result of rising urbanisation (WHO, 2006, p 7). Built up residential areas like those found in city centres magnify the demands on resources in concentrated spaces. Given that 42% of Swedes live in apartment buildings in 2012 (SCB, 2012, p 43) then future studies should expand this concept to denser areas and evaluate the difficulties in collecting enough rainwater, electrical power, heating and cooling and waste systems for a larger population. Reducing demand could be the only way of making this possible.

### 8.4.5 Autonomous beyond residential

This thesis has concentrated at the residential sector of the built environment, but the non-residential buildings count for 25% of the building stock in Europe (BPIE, 2011, p 8) and use 40% more energy than that of residential buildings (BPIE, 2011, p 52) and in Sweden the industrial sector consumes 66% more energy than the residential sector (Energimyndigheten, 2013). The application of methods and practices that create autonomous homes should be applied to the non-residential buildings and these buildings, given their function and use i.e. context, industrial buildings could be connected to residential areas as part of an autonomous community.

### 8.5 Building your own home as an alternative

One of the aims of this thesis was to explore the idea of building a home as an alternative to buying or renting an existing place to live. This Case Study has been framed by the current
personal position of my girlfriend and me and therefore these circumstances cannot be
generalised for all young adults leaving education, nevertheless I believe that the following
reasons for the first and second options below are valid for a large portion of young adults
leaving education.
Option 1: The first option of buying a home was ruled out based upon:
• Our particular circumstances of not having permanent contracts at our work places meant that the banks would not consider us for a mortgage;
• We did not have the capital required to buy a home in Uppsala outright.

Option 2: The second option of renting was ruled out because we:
• Were no longer students and therefore not eligible for student accommodation;
• With only four years on the housing waiting list with Uppsala Kommun, we are too far down the waiting list to have a realistic chance of obtaining a home through this avenue;
• Were tired of renting on the black market or through official ‘second hand’ contracts. Both of these are usually short-term contracts creating a perpetual re-locating cycle not allowing us to set down any roots in a neighbourhood and the wider community.

Option 3: The third option was for my girlfriend and me to move back to our parents or other family members. However we both have no family members living in Sweden and see Uppsala as a place for us to live and work in. Returning as ‘boomerang kids’ to the parents homes would mean leaving Sweden altogether.

Option 4: The fourth option identified was building a home ourselves. This was sparked by the ideal of living ‘rent-free’ lifestyles that allowed us to keep all of our income and/or work less.

These circumstances may also have to do with our age; both my girlfriend and me are over 30 years of age and already have some experience in renovating a home. Our attitudes towards second hand contracts and the idea of constantly moving maybe viewed through the eyes of those who have already spent over fifteen years of doing just so. Finding a place to live for longer than a few years might not be high on the list of some or most young adults leaving higher education and therefore the second option mentioned above may well be a viable alternative.

8.5.1 Self Building
I have had the benefit of thinking about and writing this thesis over 18 months, during which I have built a small cabin on the plot used in this Case Study. We did not do this alone, for the first three months we had help from an experienced carpenter who taught us the standard way of building with wood in Sweden, which was an incredible help and a huge learning curve that allowed us to continue when the carpenter left. Also, due to regulations we had a professional install the electrical system.

Financially it has cost around 250,000SEK to build the Revised Main Stuga. We were lucky to not have to borrow any money for buying the original contract to use the plot and had some money to start building the Guest Stuga (a further 32,000 SEK) as well as the Revised Main Stuga. Any money earned over the building period (which has lasted 8 months to date) has been used to purchase more materials.

Building a home is a long-term project and a large commitment and should not be taken on lightly. It takes a large portion of your time and effectively becomes your life, but in the whole scale of things, this is a short period of your life and the experience gained, the personal and financial independence gained will be far better in the long run.
That said, you don’t have to go it alone. To reduce the burden and stress of self-building there are now Intentional Communities, a term that encompasses “ecovillages, cohousing, residential land trusts, income-sharing communes, student co-ops, spiritual communities, and other projects” (FIC, n.d.). These more shared schemes, particularly cohousing schemes, where residents actively participate in the design and operation of their neighbourhoods. *Kollectivehus NU* is a cohousing organisation running since 1981. In an article that summarises the cohousing movement in Sweden, the author Bertil Egero discusses how the “majority of today’s activists in Kollektivhus NU are middle-aged or retired” bemoaning the lack of “Community organisation in the 21st Century.” (Egero, 2012, p 10) Egero concludes that the main challenge facing organisations and movements like cohousing is to make the alternative housing arrangements become part of mainstream thinking “among politicians, housing companies and the architect profession.” (Egero, 2012, p 11) This change in focus is probably the right direction, but who will be lobbying the politicians and the housing companies? It is down to these grassroots movements and to the few architects out there who seem to care about the issues raised in this thesis.

In an excerpt from the book *A Right to Build* available online, author Alastair Parvin calls out the large scale for-profit property developers for their economic models. He rightly points out that those who are self-building are probably more likely to invest a little more in better quality or thicker insulation as they are the ones who will benefit from it when it comes to paying for the energy bills. Whereas a property developer will only see this as an extra cost and a dent in the profit of a building that, for them, is a short-term financial asset (Parvin, 2013).

I suggest that there are three alternatives for energy efficient homes to become the norm, the standard way for property developers to build and those are:

- National building regulators increase their minimum requirements for energy efficiency for all new built homes and renovations
- Similarly, national building regulators adopt an ever evolving Green Building Standard for all new built homes and renovations
- Or the housing market recognises that energy efficient homes are more valuable in the long run, possible due to a change in public perception and resulting demand.

### 8.5.2 Scale

I mentioned scale in the Autonomous Housing discussion section, but the area that we live in is increasing. In 2008 each Swede, on average, had 92.8m² of useful floor area per dwelling per person. In 2009 the newly built apartments in Sweden had a greater floor area per person of 99.1m² (SCB, 2012, p 31). Maybe this is the wrong way to go?

From our own personal experience, going from a house design of over 150m² and down to one that was 25m² (plus a 10m² greenhouse), the financial requirements, the actual physical requirements, the amount of material required were significantly less, making building our own home more realistic and cheaper to operate. Also as the space heating is the largest energy demand, this has made the cost of keeping a comfortable temperature cheaper and easier.

The ‘Tiny House Movement’ has latterly influenced me. Similar to the background ideals and Walter Segal dynamic of this thesis, the Tiny House Movement is an informal grass roots movement that encourages people to design and build their own ‘tiny’ homes typically around
10-12m². The many examples of clever multifunctional space created by the owner-designer-builders were a great inspiration for the revised and as built design.

Architect Sarah Susanka promotes the idea of removing formal rooms to scale back the overall area of the building and to personalise the everyday spaces. She promotes the quality-not-quantity approach and promotes adding details that enrich the space and give it character. Susanka sees architects as important in changing the idea that bigger is better and instead provide homes with a sense of comfort which can only be accomplished within the residents have time to live in the houses, to fill them with personal details that provide a meaning (Susanka, 2000). Although they have different thoughts on the role of the architects this same sentiment of allowing homes to be personalised is something that Alexander et al talk about in the Pattern *Things from your life* (No.253).

### 8.5.3 The next step in architecture

The purpose of this thesis was to test out whether the idea of building your own home was a viable option for young adults. This was partly inspired by the architect Walter Segal who sold plans for homes that could be built with materials readily available at hardware stores and were easy for people with no real knowledge of the construction industry to follow.

These Walter Segal plans had to be bought, however with the age of the internet and the rise in Creative Commons thinking, I predict that open source plans for easy to build homes are not in the too distant future and the revolution has already started.

WikiHouse is a creative commons organisation backed by an architecture firm that has developed a simple building system that requires no more than a CNC machine (computerised numerical control) to cut out the patterns from plywood, which then a group of people, novices, to put together like a giant jigsaw. The WikiHouse movement has grown to include people from all over the world, collaborating in developing the idea further and producing models feeding back their experiences to the WikiHouse worldwide community. With the plans available online, the software (*Sketchup*) to use and manipulate the plans freely available (*Sketchup*), you only need access to a CNC machine that are becoming more readily available and a group of friends to help you erect the basic structure. WikiHouse is in the early stages, but it is pushing the boundary and providing and opportunity for people to design and construct their own home with basic knowledge.

### 8.6 Recommendations

Having spent some time with this topic of self-building, sustainable homes, autonomous home and having had some experience of seeing and taking part in construction from the ground up I have a few suggestions. Some are ‘top down’ offerings to those who are in positions to take on board these suggestions, the others are more ‘bottom up’ ideas of where anyone who is interested can look at as starting places:

- Adopt the standards that look beyond individual buildings; ask the designers, architects and construction companies to really think about how their building interacts with its surrounds. What is the genius loci of the place? How will this new building change this for good or for bad?
- Change it so that not one company can buy more than 50% of the land available to build on.
- Sell off ‘plots’ to give the opportunity for people to design and build how they want to, what suits their needs, allow them to start off small and extend as/when needed.
• Think before you design or set requirements for connections to wastewater systems, all wastewater should be treated on-site or close-by.
• Include all parties in the development of an area
• Whenever you design a building, always look for ways of making it smaller.
• Look at and help develop the ideas such as WikiHouse and 3D printing, these technologies could change the way we build and make the possibility of opening up the challenge of building your own home.

8.7 Concluding Remarks
This section completed the three ‘snapshots’ that ran through this thesis; but the case study will continue. There are elements of the Revised Main Stuga and the rest of the case study plot that will continue to be developed. Outside the borders of the plot provides further opportunities to become active members of the community and to hopefully inspire others. Autonomous housing or at least ‘independent communities’ have a role to play in the future of the built environment.

We are at a point in Sweden where there is a clear shortage of homes for young people. There are now discussions, politically and socially as well as professionally regarding the upgrade, maintenance and improvements on those houses built during the Miljonprogrammet. These upgrades and maintenance are partly a response to the criticism of style and design of the Miljonprogrammer but can be more than a face-lift of colours and balconies. This is a good opportunity for Sweden to improve the efficiency of a significant number of their residential buildings, remove reliance on centralized production and waste systems and understand that the built environment, with participation in the rejuvenation of the residents, can lead to healthier and more sustainable lifestyle for the people of today and future generations.
9 Summary

Sustainable development is a complex and multifaceted issue, the built environment is a major contributor to greenhouse gases and the energy required to support our lifestyles is a third of that produced. Reducing the energy demand through efficiency is a clear goal; this thesis speculated whether buildings could also reconnect us to nature through design, awareness about the resources they use and produce. Through this framing, this thesis set out to answer the following research questions:

• Is an autonomous house possible in Sweden?
• And can one design build an autonomous home in the spirit of Walter Segal?

Also, within these two questions and framed by a the Case Study methodology there was a design challenge to:

“...explore the idea of building a house, a home for a small family who are able to live in the house around the year, with minimal negative impact on the environment. The house should be designed to be as near autonomous as possible with minimal reliance on large infrastructure and designed with materials that can be bought from local retailers, that can be re-used or recycled when/if the building’s life comes to an end.”

To answer the first question, is an autonomous house possible in Sweden? The answer is of course... depending on the context! It is said of the Case Study methodology that, due to the specifics of the case, are often difficult to conclude with generalisations. However the take-away positives from the initial Main Stuga design (Section 8.2.1) provided some good general rules when thinking about designing an autonomous house in Sweden.

My own thinking, over the past year and based upon the experience gained from this thesis has been to think beyond the boundaries of a single home, look towards the neighbours to find commonalities and collaborations. It’s pleasing to see that BREEAM have expanded their horizons with the BREEAM Communities and that, in the UK at least, there are more opportunities for a group of people to compete with large housing developers with the support of the Communities Initiative.

Which brings me to the deeper underlying idea of this thesis: can one take the housing shortage into their own hands by building a home for themselves. Again, the answer is never black or white. Having gone on a journey, documented in this case study, this thesis; I can say that it is not a challenge to take on light heartedly. Unwritten here is the amount of time and energy it took to build the Revised Main Stuga. There was a huge amount of stress and always a lingering doubt in our abilities. Any monetary savings we had is gone. With that said, it could be argued that, through the design, construction and occupation of Revised Main Stuga we have satisfied the ‘higher’ levels on Maslow’s Pyramid. My girlfriend and I feel a great sense of achievement and have learned a great deal from the hands on experience. There is plenty of information whether it’s looking through A Pattern Language, searching the internet or asking experience people around for help and advice, even buying a Walter Segal architectural drawings would help with giving some inspiration and build up a knowledge and confidence to have a go yourselves.

The willingness to ‘reduce’ our standards was also a major factor of the success of the Revised Main Stuga. The living space that we have created for ourselves is perfectly sized to our needs with the additional buildings on the plot providing the storage and flexibility we
need when friends and family come to visit. Financially, we have a rent that is one-twelfth of our contemporaries and we now have an asset within the real estate market.

The *Game of Life* continues, but the end goals have changed. No longer should we strive and compete with one another to reach *Millionaire’s Mansion*. Our buildings reflect our time and thinking; the goals for a sustainable life lie in the multiple directions with no one true path. Understanding this concept and designing with context as the overarching factor, the designer should use a series of *tools or patterns* to help him or her to develop a design that, one the hand provides the human wants and needs, but does so with full knowledge of the effects and impacts on the surrounding environment. We should no longer see a home or a building as a single entity, but as part of a community with commonalities distributed and differences shared; and before that within the environment in which it sits. Context is King.
10 Acknowledgements

As I’ve already mentioned, this thesis has been written over an extended period of time and has allowed me to think more about the overall design, specific elements of the design but also during this time I have had the chance to build a small home. This practical experience has been valuable for me to see the building process from the ground up and has allowed me to develop ideas.

I have been lucky to have had the luxury of being on site, to be able make decisions about the overall design of the building. A quick anecdote from building the Main Stuga: one day we replaced a window in the north wall when renovating the north wall, however when in place it no longer looked right, almost too big for the space. That evening I sat in the Main Stuga for an hour or two looking out of the replaced window – it offered no beneficial view and being in the north wall was detrimental to the energy efficiency of the building. The next day I removed the window again and built up the north wall to enclose the hole where the window once stood. I think Christopher Alexander would be pleased to hear of this process, of the designer-builder having the flexibility of designing as they go.

This thesis would not have been written without the help of a few people…

The Main Stuga, what now stands, would not have been completed without the driving forces of my girlfriend and fellow Segalite Elle Nikishkova. We had luck with the weather, but we also had luck with our friends: Vicky ‘the brush’ Zalameda, Ida ‘Lesbian of the year’ Frisk, Eric ‘Hammer Hands’ Beal, Magnus Posjnov, Spencer Shander, Justin Casmir and Lakin Anderson. There were many more who have helped, not just with the construction, but also with the destruction and I would like to thank them too.

My own thinking and direction towards sustainable homes would not have been without the inspiration I have taken from Per Andersson, Chris Wegweiser, Fredrik Forsman and Niklas Svensson.

I would like to thank my Supervisor, Per Berg, for introducing me to *A Pattern Language* and providing support and encouragement during this extended period. And finally, I would like to thank my Evaluator, Per Hedfors, for his comments and suggestions.

This thesis is dedicated to the memory of Per Hulten, a friend, a mentor and an inspiration.
11 References


Case Study Location: Nåntuna Lund

Appendix A

Ben Owen

Master thesis in Sustainable Development

Autonomous House in Sweden

Context is King: A Case Study of an
Case Study  Location: Nåntuna Lund

Photo A – View of Nåntuna Lund from the Fyrisån (by author, May 2015)
Photo B – View from the veranda at sunset (by author, August 2014)
Photo C – Spring time in local area (by author, May 2015)
Photo D – View north towards Uppsala (by author, May 2015)
Photo E – View south (by author, May 2015)
Photo F – Linnéstig in the local area

Detail A – Overview of Nåntuna Lund (screen capture from Eniro.se)

Appendix A
Case Study  Location: Nåntuna Lund
Case Study Location: Nåntuna Lund

Appendix A
Case Study Location: Nåntuna Lund
Case Study  Location: Nåntuna Lund

Photo A
Photo B
Photo C

Appendix A
Case Study  Location: Nåntuna Lund
Appendix A
Case Study  Location: Nåntuna Lund
Appendix B
Pictures and Maps Associated with the Case Study

Plot and Existing Buildings

Ben Owen
Master Thesis in Sustainable Development

Context is King: A Case Study of an Autonomous House in Sweden
- Existing Main Stuga is a 1950’s summer stuga, 25m2 with no running water, sanitation or waste systems.
- Attached is a 25m2 veranda built within the last 5 years.
- Case Study plot also contains a playhouse, sauna in disrepair and a guesthouse.

**Appendix B**
Pictures and maps associated with the Case Study plot and Existing buildings
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Appendix B
Pictures and maps associated with the Case Study plot and Existing buildings
Appendix B
Pictures and maps associated with the Case Study plot and Existing buildings
Appendix B
Pictures and maps associated with the Case Study plot and Existing buildings
Living Space

Kitchen

Toilet

Veranda

Main Stuga

Approx. 5m

Appendix B
Pictures and maps associated with the Case Study plot and Existing buildings
Appendix C

Solar Movement for Case Study Plot

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Autonomous House in Sweden

Context is King: A Case Study of an
Dec 21 – The yellow line shows the Solar Elevation (right) and Solar Path (left)

June 21 – The yellow line shows the Solar Elevation (right) and Solar Path (left)

Pictures are screen shots taken from Sunearthtools.com

Appendix C
Solar Movement for Case Study Plot
Case Study Pattern Language

Appendix D

Ben Owen
Master Thesis in Sustainable Development

Autonomous House in Sweden

Context is King: A Case Study of an
<table>
<thead>
<tr>
<th>TOWNS</th>
<th>Pattern</th>
<th>Essence of the problem</th>
<th>The solution</th>
<th>Applicable</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Countryside</td>
<td></td>
<td>&quot;I conceive that land belongs for use to a vast family of which many are dead, few are living, and countless members are still unborn...&quot; (p.37)</td>
<td>&quot;Create stewardships among groups of people, families and cooperatives, with each stewardship responsible for one part of the countryside. The stewards are given a lease for the land, and they are free to tend the land and set ground rules for its use - as a small farm, a forest, marshland, desert, and so forth. The public is free to visit the land, hike there, picnic, explore, boat, so long as they conform to the ground rules.&quot; With such a setup, a farm near a city might have picnickers in its fields every day during the summer.&quot; (p.39)</td>
<td>No</td>
<td>Out of scope - problem quote refers to Land Stewardship</td>
</tr>
<tr>
<td>Looped Local Roads</td>
<td>**</td>
<td>&quot;Nobody wants fast through traffic going by their homes.&quot; (p.265)</td>
<td>&quot;Lay out local roads so that they form loops. A loop is defined as any stretch of road which makes it impossible for cars that don't have destinations on it to use it as a shortcut. Do not allow any one loop to serve more than 50 cars, and keep the road nearly narrow - 17 to 20 feet is quite enough.&quot; (p.263)</td>
<td>No</td>
<td>Out of scope</td>
</tr>
<tr>
<td>Green Streets</td>
<td>**</td>
<td>&quot;There is too much hot hard asphalt in the world. A local road, which only gives access to buildings, needs a few stones for the wheels of the cars; nothing more. Most of it can still be green.&quot; (p.267)</td>
<td>&quot;On local roads, closed to through traffic, plant grass all over the road and set occasional pavers stones into the grass to form a surface for the wheels of those cars that need access to the street. Make no distinction between street and sidewalk. Where houses open off the street, put in more paving stones or gravel to let cars turn into their own land.&quot; (p.269)</td>
<td>No</td>
<td>Out of scope - however, the access road is already a 'green street' but without the stones to firm up the ground under the wheels of cars. The area around the access to the house might need saying up it gets heavy use.</td>
</tr>
<tr>
<td>Main Gateways</td>
<td>**</td>
<td>&quot;Any part of a town - large or small - which is to be identified by its inhabitants as a precinct of some kind, will be reinforced, helped in its distinctness, marked, and made more vivid, if the paths which enter it are marked by gateways where they cross the boundary.&quot; (p.277)</td>
<td>&quot;Mark every boundary in the city which has important human meaning - the boundary of a building cluster, a neighborhood, a precinct - be great gateways where the major entering paths cross the boundary.&quot; (p.278)</td>
<td>No</td>
<td>Out of scope</td>
</tr>
<tr>
<td>Accessible Green</td>
<td>**</td>
<td>&quot;People need green open places to go to; when they are close they use them. But if the greens are more than three minutes away, the distance overwhelms the need.&quot; (p.305)</td>
<td>&quot;Build one open public green within three minutes' walk - about 750 feet - of every house and workplace. This means that the greens need to be uniformly scattered at 1500-foot intervals, throughout the city. Make the greens at least 150 feet across, and at least 60,000 square feet in area.&quot; (p.309)</td>
<td>No</td>
<td>Out of scope - the site location is a 'green space', but what about access to 'blue spaces'? See No.71 Still Water</td>
</tr>
<tr>
<td>Small Public Square</td>
<td>**</td>
<td>&quot;A town needs public squares; they are the largest, most public rooms, that the town has. But when they are too large, they look and feel deserted.&quot; (p.311)</td>
<td>&quot;Make a public space much smaller than you would at first imagine; usually no more than 45 to 60 feet across, never more than 70 feet across. This applies only to its width in the short direction. In the long direction it can be certainly longer.&quot; (p.313)</td>
<td>No</td>
<td>Out of scope</td>
</tr>
<tr>
<td>Common Land</td>
<td>**</td>
<td>&quot;Without common land no social system can survive.&quot; (p.337)</td>
<td>&quot;Give over 25 per cent of the land in house clusters to common land which touches, or is very very near, the homes which share it. Basic: be wary of the automobile; on no account let it dominate this land.&quot; (p.339)</td>
<td>No</td>
<td>Out of scope</td>
</tr>
<tr>
<td>Still Water</td>
<td></td>
<td>&quot;To be in Touch with Water, we must above all be able to swim; and to swim daily, the pools and ponds and holes for swimming must be so widely scattered through the city, that each person can reach one within minutes.&quot; (p.359)</td>
<td>&quot;In every neighborhood, provide some still water - no pond, a pool for swimming. Keep the pool open to the public at all times, but make the entrance to the pool only from the shallow side of the pool, and make the pool deepen gradually, starting from one or two inches deep.&quot; (p.361)</td>
<td>No</td>
<td>Out of scope - hard for the project to impact the are with this pattern. - There are already plenty of options locally with the nearby lake and river. - pattern fits into the idillic Swedish life</td>
</tr>
<tr>
<td>House for a Small Family</td>
<td>**</td>
<td>&quot;In a house for a small family, it is the relationship between children and adults which is most crucial.&quot; (p.382)</td>
<td>&quot;Conceive a house for a couple as being made up of Yes of two kinds of places - a shared couple’s realm and individual private worlds. Imagine the shared realm as half-public and half-intimate; and the private worlds as entirely individual and private.&quot; (p.384)</td>
<td>No</td>
<td>Out of scope - hand for the project to impact the are with this pattern. - There are already plenty of options locally with the nearby lake and river. - pattern fits into the idillic Swedish life</td>
</tr>
</tbody>
</table>

**Context is King: A Case Study of an Autonomous House in Sweden**

Appendix D - Case Study: Pattern Language

Ben Owen
<table>
<thead>
<tr>
<th>No.</th>
<th>Pattern</th>
<th>Essence of the problem</th>
<th>The solution</th>
<th>Applicable</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>Your Own Home</td>
<td><strong>&quot;People cannot be genuinely comfortable and healthy in a house which is not theirs. All forms of rental - whether from private landlords or public housing agencies - work against the natural processes which allow people to form stable, self-healing communities.&quot;</strong> (p. 393)</td>
<td>Do everything possible to make the traditional forms of rental impossible, indeed, illegal. Give every household its own home, with space enough for a garden. Keep the emphasis in the definition of ownership on control, not on financial ownership. Indeed, where it is possible to construct forms of ownership which give people control over their homes and gardens, but make financial speculation impossible, choose these forms above all others. In all cases give people the legal power, and the physical opportunity to modify and repair their own places. Pay attention to this rule, especially, in the case of high density apartments: build the apartments in such a way that the individual apartment has a garden, or a terrace where vegetables will grow, and that given in this situation, each family can build, and change, and add on to their house as they wish.&quot; (p. 393)</td>
<td>Yes</td>
<td>This is really important, it almost describes the way in which the land/building is leased to us - SLU owns the land, we pay rent for the land of 6,000kron/year, but we own the buildings on site. - I've also been thinking a lot recently about 'Land Stewardship', being custodians of the land rather than owners and this pattern resonates with this ideal.</td>
</tr>
</tbody>
</table>

### BUILDINGS

<table>
<thead>
<tr>
<th>No.</th>
<th>Pattern</th>
<th>Essence of the problem</th>
<th>The solution</th>
<th>Applicable</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>Building Complex</td>
<td><strong>&quot;A building cannot be a human building unless it is a complex of still smaller buildings or smaller parts which manifest its own internal social facts.&quot;</strong> (p. 469)</td>
<td>&quot;Never build large monolithic buildings. Whenever possible translate your building program into a building complex, whose parts manifest the actual social facts of the situation. At low densities, a building complex may take the form of a collection of small buildings connected by arcades, paths, bridges, shared gardens, and walls. At higher densities, a single building can be treated as a building complex, if its important parts are picked out and made identifiable while still part of one three-dimensional fabric. Even a small building, a house for example, can be conceived of as a &quot;building complex&quot; - perhaps part of it is higher than the rest with wings and an adjoining cottage.&quot; (p. 472)</td>
<td>Yes</td>
<td>Given the text in the pattern, this doesn't really apply to the site and scale. However, attention must be paid to the parking area to ensure that it doesn't take anything away from the view and access to the main building.</td>
</tr>
<tr>
<td>97</td>
<td>Shielded Parking</td>
<td>* &quot;Large parking structures full of cars are inhuman and dead buildings - no one wants to see them or walk by them. At the same time, if you are driving, the entrance to a parking structure is essentially the main entrance to the building and it needs to be visible.&quot; (p. 477)</td>
<td>* &quot;Put all large parking lots, or parking garages, behind some kind of natural wall, so that the cars and parking structures cannot be seen from outside. The wall which surrounds the cars may be a building, connected houses, or housing hills, earth berms, or drops. Make the entrance to the parking lot a natural gateway to the buildings which it serves, and place it so that you can easily see the main entrance to the building from the entrance to the parking.&quot; (p. 479)</td>
<td>Yes and No</td>
<td></td>
</tr>
<tr>
<td>98</td>
<td>Circulation Realms</td>
<td><strong>&quot;In many modern building complexes the problem of disorientation is acute. People had no idea where they are, and they experience considerable mental stress as a result.&quot;</strong> (p. 481)</td>
<td>* &quot;Lay out very large buildings and collections of small buildings so that one reaches a given point inside by passing through a sequence of realms, each marked by a gateway and becoming smaller and smaller, as one passes from one each, through a gateway, to the next. Choose the realms so that each one can be easily named, so that you can tell a person where to go, simply by telling him which realms to go through.&quot; (p. 484) &quot;For any collection of buildings, decide which building in the group houses the most essential function - which building is the soul of the group, as a human institution. The form this building as the main building, with a central position, higher roof. Even if the building complex is so dense that it is a single building, build the main part of it higher and more prominent that the rest, so that the eye goes immediately to the part which is the most important.&quot; (p. 487)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>Main Building</td>
<td>* &quot;A complex of buildings with no center is like a man without a head.&quot; (p. 486)</td>
<td>* &quot;Arrange buildings so that they form pedestrian streets with many entrances and open stairs directly from the upper stories to the street, so that even movement between rooms is outdoors, not just movement between buildings.&quot; (p. 493)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>Pedestrian Street</td>
<td><strong>&quot;The simple social intercourse created when people run shoulders in public is one of the most essential kinds of social &quot;glue&quot; in society.&quot;</strong> (p. 489)</td>
<td>* &quot;Arrange buildings so that they form pedestrian streets with many entrances and open stairs directly from the upper stories to the street, so that even movement between rooms is outdoors, not just movement between buildings.&quot; (p. 493)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>101</td>
<td>Building Thoroughfare</td>
<td>* &quot;When a public building complex cannot be completely served by outdoor pedestrian streets, a new form of indoor street, quite different from the conventional corridor, is needed.&quot; (p. 493)</td>
<td>* &quot;Whenever density or climate force the main lines of circulation indoors, build them as building thoroughfares. Place each thoroughfare in a position where it functions as a shortcarr, as continuous as possible with the public street outside, with wide open entrances. And line its edges with windows, places to sit, counters, and entrances which project out into the hallway, expose the buildings' main functions to the public. Make it wider than a normal corridor - at least 11 feet wide and more usually, 15 to 20 feet wide; give it a high ceiling, at least 15 feet, with a glazed roof if possible and low places along the edge. If the street is several stories high, then the walkways along the edges, on the different stories, can be used to form the low places.&quot; (p. 498)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Pattern</td>
<td>Essence of the problem</td>
<td>The solution</td>
<td>Applicable</td>
<td>Notes</td>
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</tr>
<tr>
<td>102</td>
<td>Family of Entrances</td>
<td>&quot;When a person arrives in a complex of offices or services or workshops, or in a group related houses, there is a good chance he will experience confusion unless the whole collection is laid out before him, so that he can see the entrance of the place where he is going.&quot; (p.500)</td>
<td>1. They form a group, are visible together, and each is visible from all the others.</td>
<td>No</td>
<td>- If the Main building is done correctly, along with the patterns 110. Main Entrance, 120. Paths and Goals and 121. Path Shape, then this shouldn’t be a problem</td>
</tr>
<tr>
<td>104</td>
<td>Site Repair</td>
<td>** &quot;Buildings must always be built on those parts of the land which are in the worst condition, not the best.&quot; (p.509) **</td>
<td>&quot;On no account place buildings in the places which are most beautiful. In fact, do the opposite. Consider the sins and its buildings as a single living eco-system. Leave those areas that are the most precious and beautiful, comfortable, and healthy as they are, and build new structures in those parts of the site which are least pleasant now.&quot; (p.511)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>South-Facing Outdoors</td>
<td>** &quot;People use open space if it is sunny, and do not use it if it isn’t, in all but desert climates.&quot; (p.514) **</td>
<td>&quot;Always place buildings to keep the north of the outdoors spaces that go with them, and keep the outdoor spaces to the south. Never leave a deep band of shade between the building and the sunny part of the outdoors.&quot; (p.516)</td>
<td>Yes</td>
<td>- convex not concave corners</td>
</tr>
<tr>
<td>106</td>
<td>Positive Outdoor Spaces</td>
<td>** &quot;Outdoor spaces which are merely ‘left over’ between buildings will, in general, not be used.&quot; (p.518) **</td>
<td>&quot;Make all the outdoor spaces which surround and lie between your buildings positive. Give each one some degree of enclosure; surround each space with wings of buildings, trees, hedges, fences, arcades, and trellised walks, until it becomes an entity with a positive quality and does not spill out indefinitely around corners.&quot; (p.522)</td>
<td>Yes</td>
<td>- this pattern is applicable, but given the size of building footprint this happens by default</td>
</tr>
<tr>
<td>107</td>
<td>Wings of Light</td>
<td>** &quot;Modern buildings are often shaped with no concern for natural light - they depend almost entirely on artificial light. But buildings which displace natural light as the major source of illumination are not fit places to spend the day.&quot; (p.525) **</td>
<td>&quot;Arrange each building so that it breaks down into wings which correspond, approximately, to the most important natural sociocentric division of the building. Make each wing long and narrow as you can - never more than 25 feet wide.&quot; (p.529)</td>
<td>Yes and No</td>
<td>- link the main stage to the suana and storage room - use covered walkway</td>
</tr>
<tr>
<td>108</td>
<td>Connected Buildings</td>
<td>* &quot;Isolated buildings are symptoms of a disconnected sick society.&quot; (p.532) *</td>
<td>&quot;Connect your building up, wherever possible, to the existing buildings round about. Do not keep set back between buildings; instead, try to form new buildings as continuations of the older buildings.&quot; (p.534)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>109</td>
<td>Long Thin House</td>
<td>* &quot;The shape of a building has a great effect on the relative degrees of privacy and overcrowding in it, and this in turn has a critical effect on people’s comfort and well being.&quot; (p.535) *</td>
<td>&quot;In small buildings, don’t cluster all the rooms together around each other; instead string out the rooms one after another, so that distance between each room is as great as it can be. You can do this horizontally - so that the plan becomes a thin, long rectable; or you can do it vertically - so that the building becomes a tall narrow tower. In either case, the building can be surprisingly narrow and still work - 8, 10 and 12 feet are all quite possible.&quot; (p.537)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>Main Entrance</td>
<td>** &quot;Placing the main entrance (or main entries) is perhaps the single most important step you take during the evolution of a building plan.&quot; (p.541) **</td>
<td>&quot;Place the main entrance of the building at a point where it can be seen immediately from the main avenues of approach and give it a bold, visible shape which stands out in front of the building.&quot; (p.544)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>Half-Hidden Garden</td>
<td>* &quot;If a garden is too close to the street, people won’t use it because it isn’t private enough. But if it is too far from the street, then it won’t be used either, because it is too isolated.&quot; (p.545) *</td>
<td>&quot;Do not place the garden fully in front of the house, nor fully to the back. Instead, place it in some kind of half-way position, side-by-side with the house, in a position which is half-hidden from the street, and half exposed.&quot; (p.547)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>Entrance Transition</td>
<td>** &quot;Buildings, and especially houses, with a graceful transition between the street and the inside, are more tranquil than those which are open directly off the street.&quot; (p.549) **</td>
<td>&quot;Make a transition space between the street and the front door. Bring the path which connects street and entrance through this transition space, and mark it with a change of light, a change of sound, a change of direction, a change of surface, a change of level, perhaps by gateways which make a change of enclosure, and above all with a change of view.&quot; (p.552)</td>
<td>Yes</td>
<td>- the house is judged during this transition, therefore it needs to be done right</td>
</tr>
<tr>
<td>113</td>
<td>Car Connection</td>
<td>- &quot;The process of arriving in a house, and leaving it is fundamental to our daily lives; and very often it involves a car. But the place where cars connect to houses, far from being important and beautiful, is often off to one side and neglected.&quot; (p.554) - &quot;Place the parking space for the car and the main entrance, in such a relation to each other, that the shortest route from the parked car into the house, both to the kitchen and to the living rooms, is always through the main entrance. Make the parking place for the car into an actual room which makes a positive and graceful place where the car stands, not just a gap in the terrain.&quot; (p.556) - &quot;Whatever space you are shaping - whether it is a garden, terrace, street, part, public outdoor room, or courtyard, make sure of two things. First, make at least one smaller space, which loops into it and forms a natural back for it. Second, place it, and its openings, so that it looks into at least one larger space. When you have done this, every outdoor space will have a natural &quot;back&quot;, and every person who takes us the natural position, with his back to this &quot;back&quot;, will be looking out toward some larger distant view.&quot; (p.560)</td>
<td>- times have changed - the important description in this pattern is the ‘daily lives’ - we don’t intend to use the car (if we have one) as our main/daily source of transport.</td>
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<td>114</td>
<td>Hierarchy of Open Space</td>
<td>* &quot;Outdoors, people always try to find a spot where they can have their backs protected, looking out toward some larger opening, beyond the space immediately in front of them.&quot; (p.568) *</td>
<td>&quot;Standing back to the door, they turn outward, looking from the back of the house, out to the street, and then to the courtyard, in a “herringbone” pattern. Nothing is added to the plot of land here, and nothing is subtracted from it - just a change of view.&quot; (p.569)</td>
<td>Yes</td>
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Context King: A Case Study of an Autonomous House in Sweden

Appendix D - Case Study: Pattern Language

Ben Owen
<table>
<thead>
<tr>
<th>No.</th>
<th>Pattern</th>
<th>Essence of the problem</th>
<th>The solution</th>
<th>Applicable</th>
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<tbody>
<tr>
<td>115</td>
<td>Courtyards which Live</td>
<td><strong>&quot;The courtyards built in modern buildings are very often dead. They are intended to be private open spaces for people to use - but they end up unused, full of gravel and abstract scultures.&quot;</strong> (p.562)</td>
<td>&quot;Place every courtyard in such a way that there is a view out of it to some larger open space; place it so that at least two or three doors open from the building into it and so that natural paths which connect these doors pass across the courtyard. And, at one edge, beside a door, make a rooted veranda or a porch, which is continuous with both the inside and the courtyard.&quot; (p.564)</td>
<td>Yes and No</td>
<td></td>
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<tr>
<td>116</td>
<td>Cascade of Roofs</td>
<td><strong>&quot;Few buildings will be structurally and socially intact, unless the floors step down toward the ends of wings, and unless the roof according, forms a cascade.&quot;</strong> (p.566)</td>
<td>&quot;Visualize the whole building, or building complex, as a system of roofs. Place the largest, highest and widest roofs over those parts of the building which are most significant; when you come to lay the roofs out in detail, you will be able to make all lesser roofs cascade off these large roofs and form a stable self-buttressing system, which is congruent with the hierarchy of social spaces underneath the building.&quot; (p.568)</td>
<td>No</td>
<td>- given the size of the buildings it is difficult to implement, plus the &quot;lesser&quot; buildings are at a higher level and therefore break the 'hierarchy of social spaces'.</td>
</tr>
<tr>
<td>117</td>
<td>Sheltering Roof</td>
<td><strong>&quot;The roof plays a primal role in our lives. The most primitive buildings are nothing but a roof: if the roof is hidden, if its presence cannot be felt around the building, or if it cannot be used, then people will lack a fundamental sense of shelter.&quot;</strong> (p.570)</td>
<td>&quot;Slope the roof or make a vault of it, make its entire surface visible, and bring the eaves of the roof down low, as low as 6&quot;) or 6&quot;) at places like the entrance, where people pause. Build the top story of each wing right into the roof, so that the roof does not only cover it, but actually surrounds it.&quot; (p.573)</td>
<td>Yes</td>
<td>- Pitched roofs are best, not flat ones. - use the space created by the pitch.</td>
</tr>
<tr>
<td>118</td>
<td>Roof Garden</td>
<td><strong>&quot;A vast part of the earth's surface, in a town, consists of roofs. Couple this with the fact that the total area of town which can be exposed to the sun is finite, and you will realise that it is natural, and indeed essential, to make roofs which take advantage of the sun and air.&quot;</strong> (P.576)</td>
<td>&quot;Make parts of almost every roof system usable as roof gardens. Make these parts flat, perhaps terraced for planting, with places to sit and sleep, private places. Place the roof gardens at various stories, and always make it possible to walk directly out onto the roof garden from some lived in part of the building.&quot; (p.579)</td>
<td>Yes and No</td>
<td>- difficult to implement</td>
</tr>
<tr>
<td>119</td>
<td>Arcades</td>
<td><strong>&quot;Arcades - covered walkways at the edge of buildings, which are partly inside, partly outside - play a vital role in the way that people interact with buildings.&quot;</strong> (p.581)</td>
<td>&quot;Whenever paths run along the edge of buildings, build arcades, and use the arcades, above all to connect up the buildings to one another, so that a person can walk from place to place under the cover of the arcades.&quot; (p.583)</td>
<td>Yes, more for the future</td>
<td>- could do a design which looked at wrapping the east, south and west walls with arcades, then along the sauna to the storage room.</td>
</tr>
<tr>
<td>120</td>
<td>Paths and Goals</td>
<td><strong>&quot;The layout of paths will seem right and comfortable only when it is compatible with the process of walking. And the process of walking is far more subtle than one might imagine.&quot;</strong> (p.586)</td>
<td>&quot;To lay out paths, first place goals at natural points of interest. Then connect the goals to another form the paths. The paths may be straight, or gently curving between goals; their paving should swirl around the goals. The goals should never be more than a few hundred feet apart.&quot; (p.587)</td>
<td>Yes</td>
<td>- out of scope, but we could modify the pathway by the house access</td>
</tr>
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<td>121</td>
<td>Path Shape</td>
<td><strong>&quot;Streets should be staying in, and not just for moving through, the way they are today.&quot;</strong> (p.590)</td>
<td>&quot;Make a bulge in the middle of a public path, and make the ends narrower, so that the path forms an enclosure which is a place to stay, not just a place to pass through.&quot; (p.591)</td>
<td>No</td>
<td>- out of scope, but we could modify the pathway by the house access</td>
</tr>
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</table>
| 122 | Building Fronts | **"Building set-backs from the street, originally intended to protect the public welfare by giving every building light and air, have actually helped greatly to destroy the street as a social space."
(p.593) | "On no account allow set-backs between streets or paths or public open land and the buildings which front on them. The set-backs do nothing valuable and almost always destroy the value of the open areas between the buildings. Build right up to the paths; change the laws in all communities where obsoletely-by-laws make this impossible. And let the building fronts take on slightly uneven angles as they accommodate to the shape of the street." (p.594) | No | - Existing structure set back from 'street' |
<p>| 123 | Activity Pockets | <strong>&quot;The life of a public square forms naturally around its edge. If the edge falls, then the space never becomes lively.&quot;</strong> (p.600) | &quot;Surround public gathering places with pockets of activity - small, partly enclosed areas at the edges, which put forward into the open space between the paths, and contain activities which make it natural for people to pause and get involved.&quot; (p.602) | No | - out of scope |
| 124 | Stair seats | <strong>&quot;Whenever there is action in a place, the spots which are the most inviting are those high enough to give people a vantage point, and low enough to put them in action&quot;</strong> (p.604) | &quot;In any public place where people loiter, add a few steps at the edge where stairs come down or where there is a change in level. Make these raised areas immediately accessible from below, so that people may congregate and sit to watch the goings-on.&quot; (p.605) | No | - out of scope - there will be steps up to the house, maybe something could be done there...? |
| 125 | Something Roughly in the Middle | <strong>A public space without a middle is quite likely to stay empty.</strong> (p.606) | &quot;Between the natural paths which cross a public square or courtyard or a piece of common land choose something to stand roughly in the middle: a fountain, a tree, a statue, a clock-tower with seats, a windmill, a bandstand. Make it something which gives a strong and steady pulse to the square, drawing people in toward the center. Leave it exactly where it falls between the paths; resist the impulse to put it exactly in the middle.&quot; (p.608) | No | - out of scope |
| 126 | Intimacy Gradient | <strong>Unless the spaces in the building are arranged in a sequence which corresponds to their degrees of privativeness, the visits made by strangers, friends, guests, clients, family, will always be a little awkward.&quot;</strong> (p.610) | &quot;Lay out the spaces of a building so that they create a sequence which begins with the entrance and the most public parts of the building, then leads into the slightly more private areas, and finally to the most private domains. P.613)&quot; | Yes | - entrance, kitchen, livingroom, bathroom and bedroom. |</p>
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<th>Applicable Notes</th>
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<tbody>
<tr>
<td>125</td>
<td>Indoor Sunlight</td>
<td>“If the right rooms are facing south, a house is bright and sunny and cheerful; if the wrong rooms are facing south the house is dark and gloomy.” (p.655)</td>
<td>“Place the most important rooms along the south edge of the building, and spread the building out along the east-west axis. Fine tune the arrangement so that the proper rooms are exposed to the south-east and the south-west sun. For example: give the common area a full southern exposure, bedrooms the south-east, porch south-west. For most climates this means the shape of the building is elongated east-west.” (p.657)</td>
<td>hard to implement fully as pattern discription given footprint already set.</td>
</tr>
<tr>
<td>126</td>
<td>Common Areas at the Heart</td>
<td>&quot;No social group - whether a family, a work group, or a school group - can survive without constant informal contact among it's members.&quot; (p.618)</td>
<td>“Create a single common area for every social group. Locate it at the center of gravity of all the spaces the group occupies, and in such a way that paths which go in and out of the building lie tangent to it.” (p.621)</td>
<td>Kitchen will probably be the heart of this home. We spend a lot of time cooking and preparing meals as well as baking and we're amateur jam/marmalade producers. Given the size of the building, the kitchen will also be the main entertaining area as we invite friends and family over for meals. The kitchen is likely to be situated to the right as you first enter the building, just off the small corridor that leads from the main entrance, there will be no door that leads to the kitchen but a large walkway that probably employs pattern No. 193 Half Open Wall.</td>
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<tr>
<td>130</td>
<td>Entrance Room</td>
<td>&quot;Arriving in a building, or leaving it, you need a room to pass through, both inside the building and outside it. This is the entrance room.&quot;</td>
<td>&quot;At the main entrance to a building, make a light-filled room which marks the entrance and straddles the boundary between indoors and outdoors, covering some space outdoors and some space indoors. The outside part may be like an old-fashioned porch; the inside like a hall or sitting room.&quot;</td>
<td>- important to get this light right - do we have the space to incorporate this pattern with any conviction. I don't think there's space to do it justice.</td>
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<td>131</td>
<td>The Flow Through Rooms</td>
<td>&quot;The movement between rooms is an important as the rooms themselves; and its arrangement has as much effect on social interaction in the rooms, as the interiors of the rooms.&quot; (p.628)</td>
<td>&quot;As far as possible, avoid the use of corridors and passages. Instead, use public rooms and common rooms as rooms for movement and for gathering. To do this, place the common rooms to form a chain, or loop, so that it becomes possible to walk from room to room - and so that private rooms open directly off these public rooms. In every case, give this indoor circulation from room to room a feeling of great generosity, passing in a wide and ample loop around the house, with views of fires and great windows.” (p.631)</td>
<td>- initial thoughts - doesn't apply to this project given the size of the project. - does give me an idea of making an extra door on the inside of the kitchen to lounge area to create this 'loop' if there is space and it doesn't affect the kitchen dining area.</td>
</tr>
<tr>
<td>132</td>
<td>Short Passages</td>
<td>&quot;...long, sterile corridors set the scene for everything bad about modern architecture.&quot; (p.633)</td>
<td>“Keep passages short. Make them as much like rooms as possible, with carpets or wood on the floor, furniture, bookshelves, beautiful windows. Make them generous in shape, and always give them plenty of light; the best corridors and passages of all those which have windows along the entire wall.” (p.635)</td>
<td>- initial thoughts - doesn't apply to this project given the size of the project, there wouldn't be long corridors. - check final design for this pattern if it appears</td>
</tr>
<tr>
<td>133</td>
<td>Staircase as a Stage</td>
<td>&quot;A staircase is not just a way of getting from one floor to another. The stair is itself a space, a volume, a part of the building; and unless this space is made to live, it will be a dead spot, and work to disconnect the building and to tear its processes apart.” (p.638)</td>
<td>&quot;Place the main stair in a key position, central and visible. Treat the whole staircase as a room (or if it is outside, as a courtyard). Arrange it so that the stair and the room are one, with the stair coming down around one or two walls of the room. Flare out the bottom of the stair with open windows or balustrades and with wide steps so that people coming down the stair become part of the action in the room while they are on the stair, and so that people below will naturally use the stair for seats.” (p.639)</td>
<td>- pattern feels like it is meant for larger buildings, with such a tight space we're going to have to restrict stairs to a less 'grand' role. However, the location - visible but away from the front door - is something to keep in mind.</td>
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<td>134</td>
<td>Zen View</td>
<td>&quot;The archetypal zen view occurs in a famous Japanese house, which gives this pattern its name.” (p.642)</td>
<td>&quot;If there is a beautiful view, don't spoil it by building huge windows that gape incessantly at it. Instead, put the windows which look onto the view at places of transition - along paths, in hallways, in entry ways, on stairs, between rooms. If the view window is correctly placed, people will see a glimpse of the distant view as they come up to the window or pass it; but the view is never visible from the places where people stay.” (p.643)</td>
<td>- there is a view across to Ultuna, but in a house this small, with one tiny corridor it's difficult to implement.</td>
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<tr>
<td>135</td>
<td>Tapestry of Light and Dark</td>
<td>&quot;In a building with uniform light level, there are few &quot;places&quot; which function as effective settings for human events. This happens because, to a large extent, the places which make effective settings are defined by light.” (p.645)</td>
<td>&quot;Create alternating areas of light and dark throughout the building, in such a way the people naturally walk toward the light, whenever they are going to important places: seats, entrances, stairs, passages, places of special beauty, and make other areas darker, to increase the contrast.&quot; (p.646)</td>
<td>used in bathroom/kitchen corridor</td>
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<td>136</td>
<td>Couple's Realm</td>
<td>&quot;The presence of children in a family often destroys the closeness and the special paniness which a man and wife need together.” (p.649)</td>
<td>&quot;Make a special part of the house distinct from the common areas and all the children's rooms, where the man and woman of the house can be together in private. Give this place a quick path to the children's rooms, but, at all costs, make it a distinctly separate realm.” (p.650)</td>
<td>It's a small house, one way of incorperating this is to increase the bedroom area to include a child's room area, away from the main social spaces.</td>
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<td>The solution</td>
<td>Applicable to the future</td>
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<td>137</td>
<td>Children's Realm</td>
<td>&quot;Children do not have space to release a tremendous amount of energy when they need to, they will drive themselves and everybody else in the family up the wall.&quot; (p.652)</td>
<td>Placing the small area which will belong entirely to the children - the cluster of their beds. This includes a bedroom, playroom, and bathroom. Place it in a separate position toward the back of the house and in such a way that a continuous play space can be made from this cluster to the street. Almost like a wide swath inside the house, muddy, toys strewn along the way, touching those family rooms which children need - the bathroom and the kitchen most of all - passing the common area along one side (but leaving quiet sitting areas and the couple’s realm entirely separate and inviolate), reaching out to the street, either through it’s own door or through the entrance room, and ending in an outdoor room, connected to the street, and sheltered, and large enough so that the children can play in it when it rains. Yet, still be outdoors.&quot; (p.655)</td>
<td>Although not decided that we’ll be having children, the size of the house has been increased based on this. The second floor - the loft space - will be us as extra sleeping areas, however after reading this pattern it makes sense to design the home with the children’s realm on the lower level. One for the future.</td>
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<tr>
<td>138</td>
<td>Sleeping to the East</td>
<td>“This is one of the patterns people most often disagree with. However, we believe they are mistaken.” (p.657)</td>
<td>“Given those parts of the house where people sleep, an eastern orientation, so that they wake up with the sun and light. This means, typically, that the sleeping area needs to be on the eastern side of the house; but it can also be on the western side provided there is a courtyard or a terrace to the east of it.” (p.659)</td>
<td>- be careful not to get sun directly on the bed - this deals with health issues of waking up in a natural way, which are great if you didn’t have to job and didn’t live with such vast differences between sun rise throughout the year - that said, windows to the west would increase light into the room during the summer sun and make it difficult to sleep, blackout curtains could help.</td>
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<tr>
<td>139</td>
<td>Farmhouse Kitchen</td>
<td>“The isolated kitchen, separate from the family and considered as an efficient but unpleasant factory for food is a hangover from the days of servants; and from the more recent days when women willingly took over the servants roles.” (p.661)</td>
<td>“Make the kitchen bigger than usual, big enough to include the ‘family room’ space, and place it near the center of the commons, not so far back in the house as an ordinary kitchen. Make it large enough to hold a good big table and chairs, some soft and some hard, with counters and stove and sink around the edge of the room; and make it bright and comfortable room.” (p.663)</td>
<td>The kitchen will be the largest in the home, we’re willing to sacrifice space in other areas to increase the kitchen size. Living in our current apartment, the kitchen is dark and small and is difficult to work within with more than one person.</td>
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<td>140</td>
<td>Private Terrace on the Street</td>
<td>“The relationship of a house to a street is often confused; either the house opens entirely to the street and there is no privacy; or the house turns its back on the street, and communication with street life is lost.” (p.665)</td>
<td>“Let the common rooms open onto a wide terrace or a porch which looks into the street. Raise the terrace slightly above street level and protect it with a low wall, which prevents people on the street from looking into the common rooms.” (p.667)</td>
<td>- the house isn’t situated on a busy street - the house is already above ‘street’ level and therefore doesn’t require the elevation wall spoken about - but the interaction with the house and the path could be looked at. - difficult to implement this pattern at the scale we’re dealing with. - scope to use the spine cabin as this pattern</td>
</tr>
<tr>
<td>141</td>
<td>A Room of One’s Own</td>
<td>“No one can be close to others, without also having frequent opportunities to be alone.” (p.669)</td>
<td>“Give each member of the family a room of his own, especially adults. A minimum room of one’s own is an acove with desk, shelves, and curtain. The maximum is a cottage - like a TEENAGER’S COTTAGE (154), or an OLD AGE COTTAGE (155). In all cases, especially the adult ones, place these rooms at the far ends of the intimacy gradient - far from the common rooms.” (p.671)</td>
<td>- no such thing as ‘sitting room’ - go through the house, identify sitting spaces and grade them: public, semi-public and private; screen appropriately</td>
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<tr>
<td>142</td>
<td>Sequence if Sitting Spaces</td>
<td>“Every corner of a building is a potential sitting space. But each sitting space has different needs for comfort and enclosure according to its position in the intimacy gradient” (p.637)</td>
<td>“Put in a sequence of graded sitting spaces throughout the building, varying according to their degree of enclosure. Enclose the most formal ones entirely, in rooms by themselves; put the least formal ones in corners of other rooms, without any kind of screen around them; and place the intermediate one with partial enclosure round them to keep connected to some larger space, but also partly separate.” (p.674)</td>
<td>- right now, in later phases</td>
</tr>
<tr>
<td>143</td>
<td>Bed Cluster</td>
<td>“Every child in the family needs a private place, generally centered around the bed. But in many cultures, perhaps all cultures, young children feel isolated if they sleep alone, if their sleeping area is too private.” (p.677)</td>
<td>“Place the children’s beds in alcoves or small alcove-like rooms, around a common play space. Make each alcove large enough to contain a table, or chair, or shelves - at least some floor area, where each child has his own things. Give the alcoves curtains looking into the common space, but not walls or doors, which will tend once more to isolate their beds too greatly.” (p.679)</td>
<td>Not right now, we expect to have two sleeping areas - one on the lower level and one on the upper level. When the time comes to adapt this area, this pattern will provide some help with dividing the space.</td>
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<tr>
<td>144</td>
<td>Bathing Room</td>
<td>“The motions we call bathing are mere ablutions which formerly preceded the bath. The place where they are performed, though adequate for the routine, does not deserve to be called a bathroom” p.682 quote from Bernard Rudofsky</td>
<td>“Concentrate the bathing room, toilets, showers, and basins of the house in a single tiled area. Locate this bathing room beside the couple’s realm - with private access - in a position half-way between the private secluded parts of the house and the common areas; if possible, give it access to the outdoors; perhaps a tiny balcony or walled garden. Put in a large bath - large enough for at least tow people to get completely immersed in water; an efficiency shower and basins for the actual business of cleaning; and two or three rads for huge tows - one by the door, one by the shower and one by the sink.” (p.686)</td>
<td>- they’re right, in the modern world little time is spent bathing, with the focus more on cleaning. - I like the idea brought up earlier of the sauna, we’ve spoken about this before, there is already one on site, but is in disrepair. The new design will house a sauna in a separate building, this will house most of the desirable elements talked about in this pattern.</td>
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<tr>
<td>145</td>
<td>Bulk Storage</td>
<td>“In houses and workplaces there is always some need for bulk storage space; a place for things like suitcases, old furniture, old files, boxes - all those things which you are not ready to throw away, and yet not using everyday.” (p.687)</td>
<td>“Do not leave bulk storage till last or forget it. Include a volume for bulk storage in the building - its floor area at least 15 to 20 per cent of the whole building area - not less. Place this storage somewhere in the building where it costs less than other rooms - because, of course, it doesn’t need a finish.” (p.688)</td>
<td>- that 15-20% could be an important metric to measure against the final design. Question - the more self sufficient household is, the more space it needs.”</td>
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<td>146</td>
<td>Flexible Office Space</td>
<td>&quot;It is possible to create a kind of space which is specifically tuned to the needs of people working, and yet capable of infinite number of various arrangements and combinations within it.&quot; (p.690)</td>
<td>&quot;Let the office space as wings of open space, with free standing columns around their edges, so they define half-private and common spaces opening into one another. Set down enough columns so that people can fill them in over the years, in many different ways - but always in a semi-permanent fashion. If you build to the working group before you build the space, then make it more like a house, more closely tailored to their needs. In either case, create a variety of space throughout the office - comparable in variety to the different sizes and kinds of space in a large old house.&quot; (p.694)</td>
<td>No</td>
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<tr>
<td>147</td>
<td>Communal Eating</td>
<td>* &quot;Without communal eating, no human group can hold together.&quot; (p.687)</td>
<td>&quot;Give every institution and social group a place where people can eat together. Make the common meal a regular event. In particular, start a common lunch in every work place, so that a genuine feel around a common table (not our of boxes, machines, or bags) becomes an important, comfortable, and daily event with room for invited guests. In our own work group at the Center, we found this worked beautifully when we took it in turns to cook the lunch. The length of an event: a gathering: something that each of us put our love and energy into, on our day to cook.&quot; (p.689)</td>
<td>No</td>
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<tr>
<td>148</td>
<td>Small Work Groups</td>
<td>** &quot;When more than half a dozen people work in the same place, it is more essential that they not be forced to work in one huge undifferentiated space, but that instead, they can divide their workspace up, and so form smaller groups.&quot; (p.702)</td>
<td>&quot;Break institutions into small, spatially identifiable work groups, with less than half a dozen people in each. Arrange these work groups so that each person is in at least partial presence of the other members of his own group; and arrange several groups in such a way that they share a common entrance, food, office equipment, drinking fountains, bathrooms.&quot; (p.703)</td>
<td>No</td>
</tr>
<tr>
<td>149</td>
<td>Reception Welcomes You</td>
<td>- &quot;Have you ever walked into a public building and been processed by the receptionist as if you were a package?&quot; (p.705)</td>
<td>&quot;Arrange a series of welcoming things immediately inside the entrance - soft chairs, a fireplace, food, coffee. Place the reception desk so that it is not between the receptionist and the welcoming area, but to one side at an angle - so that she, or he, can get up and walk toward the people who come in, greet them, and then invite them to sit down.&quot; (p.706)</td>
<td>No</td>
</tr>
<tr>
<td>152</td>
<td>Half-Private Office</td>
<td>- &quot;What is the right balance between privacy and connection in office work?&quot; (p.717)</td>
<td>&quot;Make a workroom, whether it is for a group of two or three people or for one person, half-open to the other workgroups and the world immediately beyond it. At the front, just inside the door, make comfortable sitting space, with the actual workspace away from the door, and further back.&quot; (p.718)</td>
<td>No</td>
</tr>
<tr>
<td>153</td>
<td>Rooms to Rent</td>
<td>- &quot;As the life in a building changes, the need for space shrinks and swells cyclically. The building must be able to adapt to this irregular increase and decrease in the need for space.&quot; (p.720)</td>
<td>&quot;Make at least some part of the building rentable: give it a private entrance over and above its regular connection to the rest of the house. Make sure that the regular entrance can be easily closed off without destroying the circulation in the house, and make sure that a bathroom can be directly reached from this room without having to go through the main house.&quot; (p.722)</td>
<td>Yes, more for the future</td>
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<tr>
<td>154</td>
<td>Teenager’s Cottage</td>
<td>- &quot;If a teenager’s place in the home does not reflect his need for a measure of independence, he will be locked in conflict with his family.&quot; (p.724)</td>
<td>&quot;To mark a child’s coming of age, transform his place in the home into a kind of cottage that expresses in a physical way the beginning of independence. Keep the cottage attached to the home, but make it a distinctly visible budge, far away from the master bedroom, with its own private entrance, perhaps its own roof.&quot; (p.727)</td>
<td>Yes, more for the future</td>
</tr>
<tr>
<td>155</td>
<td>Old Age Cottage</td>
<td>** &quot;Old people, especially when they are alone, face a terrible dilemma. On the one hand, there are inescapable forces pushing them toward independence: their friends and wives and husbands die. On the other hand, by the very nature of aging, old people become dependent on the simple conveniences, simple connections to the society about them.&quot; (p.730)</td>
<td>&quot;Build some of them on the land of larger houses, for a grandparent; build others on individual lots, much smaller than ordinary lots, in space these cottages at ground level, right on the street, where people are walking by, and close to the neighborhood services and common land.&quot; (p.731)</td>
<td>Not as written, beyond scope of project.</td>
</tr>
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<td>157</td>
<td>Home Workshop</td>
<td>- &quot;As the decentralization of works becomes more and more effective, the workshop in the home grows and grows in importance.&quot; (p.738)</td>
<td>&quot;Make a place in the home, where substantial work can be done; not just a hobby, but a job. Change te zoning laws to encourage modest, quiet work operations to locate in neighborhoods. Give the workshop perhaps a few hundred square feet; and located it so it can be seen from the street and the owner can hand out a shingle.&quot; (p.739)</td>
<td>Not right now, in later phases</td>
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<tr>
<td>No.</td>
<td>Pattern</td>
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<td>138</td>
<td>Open Stairs</td>
<td>* Internal staircases reduce the connection between upper stories and the life of the street to such an extent that they can do enormous social damage.* (p.741)</td>
<td>No</td>
<td>- difficult to implement on a private residence in Sweden and at this scale - especially given this project scope. - nice theory though</td>
</tr>
<tr>
<td>159</td>
<td>Light on Two Sides of Every Room</td>
<td>** &quot;When they have a choice, people will always gravitate to those rooms which have light on two sides, and leave the empty rooms which are lit only from one side unused and empty.&quot; (p.747)</td>
<td>Yes</td>
<td>Given the number of rooms ([kitchen, living room, bathroom, bedroom and entrance hall] and the current idea of a regular rectangle layout, this may make making 'cuts' in the regular shape.</td>
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<td>160</td>
<td>Building Edge</td>
<td>** &quot;A building is most often thought of as something which turns inward - toward its rooms. People do not often think of a building as something which must also be oriented toward the outside.&quot; (p.753)</td>
<td>Yes</td>
<td>- Important place - Elle wants 'taming spots' - more than one? - I get the feeling that this is decided upon after the main building design is done.</td>
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<td>161</td>
<td>Sunny Place</td>
<td>** &quot;The area immediately outside the building, to the south - that angle between its walls and the earth where the sun falls - must be developed and made into a place which lets people bask in it.&quot; (p.758)</td>
<td>Yes</td>
<td>- it's a large area, need to use this wisely - wood storage - water storage</td>
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<tr>
<td>162</td>
<td>North Face</td>
<td>&quot;Look at the north sides of the buildings which you know. Almost everywhere you will find that these are the spots which are dead and dark, gloomy and useless. Yet there are hundreds of acres in a town on the north sides of buildings; and it is inevitable that there must always be land in this position, wherever there are buildings.&quot; (p.761)</td>
<td>Yes</td>
<td>- could be part of building arrangement that constitutes the sauna and storage space - could also encorporate a lot of other patterns</td>
</tr>
<tr>
<td>163</td>
<td>Outdoor Room</td>
<td>** &quot;A garden is the place for lying in the grass, swinging, croquet, growing flowers, throwing a ball for the dog. But there is another way of being outdoors: and its needs are not met by the garden at all.&quot; (p.765)</td>
<td>Yes, more for the future</td>
<td></td>
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<td>164</td>
<td>Street Windows</td>
<td>&quot;A street without windows is blind and frightening. And it is equally uncomfortable to be in a house which bounds a public street with no window at all on the street.&quot; (p.770)</td>
<td>No</td>
<td></td>
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<tr>
<td>166</td>
<td>Gallery Surround</td>
<td>** &quot;If people walk out from the building into balconies and terraces which look toward the outdoor space around the building, then neither they themselves nor the people outside have any medium which helps them feel the building and the larger public world are intertwined.&quot; (p.778)</td>
<td>Q books considers pattern * fundamental...&quot; (p.778)</td>
<td></td>
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<tr>
<td>167</td>
<td>Sloe-Foot Balcony</td>
<td>** &quot;Balconies and porches which are less than six feet deep are hardly ever used.&quot; (p.782)</td>
<td>Yes</td>
<td>- I've noticed how little this pattern is used in modern apartment building up in Uppsala. Having had an open and small balcony I've noticed how little it is used with regards to a neighbours balcony that was much larger and more private.</td>
</tr>
<tr>
<td>168</td>
<td>Connection to the Earth</td>
<td>** &quot;A house feels isolated from the nature around it, as its floors are interleaved directly with the earth that is around the house.&quot; (p.786)</td>
<td>Yes</td>
<td>- from kitchen to outside will be an important transition from building to 'earth'</td>
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<tr>
<td>169</td>
<td>Terraced Slope</td>
<td>** &quot;On sloping land, erosion caused by run off can kill the soil. It also creates uneven distribution of rainwater over the land, which naturally does less for plant life than it could if it were evenly distributed.&quot; (p.791)</td>
<td>Yes</td>
<td>- The plot this is required * - goes against the grain of letting the land be what it wants to be i.e. man is manipulating the land for his own benefits... They do talk about building to the contours though - maybe swales are as good as the suggested terraces. - this would come much later in the building process</td>
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<td>170</td>
<td>Fruit Trees</td>
<td>&quot;In the climates where fruit trees grow, the orchards give the land an almost magical identity; think of the orange groves of Southern California, the cherry trees of Japan, the olive trees of Greece. But the growth of cities seems always to destroy these trees and the quality they possess.&quot; (p. 795)</td>
<td>&quot;Plant small orchards of fruit trees in gardens and on common land along paths and streets, in parks, in neighborhoods: wherever there are well-established groups that can themselves care for the trees and harvest the fruit.&quot; (p. 796)</td>
<td>Yes - like the romantic ‘bringing the seasons to the home’; important for our home made produce; family-related task</td>
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<td>171</td>
<td>Tree Places</td>
<td><strong>&quot;When trees are planted pruned without regard for the special places they can create, they are as good as dead for the people who need them.&quot; (p. 798)</strong></td>
<td>&quot;If you are planting trees, plant them according to their nature, to form enclosures, avenues, squares, groves, and single spreading trees toward the middle of open spaces. And shape the nearby buildings in response to trees, so that the trees themselves, and the trees and buildings together, form places which people can use.&quot; (p. 800)</td>
<td>Yes - if up plant trees, then you must take care of them - Land Stewardship; it’s enough for the tree formations suggested; we will only plant fruit and/or nut trees</td>
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<td>172</td>
<td>Garden Growing Wild</td>
<td><strong>&quot;A garden which grows true to its own laws is not a wilderness, yet not entirely artificial either.&quot; (p. 802)</strong></td>
<td>&quot;Grow grasses, mosses, bushes, flowers, and trees in a way which comes close to the way that they occur in nature&quot; intermingled, without barriers between them, without bare earth, without formal flower beds, and with all the boundaries and edges made in rough stone and bristled with plants which become part of the natural growth.&quot; (p. 803)</td>
<td>Yes - Forest gardens</td>
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<td>173</td>
<td>Garden Wall</td>
<td>&quot;Gardens and small public parks don’t give enough relief from noise unless they are well protected.&quot; (p. 806)</td>
<td>&quot;Form some kind of enclosure to protect the sight of the quiet garden from the street and the sounds of passing traffic. If it is a large garden or a park, the enclosure can be soft, can include bushes, trees, slopes, and so on. The smaller the garden, however, the harder and more definite the enclosure must become. In a small garden, form the enclosure with buildings or walls; even hedges and fences will not be enough to keep out sound.&quot; (p. 808)</td>
<td>No - This pattern is about sound reduction, give the site location there is no need for enclosure designed to keep out sound.</td>
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<td>174</td>
<td>Trellised Walkway</td>
<td><strong>&quot;Trellised walks have their own special beauty. They are so unique, so different from other ways of shaping a path, that they are almost archetypal.&quot; (p. 810)</strong></td>
<td>&quot;Where paths need special protection or where they need some intimacy, build a trellis over the path and plant it with climbing flowers. Use the trellis to help shape the outdoor spaces on either side of it.&quot; (p. 811)</td>
<td>Yes, more for the future path way around house to suana and storage room.</td>
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<td>175</td>
<td>Greenhouse</td>
<td>&quot;Many efforts are being made to harness solar energy by converting it into hot water or electric power. And yet the easiest way to harness solar energy is the most obvious and the oldest: namely, to trap the heat inside a greenhouse and use it for growing flowers and vegetables.&quot; (p. 813)</td>
<td>&quot;In temperate climates, build a greenhouse as part of your house or office, so that it is both a ‘room’ of the house which can be reached directly without going outdoors and a part of the garden which can be reached directly from the garden.&quot; (p. 814)</td>
<td>Yes</td>
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<td>176</td>
<td>Garden Seat</td>
<td>&quot;Somewhere in every garden, there must be at least one spot, a quiet garden seat, in which a person - or two people - can reach into themselves and be in touch with nothing but nature.&quot; (p. 816)</td>
<td>&quot;Make a quiet place in the garden - a private enclosure with a comfortable seat, thick planting, sun. Pick the place for the seat carefully; pick the place that will give you the most intense kind of solitude.&quot; (p. 817)</td>
<td>Yes</td>
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<td>177</td>
<td>Vegetable Garden</td>
<td>&quot;In a healthy town every family can grow vegetables for itself. The time is past to think of this as a hobby for enthusiasts; it is a fundamental part of human life.&quot; (p. 819)</td>
<td>&quot;Set aside one place of land either in the private garden or on common land as a vegetable garden. About one-tenth of an acre is needed for each family of four. Make sure the vegetable garden is in a sunny place and central to all the households it serves. Fence it in and built a small storage shed for gardening tools beside it.&quot; (p. 821)</td>
<td>Yes - talks about using greywater at end of pattern description; important pattern in the way we want to live our lives; veg garden important and probably supplemented by nearby allotment</td>
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<td>178</td>
<td>Compost</td>
<td>&quot;Our current ways of getting rid of sewage poison the great bodies of natural water, and rob the land around our buildings of the nutrients they need.&quot; (p. 823)</td>
<td>&quot;Arrange the toilets over a dry composting chamber; load organic garbage chutes to the same chamber, and use the combined products for fertilizer.&quot; (p. 825)</td>
<td>Yes - important given location and difficulty (and costly) connection to existing communal services; talks about using kitchen waste in toilet waste.</td>
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<td>179</td>
<td>Alcoves</td>
<td><strong>&quot;No homogeneous room, of homogeneous height, can serve a group of people well. To give a group a chance to be together, as a group, a room must also give them the chance to be alone, in one’s and two’s in the same space.&quot; (p. 829)</strong></td>
<td>&quot;Make small places at the edge of any common room, usually no more than 6 feet wide and 3 to 6 feet deep and possibly smaller. These alcoves should be large enough for two people to sit, chat, or sit and sometimes large enough to contain a desk or a table.&quot; (p. 832)</td>
<td>Yes - feel that this is difficult to incorporate given the footprint, potential in living room.</td>
</tr>
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<td>180</td>
<td>Window Place</td>
<td><strong>&quot;Everybody loves window seats, bay windows, and big windows with low sills and comfortable chairs drawn up to them.&quot; (p. 834)</strong></td>
<td>&quot;In every room where you spend any length of time during the day, make at least one window into a ‘window place’.&quot; (p. 837)</td>
<td>Yes - could be done with a Rocket Stove in one or two locations - the kitchen must have one of these. - Rocket Stove - could be positioned at the corner of the kitchen and living area - central to the house with the excludes both in the kitchen and living area. - Standard wood burning stove is also possible - open fireplace would also be interesting to look at how it would fit in a design - We’ve always thought about having a large round table that would accommodate as many as 8 people, space around such a table could be tricky given the space available. Concerned that such a large table would overcome a dumping ground for/accumulation of things daily life. - lighting important in this</td>
</tr>
<tr>
<td>181</td>
<td>The Fire</td>
<td><strong>&quot;Everybody loves window seats, bay windows, and big windows with low sills and comfortable chairs drawn up to them,&quot;</strong></td>
<td>&quot;Build the fire in a common space - perhaps in the kitchen-where it provides a natural focus for talk and dreams and thought. Adjust the location until it turns into the social spaces and rooms around it, giving them each a glimpse of the fire; and make a window or some other focus to sustain the place during the times when the fire is out.&quot; (p. 842)</td>
<td>Yes - feel that this is difficult to incorporate given the footprint, potential in living room.</td>
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<td>182</td>
<td>Eating Atmosphere</td>
<td>&quot;When people eat together, they may actually be together in spirit - or they may be far apart. Some rooms invite people to eat leisurely and comfortably and feel together, while others force people to eat as quickly as possible so they can go somewhere else to relax.&quot; (p. 844)</td>
<td>&quot;Put a heavy table in the center of the eating space - large enough for the whole family or the group of people using it. Put a light over the table to create a pool of light over the group, and make it possible to no the space with walls or with contrasting darkness. Make the space large enough so the chairs can be pulled back comfortably, and provide shelves and counters at hand for things related to the meal.&quot; (p. 844)</td>
<td>Yes - open fireplace would also be interesting to look at how it would fit in a design - We’ve always thought about having a large round table that would accommodate as many as 8 people, space around such a table could be tricky given the space available. Concerned that such a large table would overcome a dumping ground for/accumulation of things daily life. - lighting important in this</td>
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<td>183</td>
<td>Workspace Enclosure</td>
<td>“People cannot work effectively if their workspace is too enclosed or too exposed. A good workspace strikes the balance.” (p.847)</td>
<td>“Give each workspace an area of at least 60 square feet. Build walls and windows round each workspace to such an extent that their total area (counting windows at one-half) is 50 to 75 per cent of the full enclosure that would be there if all four walls around the 60 square feet were solid. Let the front of the workspace be open for at least 8 feet in front, always into a larger space. Place the desk so that the person working at it has a view out, either to the front or to the side. If there are other people working nearby, arrange the enclosure so that the person has a sense of connection to two or three others; but never put more than eight workspaces within view or earshot of one another.” (p.851)</td>
<td>No</td>
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<td>184</td>
<td>Cooking Layout</td>
<td>“Cooking is uncomfortable if the kitchen counter is too short and also if it too long.” (p.854)</td>
<td>“To strike the balance between the kitchen which Yes is too small, and the kitchen which is too spread out, place the stove, sink, and food storage and counter in such a way that: 1. No two of the four are more than 10 feet apart. 2. The total length of the counter - excluding sink, stove, and refrigerator - is at least 12 feet. 3. No one section of the counter is less than 4 feet long. There is no need for the counter to be continuous or entirely ‘built-in’ as it is in many modern kitchens - it can even consist of free-standing tables or counter tops. Only the three functional relationships described above are critical.”</td>
<td>Yes</td>
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<td>185</td>
<td>Sitting Circle</td>
<td>“A group of chairs, a sofa and a chair, a pile of cushions - these are the most obvious things in everybody’s life - and yet to make them work, so many people become animated and alive in them, is a very subtle business. Most seating arrangements are sterile, people avoid them, nothing ever happens there. Others seem somehow to gather life around them, to concentrate and liberate energy. What is the difference between the two?” (p.858)</td>
<td>“Place each sitting space in a position which is protected not cut by paths or movement, roughly circulate, so that the room itself helps to suggest the circle - not too strongly - with paths and activities around it, so that people naturally gravitate toward the chairs when they get into the mood to sit. Place the chairs and cushions loosely in the circle, and have a few too many.” (p.859)</td>
<td>Yes</td>
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<td>186</td>
<td>Marriage Bed</td>
<td>“The bed is the center of a couple’s life together: the place where they lie together, talk, make love, sleep, sleep late, take care of each other during illness. But beds and bedrooms are not often made in ways which intensify their meaning, and these experiences cannot take hold.” (p.865)</td>
<td>“At the right moment in a couple’s life, it is important that they make for themselves a special bed - an intimate anchor point for their lives; slightly enclosed, with a low ceiling or a canopy, with the room shaped to it; perhaps a tiny room built around the bed with many windows. Give the bed some shape of its own, perhaps as a four-poster with head board that can be hand carved or painted over the years.” (p.867)</td>
<td>Yes</td>
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<td>187</td>
<td>Bed Alcove</td>
<td>&quot;Bedrooms make no sense” (p.869)</td>
<td>&quot;If you are building a very small house no more than 300 or 400 square feet - perhaps with the idea of adding to it gradually - this pattern plays an essential role. It will probably be best then to put the alcoves off the family room.” (p.873)</td>
<td>Yes</td>
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<td>188</td>
<td>Dressing Room</td>
<td>&quot;Dressing and undressing, storing clothes, having clothes lying around have no reason to be part of any larger complex of activities. Indeed they distrust other activities; they are so self-contained that they themselves need concentrated space which has no other function.” (p.873)</td>
<td>&quot;Give everyone a dressing room - with private or shared - between their bed and the bathing room. Make this dressing room big enough so there is an open area in it at least three feet diameter; about six linear feet of clothes hanging space; and another six feet of open shelves, tro or three draw, and a mirror.” (p.874)</td>
<td>Yes and No</td>
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| 190 | Ceiling Height Variety | "A building in which the ceiling heights are all the same is virtually incapable of making people comfortable.” (p.877) | "Vary the ceiling heights continuously throughout the building, especially between rooms which open into each other, so that the relative intimacy of different spaces can be felt. In particular, make ceilings high in rooms which are public or meant for large gatherings (10 o 12 feet), lower in rooms for smaller gatherings (7 to 9 feet), and very low in rooms or alcoves for one or two people (6 to 7 feet)” (p.881) | Yes | "Large discussion on the theory behind this pattern - useful in defining public and private spaces."
| 191 | The Shape of Indoor Space | "The perfectly crystalline squares and rectangles of ultra-modern architecture make no special sense in human or in structural forms. They only express the rigid desires and fantasies which people have when they get too preoccupied with systems and the means of their production.” (p.883) | "With occasional exceptions, make each indoor space or each position of a space a rough rectangle, with roughly straight walls, near right angles in the corners, and a roughly symmetrical vault over each room.” (p.888) | Yes | "Cutting a corner or shaping a corner of the building - makes me wonder about building cob internal walls, as these can be easily curved and have a more organic feel about them" |
| 192 | Windows Overlooking Life | "Rooms without a view are prisons for the people who have to stay in them.” (p.890) | "In each room, place the windows in such a way that their total region (25 cer ce or more of the floor area, in the San Francisco Bay Area, and place them in positions which give the best possible views out over life: activities in streets, quiet gardens, anything different from the indoor scene.” (p.892) | Not as written, beyond scope of project. | Site overlooks ‘street’, but this site doesn’t fit pattern as written
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<td>193</td>
<td>Half-Open Wall</td>
<td>&quot;Rooms which are too closed prevent the natural flow of social occasions, and the natural process of transition from one social moment to another. And rooms which are too open will not support the differentiation of events which social life requires.&quot; (p.893)</td>
<td>Yes</td>
<td>The two social spaces in the house are the kitchen and the lounge, the flow between these two rooms will be important.</td>
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<td>194</td>
<td>Interior Windows</td>
<td>&quot;Windows are most often used to create connections between the indoor and the outdoors. But there are many cases when an indoor space needs connecting window to another indoor space.&quot; (p.898)</td>
<td>&quot;Put in fully glazed fixed windows between rooms which tend to be dead because they have too little action in them or where inside rooms are unusually dark.&quot; (p.898)</td>
<td>Yes</td>
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<td>195</td>
<td>Staircase Volume</td>
<td>&quot;We are putting this pattern in the language because our experiments have shown is that lay people often make mistakes about the volume which a staircase needs and therefore make their plans unbuildable.&quot; (p.901)</td>
<td>&quot;Make a two story volume to contain the stairs. It Yes may be straight, L-shaped, U-shaped, or C-shaped. The stair may be 2 feet wide (for a very steep stair) or 5 feet wide for a generous shallow stair. But, in all cases, the entire stairwell must form one complete structural bay, two stories high. Do not assume that all stairs have to have the &quot;standard&quot; angle of 30 degrees. The steepest stair may almost be a ladder. The most generous stair can be as shallow as a ramp and quite qde. As you work out of the exact slope of the stair, bear in mind the relationship rise x tread = 11 1/2 inches.&quot; (p.903)</td>
<td>Yes</td>
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<td>196</td>
<td>Corner Doors</td>
<td>&quot;The success of a room depends to a great extent on the position of the doors. If the doors create a pattern movement which destroys the places in the room, the room will never allow people to be comfortable.&quot; (p.904)</td>
<td>&quot;Except in very large rooms, a door only rarely makes sense in the middle of a wall. It does in an entrance room, for instance because this room gets its character essentially from the door. But in most rooms, especially small ones, put the doors as near the corners of the room as possible. If the room has two doors, and people move through it, keep both doors at one end of the room.&quot; (p.905)</td>
<td>Yes</td>
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<td>197</td>
<td>Thick Walls</td>
<td>&quot;Houses with smooth hard walls made of prefabricated concrete, gypsum, steel, aluminum, or glass always stay impersonal and dead.&quot; (p.909)</td>
<td>&quot;Open your mind to the possibility that the walls of your building can be thick, can occupy a substantial volume - even actual useable space - and need not be merely thin membranes which have no depth. Decide where these thick walls ought to be.&quot; (p.911)</td>
<td>Yes</td>
<td></td>
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<td>198</td>
<td>Closets Between Rooms</td>
<td>&quot;The provision of storage and closets usually comes as an afterthought.&quot; (p.914)</td>
<td>&quot;Mark all the rooms where you want closets. Then place the closets themselves on those interior walls which lie between two rooms and between rooms and passages where you need acoustic insulation. Place them so as to create transition spaces for the doors into the rooms. On no account put closets on exterior walls. It wastes the opportunity for good acoustic insulation and cuts of precious light.&quot; (p.915)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>199</td>
<td>Sunny Counter</td>
<td>&quot;Dark gloomy kitchens are depressing. The kitchen needs the sun more than the other rooms, not less.&quot; (p.917)</td>
<td>&quot;Place the main part of the kitchen counter on the south and southeast side of the kitchen, with big windows around it, so that sun can flood in and fill the kitchen with yellow light both morning and afternoon.&quot; (p.918)</td>
<td>Yes</td>
<td></td>
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<tr>
<td>200</td>
<td>Open Shelves</td>
<td>&quot;Cupboards that are too deep waste valuable space, and it always seems that what you want is behind something else.&quot; (p.920)</td>
<td>&quot;Cover the walls with narrow shelves of varying depth but always shallow enough so that things can be placed on them one deep - nothing hiding behind anything else.&quot; (p.921)</td>
<td>Yes, but I don't think much goes against the grain of the modern kitchen.</td>
<td></td>
</tr>
<tr>
<td>201</td>
<td>Waist-High Shelf</td>
<td>In every house and every workplace there is a daily traffic of the objects which are handled most. Unless such things are immediately at hand, the flow of life is awkward, full of mistakes, things are forgotten, misplaced.&quot; (p.922)</td>
<td>&quot;Build waist-high shelves around at least a part of Yes the main rooms where people live and work.&quot; Make the long, 9 to 15 inches deep, with shelves or cupboard underneath. Interrupt the shelf for seats, windows, and doors.&quot; (p.923)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>202</td>
<td>Built-in Seats</td>
<td>&quot;Built-in seats are great. Everybody loves them. They make a building feel comfortable and luxurious. But most often they do not actually work. They are placed wrong or too narrow, or the back does not slope, or the view is wrong, or the seat is too hard. This patterns tells you what to do to make a built-in seat that really works.&quot; (p.925)</td>
<td>&quot;Before you build a seat, get hold of an old arm chair or a sofa, and put it into the position where you intend to build a seat. Move it until you really like it. Leave it there for a few days. See if you enjoy sitting in it. Move it if you don't. When you have got it into a position you like, and where you often find yourself sitting, you know it is a good position. Now build a seat that is just as wide, and just as well padded - and your built-in seat will work.&quot; (p.926)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>Child Caves</td>
<td>&quot;Children love to be in tiny, cave-like places.&quot; (p.928)</td>
<td>&quot;Whenever children play, around the house, in the neighborhood, in schools, make small &quot;caves&quot; for them. Tuck these caves away in natural left over spaces, under stairs, under kitchen counters. Keep the ceiling heights low - 2 feet 6 inches to 4 feet - and the entrance tiny.&quot; (p.929)</td>
<td>No</td>
<td>Not right now.</td>
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Context is King: A Case Study of an Autonomous House in Sweden

Ben Owen
### CONSTRUCTION

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<tr>
<th>No.</th>
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<tbody>
<tr>
<td>204</td>
<td>Secret Place</td>
<td>“Where can the need for concealment be expressed; the need to hide; the need for something precious to be lost and then revealed?” (p.930)</td>
<td>“Make a place in the house, perhaps only a few square feet, which is kept locked and secret; a place which is virtually impossible to discover - until you have been shown where it is; a place where the archives of the house, or other more potent secrets, might be kept.” (p.931)</td>
<td>Yes</td>
<td>- this would come out in the latter stages of the design work</td>
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<tr>
<td>205</td>
<td>Structure Follows Social Spaces</td>
<td>*<em>“No building ever feels right to the people in it unless the physical spaces (defined by columns, walls, and ceilings) are congruent with the social spaces (defined by activities and human groups)”.</em> (p.941)</td>
<td>“A first principle of construction: on no account allow the engineering to dictate the building’s form. Place the load bearing elements - the columns and the walls and the floors - according to the social spaces I the building; never modify the social spaces to conform to the engineering structure of the building.” (p.945)</td>
<td>Yes</td>
<td>- if the entrance room is made with flimsy partitions, it will not take hold; people won’t take it seriously.” (p.944) - does this clash with trying to round the rooms?</td>
</tr>
<tr>
<td>206</td>
<td>Efficient Structure</td>
<td>“Some buildings have column and beam structure; others have load bearing walls with slab floors; others are vaulted structures, or domes or tents. But which of these, or what mixture of them, is actually the most efficient? What is the best way to distribute materials throughout a building, so as to enclose the space, strongly and well, with the least amount of material?” (p.947)</td>
<td>“Conceive the building as a building made from one continuous body of compressive material. In its geometry, conceive it as a three-dimensional system of individually vaulted spaces, most of them roughly rectangular; with thin load bearing walls, each stiffened by columns at intervals along its length, thickened where walls meet walls and where walls meet vaults and stiffened around the openings.” (p.953)</td>
<td>No</td>
<td>- post and beam structure to be used - simple and easy to erect and understand for novice builders. - could the top edges - where the walls meet ceilings - be packed with insulation? - we’re keeping to the classic/traditional ‘Falú-rod’ house, and keeping the essence of the existing structure.</td>
</tr>
<tr>
<td>207</td>
<td>Good Materials</td>
<td>**“There is a fundamental conflict in the nature of materials for building in industrial society.” (p.956)</td>
<td>“Use only biodegradable, low energy consuming materials which are easy to cut and modify on site. For bulk materials we suggest ultra-lightweight 40/50lbs. Concrete and earth based materials like tamped earth, brick and tile. For secondary materials, use wood planks, gypsum, plywood, cloth, chickwires, paper, cardboard, particle board, corrugated iron, lime plaster, bamboo, rope and tile.” (p.960)</td>
<td>Yes</td>
<td>- “We shall therefore look upon wood as a precious material, which should not be used as a bulk material of for structural purposes.” (p.957) - Disagree, times have changed, wood is know seen as a renewable resource and the future of building?</td>
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<tr>
<td>208</td>
<td>Gradual stiffening</td>
<td>**“The fundamental philosophy behind the use of pattern languages is that buildings should be uniquely adapted to individual needs and sites; and that the plans of buildings should be rather loose and fluid, in order to accommodate these subtleties.” (p.963)</td>
<td>“Recognise that you are not assembling a building from components like an actor set, but that you are instead weaving a structure which starts out globally complete, but flimsy; then gradually making it stiffer but still rather flimsy; and only finally making it completely stiff and strong. We believe that in our own time, the most natural version of this process is to put up a shell of sheet materials, and then make it fully strong by fitting it with a compressive fill.” (p.968)</td>
<td>Yes</td>
<td>- goes against my engineering self - i want to have detailed drawings of everything as I feel that I’ll have a better understanding of the project. However, given time constraints, a more ‘relaxed’ and ‘loose’ attitude towards the building will be required. Is there a middle ground? - I was thinking of leaving the top floor completely open, first to cut costs, secondly because we don’t need to right now and thirdly to see how we use the space. - critique of lightweight concrete formwork cost and wasteful building process (p.966) - construction method suggested reminds me of the single dome Earthships that use chickwires &amp; plasters to form the formwork for the concrete.</td>
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<td>209</td>
<td>Roof Layout</td>
<td>“What kind of roof plan is organically related to the nature of the building” (p.971)</td>
<td>“Arrange the roofs so that each distinct roof corresponds to an identifiable social entity in the building or building complex. Place the largest roofs - those which are highest and have the largest span - over the largest and most important and most communal spaces; build the lesser roofs over these largest and highest roofs; in the form of half-vaults and sheds over alcoves and thick walls.” (p.976)</td>
<td>Yes</td>
<td></td>
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<tr>
<td>210</td>
<td>Floor and Ceiling Layout</td>
<td>“Again, the basic problem is to maintain the integrity of the sociaal spaces in the plan.” (p.978)</td>
<td>“Draw a vault plan, for every floor. Use two-way vaults most often; and one-way barrel vaults for any spaces which are more than twice as long as they are wide. Draw sections through the building as you plan the vaults, and bear the following facts in mind. 1. Generally speaking, the vaults should correspond to rooms. 2. There will have to be a support under the sides of each vault: this will usually be the top of a wall. Under exceptional circumstances, it can be a beam or arch. 3. A vault may span as little as 5 feet and as much as 30 feet. However, it must have a rise equal to at least 1.3 per cent of its shorter span. 4. If the edge of one vault is more than a couple of feet (in plan) from the edge of the vault below it - then the lower vault will have to contain an arch to support the load from the upper vault.” (p.981)</td>
<td>No</td>
<td>- using post and beam construction</td>
</tr>
<tr>
<td>No.</td>
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<td>211</td>
<td>The Outer Walls</td>
<td>&quot;We have established in THICK WALLS (197), how important it is for the walls of a building to have &quot;depth&quot; and &quot;volume&quot;, so that character accumulates in them, with time. But when it comes to laying out a building and constructing it, this turns out to be quite hard to do.&quot; (p.984)</td>
<td>Make all those places in the plan where seats and closets are to be. These places are given individually by ALCOVES (179), WINDOW PLACES (186), THICK WALLS (197), SUNNY CORNER (199), WAIST-HIGH SHELF (201), BUILT-IN SEATS (202), and so on. Lay out a wide swath on the plan to correspond to these positions. Make it two or three feet deep; recognize that it will be outside the main space of the room; your seats, niches, shelves, will feel attached to the main space of rooms but not inside them. Then, when you lay out columns and minor columns, place the columns in such a way that they surround and define these thick volumes of wall, as if they were rooms or alcoves. For shelves and counters less than 2 feet deep, there is no need to go to these lengths. The thickening can be built simply by deepening columns and placing shelves between them.&quot; (p.987)</td>
<td>Yes</td>
<td>- using post and beam construction</td>
</tr>
<tr>
<td>212</td>
<td>Columns at the Corners</td>
<td>&quot;We have already established the idea that the structural components of a building should be congruent with its social spaces.&quot; (p.990)</td>
<td>&quot;On your rough building plan, draw a dot to represent a column at the corners of every room and the corners formed by lesser spaces like thick walls and alcoves. Then transfer these dots onto the ground out on site with stakes.&quot; (p.993)</td>
<td>Yes</td>
<td>- using post and beam construction</td>
</tr>
<tr>
<td>213</td>
<td>Final Column Distribution</td>
<td>&quot;How should the spacing of the secondary columns which stiffen walls, vary with ceiling height, number of stories and size of rooms.&quot; (p.996)</td>
<td>Make column stiffeners furthest apart on the ground floor and closer and closer together as you go higher in the building. The exact column spacings for a particular building will depend on the heights and loads and wall thicknesses. [...] Mark in these extra stiffening columns as dots between the corner columns on the drawings you have made for different floors. Adjust them so they are evenly spaced between each pair of corner columns; but on any one floor, make sure that they are closer together along the walls of small rooms and further apart along the walls of large rooms. (p.1003)</td>
<td>No</td>
<td>- This pattern is based upon the suggested &quot;vaulted&quot; system - we only have a single story with loft space, the bulk of this pattern is for more than one stories - We'll use the industry standard of 600mm between minor columns</td>
</tr>
<tr>
<td>214</td>
<td>Root Foundations</td>
<td>&quot;The best foundations of all are the kinds of foundations which a tree has - where the entire structure of the tree simply continues below ground level, and creates a system entirely integral with the ground, in tension and compression.&quot; (p.1005)</td>
<td>&quot;Try to find a way of making foundations in which the columns themselves go right into the earth, and spread out there - so that the footing is continuous with the material of the column, and the column, with its footing, like a tree root, can resist tension and horizontal shear as well as compression.&quot; (p.1008)</td>
<td>Yes</td>
<td>- required more thought</td>
</tr>
<tr>
<td>215</td>
<td>Ground Floor Slab</td>
<td>&quot;The slab is the easiest, cheapest, and most natural way to lay a ground floor&quot; (p.1009)</td>
<td>&quot;Build a ground floor slab, raised slightly - six or nine inches above the ground - by first building a low perimeter wall around the building, tied into the column foundations, and then filling it with rubble, gravel and concrete.&quot; (p.1010)</td>
<td>No</td>
<td>- required more thought</td>
</tr>
<tr>
<td>216</td>
<td>Box Columns</td>
<td>&quot;In all the world's traditional and historic buildings, the columns are expressive, beautiful, and treasured elements. Only in modern buildings have they become ugly and meaningless.&quot; (p.1013)</td>
<td>&quot;Make the columns in the form of filled hollow tubes, with a stiff tubular outer skin, and a solid core that is strong in compression. Give the skin of the column some tensile strength - preferably in the skin itself, but perhaps with reinforcing wires in the E.&quot; (p.1016)</td>
<td>No</td>
<td>- required more thought</td>
</tr>
<tr>
<td>217</td>
<td>Perimeter Beams</td>
<td>&quot;If you conceive and build a room by first placing columns at the corners, and then gradually weaving the walls and ceiling around them, the room needs a perimeter beam around its upper edge.&quot; (p.1019)</td>
<td>&quot;Build a continuous perimeter beam around the room, strong enough to resist the horizontal thrust of the vault above, to spread the loads from upper stories onto columns, to tie the columns together, and to function as a lintel over openings in the wall. Make this beam continuous with columns, walls and floor above, and columns and walls below.&quot; (p.1021)</td>
<td>Yes</td>
<td>- required, but in wood, not concrete as written</td>
</tr>
<tr>
<td>218</td>
<td>Wall Membranes</td>
<td>&quot;In organic construction the walls must take their share of the loads. They must work continuously with the structure on all four of their sides, and act to resist shear and bending, and take loads in compression.&quot; (p.1023)</td>
<td>&quot;Build a perimeter beam in which can connect the No. columns and door frames and windows frames and is, at least in part, continuous with them. To build the wall, first put up an inner and outer membrane, which can function as a finished surface, then pour the fill into the wall.&quot; (p.1025)</td>
<td>Yes</td>
<td>- using post and beam construction</td>
</tr>
<tr>
<td>219</td>
<td>Floor-Ceiling Vaults</td>
<td>&quot;We seek a ceiling vault shape which will support a live load on the floor above, form a ceiling of the room below and generate as little bending and tension as possible so that compressive materials can be relied on.&quot;</td>
<td>&quot;Build floors and ceilings in the form of elliptical vaults which rise between 13 and 20 percent of the shorter span. Use a type of construction which makes it possible to fit the vault to any shaped room after the walls and columns are in position: on no account use a prefabricated vault.&quot; (p.1035)</td>
<td>Yes</td>
<td>- using post and beam construction</td>
</tr>
<tr>
<td>220</td>
<td>Roof Vaults</td>
<td>&quot;What is the best shape for a roof.&quot; (p.1037)</td>
<td>&quot;Build the roof vault either as a cylindrical barrel vault, or like a pitched roof with a slight convex curve in each of the two sloping sides. Put in undulations along the vault to ale the shell more effective. The curvature of the main shell, and of the undulations, can vary with the span, the bigger the span, the deeper the curvature and undulations need to be.&quot; (p.1043)</td>
<td>Yes</td>
<td>- using post and beam construction</td>
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<tr>
<td>233</td>
<td>Natural Doors</td>
<td><strong>&quot;Finding the right position for a window or a door is a subtle matter. But there are many very few ways of building which take this into consideration.&quot;</strong> (p.1047)</td>
<td>Make each window a different size, according to its place. Do not fix the exact position or size of the door and window frames until the rough framing of the room has actually been built, and you can really stand inside the room and judge, by eye, exactly where you want to put them, and how big you want them. When you decide, mark the openings with strings. Make the windows smaller and smaller, as you go higher in the building** (p.1049)</td>
<td>Yes</td>
<td>- this is going to be difficult to do, we'll have to order custom made doors and windows - expensive and time consuming, stretching the time plan making and the building water tight - it puts a lot of stress on the building project. - I like it in principle</td>
</tr>
<tr>
<td>222</td>
<td>Low Sill</td>
<td>- &quot;One of a window's most important functions is to put you in touch with the outdoors. If the sill is too high, it cuts you off.&quot; (p.1051)</td>
<td>Yes, also decide which windows should have low sills. On the first floor, make the sills of windows which you plan to sit by between 12 and 14 inches high. On the upper stories, make them higher, around 20 inches.&quot; (p.1052)</td>
<td>Yes</td>
<td>- Consideration to this pattern will be given where we can. - Could clash with the idea of reducing window sizes to reduce heat loss (a bad wall is better than a good window in terms of insulation). - It would be interesting to see if this can be done with 'standard' windows, having thick walls is a requirement especially as the pattern states a width of 10 to 12 inches.</td>
</tr>
<tr>
<td>223</td>
<td>Use Deep Reveals</td>
<td>- &quot;Windows with sharp edge where the frame meets the wall create harsh, blinding glare, and make the rooms they serve uncomfortable.&quot; (p.1054)</td>
<td>Yes, make the window frame a deep, spayed edge: about a foot wide and spayed at about 20 to 60 degrees to the plane of the window, so that gasses of daylight gives a smooth transition between the light of the window and the dark of the inner wall.&quot; (p.1055)</td>
<td>Yes</td>
<td>- of taking it for granted that your doors are simply 6 ft rectangular openings to pass through, make at least some of your doorways low enough so that the act of going through the door is a deliberate thoughtful passage from one place to another. Especially at the entrance to a house, at the entrance to a private room, or a fire corner make the doorway lower than usual, perhaps even as low as 5 ft.&quot; (p.1058)</td>
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<tr>
<td>224</td>
<td>Low Doorway</td>
<td>- &quot;High doorways are simple and convenient. But a lower door is often more pleasant.&quot;) (p.1057)</td>
<td>Yes, if it is difficult to implement this for the front door it's a busy entrance that often requires space. - could be used for access to the upper level</td>
<td>Yes</td>
<td>- Detailing around doors and windows will follow traditional borders, the current building has a dark green glass surround, white frames against a Falu-Röd. It would be nice to keep this aspect of the old house in its new guise.</td>
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<tr>
<td>225</td>
<td>Frames as Thickened Edges</td>
<td><strong>&quot;Any homogeneous membrane which has holes in it will tend to rupture at the holes, unless the edges of the holes are reinforced by thickening.&quot;</strong> (p.1060)</td>
<td>Yes, to make the wall against the concentrations of stress which develop around openings. In line with this conception, build the frames as thickening of the wall material, continuous with the wall itself, made of the same materials, and pored, or built up, in a manner which is continuous with the structure of the wall.&quot; (p.1062)</td>
<td>Yes</td>
<td>- Describing around doors and windows will follow traditional borders, the current building has a dark green glass surround, white frames against a Falu-Röd. It would be nice to keep this aspect of the old house in its new guise.</td>
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<td>226</td>
<td>Column Place</td>
<td><strong>&quot;Thin columns, spindly columns, columns which take their shape from structural arguments alone, will never make a comfortable environment.&quot;</strong> (p.1065)</td>
<td>&quot;When a column is free standing, make it as thick as a man - at least 12 inches, preferably 16 inches - and form places around it where people can sit and lean comfortably: a step, a small seat built up against the column, or a space formed by a pair of columns.&quot; (p.1067)</td>
<td>Yes</td>
<td>- It is difficult to implement this for the front door it's a busy entrance that often requires space. - could be used for access to the upper level</td>
</tr>
<tr>
<td>227</td>
<td>Column Connections</td>
<td><strong>&quot;The strength of a structure depends on the strength of its connections; and those connections are most critical at all corners, especially at the corners where the columns meet the beams.&quot;</strong> (p.1069)</td>
<td>Yes, build connections where the columns meet the beams. Any distribution of materials which fills, the corner will do: fillets, guises, column capitals, mushroom column, and most general of all, the arch, which connects column and beam in a continuous curve.&quot; (p.1072)</td>
<td>Yes</td>
<td>- referring to the vault system</td>
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<td>228</td>
<td>Stair Vault</td>
<td><strong>&quot;Within a building technology which uses compressive materials as much as possible, and excludes the use of wood, it is natural to build stairs over a vaulted void, simply to save weight and materials.&quot;</strong> (p.1074)</td>
<td>&quot;Build a curving diagonal vault in the same way that you build your FLOOR-CEILING VAULTS (219). Once the vault hardens, cover it with sets of lightweight concrete, trowel-formed into position.&quot; (p.1074)</td>
<td>Yes</td>
<td>- refers to the vault system</td>
</tr>
<tr>
<td>229</td>
<td>Dust Space</td>
<td><strong>&quot;You never know where pipes and conduits are; the are buried somewhere in the walls; but where exactly are they?&quot;</strong> (p.1076)</td>
<td>&quot;Make ducts to carry hot air conduit, plumbing, No, gas, and other services in the triangular space, within the vault, around the upper edge of every room. Connect the ducts for different rooms by vertical ducts, in special chases, in the corners of rooms. Build outlets and panels at intervals along the duct for access to the conduits.&quot; (p.1077)</td>
<td>Yes</td>
<td>- refers to the vault system</td>
</tr>
<tr>
<td>230</td>
<td>Radiant Heat</td>
<td><strong>&quot;This pattern is a biologically precise foundation of the intuition that sunlight and a hot blazing fire are best kinds of heat.&quot;</strong> (p.1078)</td>
<td>&quot;Choose a way of heating your space - especially those rooms where people are going to gather when it is cold - that is essentially a radiative process, where the heat comes more from radiation than convection.&quot; (p.1080)</td>
<td>Yes</td>
<td>- &quot;... skylights are not satisfactory as windows... because they do not create a connection between the inside and the outside world...&quot; (p.1082)</td>
</tr>
<tr>
<td>231</td>
<td>Dormer Windows</td>
<td><strong>&quot;We know from our discussion of SHELTERING ROOF (117) that the top story of the building should be right inside the roof, surrounded by it.&quot;</strong> (p.1082)</td>
<td>&quot;Wherever you have windows in the roof, make dormer windows which are high enough to stand in, and frame them like any other alcoves in the building.&quot; (p.1083)</td>
<td>Yes</td>
<td>- &quot;The traditional cladding/lining the outside of the building will be used and treated in a traditional fashion.</td>
</tr>
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<td>234</td>
<td>Lapped Outside Walls</td>
<td><strong>&quot;The main function of a building's outside wall is to keep weather out. It can only do this if the materials are joined in such a way that they cooperate to make impervious joints.&quot;</strong> (p.1094)</td>
<td>&quot;Build up the exterior wall surface with materials Yes that are lapped against the weather: either &quot;externally lapped,&quot; like exterior plaster, or more literally lapped, like shingles and boards and tiles. In either case, choose a material that is easy to repair in little patches, inexpensively, so that little by little, the wall can be maintained in good condition indefinitively.&quot; (p.1095)</td>
<td>Yes</td>
<td>Added</td>
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Appendix D - Case Study Patterns Language
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<td>235</td>
<td>Soft Inside Walls</td>
<td>* A wall which is too hard to touch is unpleasant. It makes decoration impossible, and creates hollow echoes.* <em>(p.1097)</em></td>
<td>* Make every inside surface warm to the touch, soft enough to take small nails and tacks, and with a certain slight &quot;give&quot; to the touch. Soft plaster is very good; textile hangings, carvework, weavings, also have this character. And wood is fine, where you can afford it.* <em>(p.1098)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>236</td>
<td>Windows which Open Wide</td>
<td>* Many buildings nowadays have no opening windows at all, and many of the opening windows that people do build, don't do the job that opening windows ought to do.* <em>(p.1101)</em></td>
<td>* Decide which of the windows will be opening windows. Pick those which are easy to get to, and choose the ones which open onto flowers you want to smell, paths where you might want to talk, and natural breeze. Then put in a side-hanging casement that open outward. Here and there, go all the way and build full French windows.* <em>(p.1102)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>237</td>
<td>Solid Doors with Glass</td>
<td>* An opaque door makes sense in a vast house or palace, where every room is large enough to be a world unto itself, but in small building, with small rooms; the opaque door is only very rarely useful.* <em>(p.1103)</em></td>
<td>* As often as possible build doors with glazing in them, so that the upper half at least, allows you to see through them. At the same time, build the doors solid enough, so that they give acoustic insulation and are comfortable &quot;thunk&quot; when they are closed.* <em>(p.1104)</em></td>
<td>Yes</td>
<td>to be honest I don't think there will be any internal doors other than the between the bathroom. The other doors will probably external doors - the front door and the back door.</td>
</tr>
<tr>
<td>238</td>
<td>Filtered Light</td>
<td>* Light filtered through leaves, or tracery, is wonderful. But why?* <em>(p.1106)</em></td>
<td>* Where the edge of a window of the overhanging eave of a roof is helicopters against the sky, make a rich, detailed tassistry of light and dark, can help to break up the light and soften it.* <em>(p.1107)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>239</td>
<td>Small Panes</td>
<td>** When plate glass windows became possible, people thought that they would put us more directly in touch with nature. In fact, they did the opposite.* <em>(p.1109)</em></td>
<td>* Divide each window into small panes. These panes can be very small indeed, and should hardly ever be more than a foot square. To get the exact size of the panes, divide the width and height of the window by the number of panes. Then each window will have different sized panes according to its height and width.* <em>(p.1113)</em></td>
<td>Yes</td>
<td>- I would really like to make my own windows. - in today's world of double, triple and quadruple windows this is a really expensive option and the ones that I've seen with small panes look crap (then again, I bet they were the cheap ones)</td>
</tr>
<tr>
<td>240</td>
<td>Half-Inch Trim</td>
<td>** Totalitarian, machine buildings do not require trim because they are precise enough to do without. But they buy their precision at a dreadful price: by killing the possibility of freedom in the building plan.* <em>(p.1111)</em></td>
<td>* Whenever two materials meet, place a piece of trim over the edge of the connection. Choose the pieces of trim so that the smallest piece, in each component, is always the order of 1/2 inch wide. The trim can be wood, plaster, terracotta...* <em>(p.1115)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>241</td>
<td>Seat Spots</td>
<td>** Where outdoor seats are set down without regard for view and climate, they will almost certainly be useless.* <em>(p.1119)</em></td>
<td>* Choosing good spots for outdoor seats is far more important than building fancy benches. Indeed, if the spot is right, the most simple kind of seat is perfect. In cool climates, choose them to face the sun, and to be protected from the wind; in hot climates, put them in shade and open to summer breezes. In both cases, place them to face activities.* <em>(p.1120)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>242</td>
<td>Front Door Bench</td>
<td>* People like to watch the street.* <em>(p.1122)</em></td>
<td>* Build a special bench outside the front door where people from inside can sit comfortable for hours on end and watch the world go by. Place the bench to define a half-private domain in front of the house. A low wall, planting, a tree, can create the same domain.* <em>(p.1123)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>243</td>
<td>Sitting Wall</td>
<td>** In many places walls and fences between outdoor spaces are too high; but no boundary at all does injustice to the subtlety of the divisions between spaces.* <em>(p.1125)</em></td>
<td>* Surround any natural outdoor area, and make minor boundaries between outdoor spaces at not very low walls, about 16 inches high, and wide enough to sit on. As least 12 inches wide.* <em>(p.1126)</em></td>
<td>No</td>
<td>given the location, and minimal activity on the pathway. It seems like the wrong pattern to apply to this site.</td>
</tr>
<tr>
<td>244</td>
<td>Canvas Roofs</td>
<td>* There is a very special beauty about tents and canvas awnings. The canvas has a softness, a suppleness, which is in harmony with wind and light and sun. A house or building built with some canvas will touch the elements more nearly than it can when it is made only with hard conventional material.* <em>(p.1129)</em></td>
<td>* Build canvas roofs and awnings wherever there are spaces which need softer light or partial shade in summer, or partial protection from mist and dew in autumn and winter. Build them to fold away, with ropes or wires to pull them, so that they can easily be opened.* <em>(p.1131)</em></td>
<td>Yes</td>
<td>- As I'm unsure on how or where or even if this pattern will be used I feel that this pattern is a &quot;add-on&quot;, part of the 'organic design' promoted by the book.</td>
</tr>
<tr>
<td>245</td>
<td>Raised Beds</td>
<td>* Flowers are beautiful along the edges of paths, buildings, outdoor rooms - but it is just in these places that they need the most protection from traffic. Without some protection they cannot easily survive.* <em>(p.1133)</em></td>
<td>* Soften the edges of buildings, paths, and outdoor areas with flowers. Raise the flower beds so that people can touch the flowers, bend to small them, and sit by them. And build the flower beds solid edges, so that people can sit on them, among the flowers too.* <em>(p.1134)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>246</td>
<td>Climbing Plants</td>
<td>* A building finally becomes a part of its surroundings when the plants grow over parts of it as freely as they grow along the ground.* <em>(p.1135)</em></td>
<td>* On sunny walls, train climbing plants to grow up round the openings in the wall - the windows, doors, porches, arcades, and trellises.* <em>(p.1137)</em></td>
<td>Yes</td>
<td>- There are modern semi-permeable alternatives that provide the soil benefits discussed in this pattern</td>
</tr>
<tr>
<td>247</td>
<td>Paving with Cracks Between the Stones</td>
<td>** Asphalt and concrete surfaces outdoors are easy to wash down, but they do nothing for us, nothing for the paths, and nothing for the rainwater and plants.* <em>(p.1139)</em></td>
<td>* On paths and terraces, lay paving stones with a 1 inch crack between the stones, so that grass and mosses and small flowers can grow between the stones. Lay the stones directly into the earth, not into mortar, and, of course, use no cement or mortar in between the stones.* <em>(p.1140)</em></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>248</td>
<td>Soft Tile and Brick</td>
<td>* How can a person feel the earth, or time, or any connection with his surroundings, when he is walking on the hard mechanical wash-easy surfaces of concrete, asphalt, hard-fried architectural paving bricks, or artificially concocted mixe like terrazoo.* <em>(p.1141)</em></td>
<td>* &quot;... buildings are like people - not imposing and alien, but alive, changing with time, remembering the paths which people tread.&quot; <em>(p.1141)</em></td>
<td>No</td>
<td>- nice description on how to soft baked tiles - it's a long process and one that would have to come in a later phases of the project. Instead temporary tiles or walk ways would have be created</td>
</tr>
<tr>
<td>No.</td>
<td>Pattern</td>
<td>Essence of the problem</td>
<td>The solution</td>
<td>Applicable</td>
<td>Notes</td>
</tr>
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</tr>
<tr>
<td>249</td>
<td>Ornament</td>
<td><strong>“All people have the instinct to decorate their surroundings.”</strong> (p.1147)</td>
<td>“Search around the building, and find those edges and transitions which need emphasis or extra binding energy. Corners, places where materials meet, door frames, windows, main entrances, the place where one wall meets another, the garden gate, a fence - all these are natural places which call out for ornament. Now find simple themes and apply the elements of the theme over and again to the edges of the boundaries which you decide to mark. Make the ornaments work as seams along the boundaries and edges so that they knot the two sides together and make them one.” (p.1152)</td>
<td>Yes</td>
<td>- Another pattern that fits into the organic nature of the design and build.</td>
</tr>
<tr>
<td>250</td>
<td>Warm Colors</td>
<td><strong>“The greens and greys of hospitals and office corridors are depressing and cold. Natural wood, sunlight, bright colors are warm. In some way, the warmth of the colors in a room makes a great deal of difference between comfort and discomfort.”</strong> (p.1153)</td>
<td>“Choose surface colors which, together with the color of the natural light, reflect light, and artificial lights, create a warm light in the rooms.” (p.1156)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>251</td>
<td>Different Chairs</td>
<td>- “People are different sizes, they sit in different ways. And yet there is a tendency in modern times to make all chairs alike.” (p.1158)</td>
<td>“Never furnish any place with chairs that are identically the same. Choose a variety of different chairs, some big, some small, some softer than others, some rockers, some very old, some new, with arms, without arms, some wicker, some wood, some cloth.” (p.1159)</td>
<td>Yes</td>
<td>- actually, right now we don’t have two chair alike in our apartment - more through necessity than design.</td>
</tr>
<tr>
<td>252</td>
<td>Pools of Light</td>
<td><strong>Uniform illumination - the sweetheart of the lighting engineers - serves no useful purpose whatsoever. In fact, it destroys the social nature of space, and makes people feel disoriented and unbounded.”</strong> (p.1160)</td>
<td>“Place the lights low, and apart, to form individual pools of light which encompass chairs and tables like bubbles to reinforce the social character of the spaces which they form. Remember that you can’t have pools of light without the darker places in between.” (p.1162)</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>253</td>
<td>Things from Life</td>
<td><strong>“Décor” and the conception of “interior design” have spread so widely, that very often people forget their instinct for the things they really want to keep around them.”</strong> (p.1165)</td>
<td>“Do not be ticked into believing the modern décor must be slick or psychedelic, or &quot;natural&quot; or &quot;modern art&quot;, or &quot;plants or anything else that current taste-makers claim. It is most beautiful when it comes straight from your life - the things you care for, the things that tell your story.” (p.1166)</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
Context is King: A Case Study of an Autonomous House in Sweden

Master thesis in Sustainable Development
Ben Owen

Appendix E
Details for Pattern Language Design
(Selected designs)
Pattern No.: 106  
Pattern Name: **Positive Outdoor Spaces**  

**Problem:**  
"Outdoor spaces which are merely "left over" between buildings will, in general, not be used." (p.518)

**Solution:**  
"Make all the outdoor spaces which surround and lie between your buildings positive. Give each one some degree of enclosure; surround each space with wings of buildings, trees, hedges, fences, arcades, and trellised walks, until it becomes an entity with a positive quality and does not spill out indefinitely around corners." (p.522)

**Optimal design for this pattern:**

Make this area a semi-private space, more enclosed from the footpath to the west. The distance in elevation from footpath also useful in achieving this.

Further the sense of enclosure by ‘closing’ this area with a sauna building, hedges, trees or a mixture of all of these.

I hope to avoid the use of fences.
Pattern No.: 107  
Pattern Name: **Wings of Light** 

**Problem:**  
"Modern buildings are often shaped with no concern for natural light - they depend almost entirely on artificial light. But buildings which displace natural light as the major source of illumination are not fit places to spend the day." (p.525) 

**Solution:**  
"Arrange each building so that it breaks down into wings which correspond, approximately, to the most important natural social groups within the building. Make each wing long and narrow as you can - never more than 25 feet wide." (p.529) 

**Optimal design for this pattern:** 

The proposed footprint dimensions fit within the 25ft (7.62m) in this pattern. As the buildings width faces south and woodland area to the east the final design would need to maximise the natural light with windows in the south and west.
Pattern No.: 108
Pattern Name: Connected Buildings *

Problem: 
"Isolated buildings are symptoms of a disconnected sick society" (p.532)

Solution: 
"Connect your building up, wherever possible, to the existing buildings round about. Do no keep set backs between buildings; instead, try to form new buildings as continuations of the older buildings" (p.534)

Optimal design for this pattern:

Is this pattern applicable for this project? The existing Storage Stuga is isolated from the main building – probably for the reason that it was built for – to keep less used items away from the main area. If we plan to convert this into a Guest Stuga then it should be connected by a covered walkway. This could also be ‘connected’ by building the sauna between the Main Building and the Storage Stuga.

A walkway, either covered or uncovered, could be used to connect the Playhouse with the main building, however this would be connection for connection sake and goes against the idea that the Playhouse could be used as the ‘Childs Realm’ (Pattern No.137).
Pattern No.: 112  
Pattern Name: **Entrance Transition**

**Problem:**  
"Buildings, and especially houses, with a graceful transition between the street and the inside, are more tranquil than hose which are open directly off the street." (p.549)

**Solution:**  
"Make a transition space between the street and the front door. Bring the path which connects street and entrance through this transition space, and mark it with a change of light, a change of sound, a change of direction, a change of surface, a change of level, perhaps by gateways which make a change of enclosure, and above all with a change of view." (p.552)

**Optimal design for this pattern:**

The house is judged during this transition, therefore it needs to be done right.  
- Will there be two entrances? From the car area, from the gate at the bottom?  
Should this be changed?
Pattern No.: 139
Pattern Name: **Farmhouse Kitchen**

**Problem:**
"The isolated kitchen, separate from the family and considered as an efficient but unpleasant factory for food is a hangover from the days of servants; and from the more recent days when women willingly took over the servants role." (p.661)

**Solution:**
"Make the kitchen bigger than usual, big enough to include the 'family room' space, and place it near the center of the commons, not so far back in the house as an ordinary kitchen. Make it large enough to hold a good big table and chairs, some soft and some hard, with counters and stove and sink around the edge of the room; and make it bright and confortable room." (p.663)

**Optimal design for this pattern:**

Kitchen to be located on the south side of the building and take up at least 40% of floor space:
Total floor area: 49.92m²
Kitchen Area: ca. 19.99
Appendix F

New Main Stuga Design Details

Ben Owen
Master thesis in Sustainable Development

Autonomous House in Sweden

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Description:
- Two story wooden structure built around the site of the existing building. It will be roughly 50m² on lower level with roughly 36m² of useful area on upper level plus a balcony to the south.
- Timber frame structure with straw bale in fill to provide the main insulation for the building. Clay plaster on both the inside and outside to provide wind proofing, with timber cladding on the outside to stop water from entering and damaging the outside plaster.
- Gambrel roof, timber frame using tiled roofing (still to be confirmed).
- Foundations for existing structure are poor and will require replacing.
- Greywater greenhouse at the southwest corner will house the greywater system.
- Greenhouse to the south can be accessed from the kitchen and rear garden.
Water storage tank housed to the north

New entrance to the west

Greywater Greenhouse

Balcony over south facing greenhouse
Nåntuna-Lund Stuga
Straw Bale Design
6th April 2014
New Building

Approx. 22m above sea level

Approx. 16m above sea level
To the west are views of farmers fields, Fyrisån and the old Ultuna buildings of SLU. North and south are neighbours with single story buildings of various sizes. Up the slope to the east is a woodland area, beyond which is land used by horses and Nåntuna.

A bridle path runs along the western boarder of the property, this is also car access to the property.

There are large rocks throughout the plot as well as large trees which will remain undisturbed.
There will be a compost toilet so there needs to be space underneath the toilet for a large bucket, also a small tank for urine will be located under the bathroom – but this is more flexible and can go anywhere downhill.
Windows frames will be made by hand using 170mmx21mm planks and 70mmx45mm. The nearest window frame shown has double width as it is a large window and needs to support a larger number of bales. All windows and door frames will be ‘staked’ into the straw – at least two stakes per side i.e. 8 stakes per window.
Foundations of the existing building are shown above. The plan is dismantle the veranda, keep as much of the framework as possible but completely remove the existing building.

The existing building is sat on a various rocks with 4 metal poles at the west. It is unsure how far these go down.

A larger concrete post is also at the western side – this is not very well grounded.
Nåntuna-Lund Stuga
Straw Bale Design
6th April 2014

Existing Building - Foundations
- Planhyvlat V:A 45mm x 170mm
- Obehandlat trä
- 600mm Centers
- Two planks together (2 x 170mm) around edge where straw bales sit
- Lımträpelare Gran 90mm x 90mm
- Obehandlat Gram
- Set in pairs, on the outside and the inside of the straw bale edge.
- Entrance hall frame built with Planhyvlat 45x170 Obehandlat trä
- South Greenhouse frame that holds up the balcony uses singular posts

Kitchen wall units used in this corner, therefore supports required as straw bales don’t have the strength to hold up these units

Nåntuna-Lund Stuga
Straw Bale Design
6th April 2014
New Building – Frame
Horizon in pictures could be misleading, approximate slope shown.
- Posts will need some bracing, here is an attempt at putting in bracing that doesn’t cross doors and/or windows.
- Bracing shown is 45mm x 90mm
- Planhyvlat V:A 45mm x 170mm
- Obehandlat trä
- 600mm Centers (except for entrance hall.
- As with base frame, two planks (2 x 170mm) are placed where bales are (above and below).
- Opening for stairs

Upper level wall inset 1200mm to create larger, more sheltered balcony, solid base for bales required.
- Grambrel Roof to give larger useable floor area.
- Planhyvlat 45mm x 190mm
- Obehandlat trä
- 1200mm Centers (except for entrance hall).
- Three dormer windows, one on the east side, two on the west.
- Straw Bales to be used:
  --- Width: 300mm
  --- Height: 500mm
  --- Length: 750mm

Typical density of a straw bale is 200kg/m³, therefore bales to be used are around 22.5kg

- Total number of straw bales on lower level:
  North Wall = 28 whole bales plus 12 half Straw Bales
  South Wall = 14 whole bales plus 17 half Straw Bales
  East Wall = 51 whole bales plus 15 half Straw Bale
  West Wall = 30 whole bales plus 21 half Straw Bales

- Total number of straw bales on Upper level:
  North Wall = 19 whole bales plus 2 half Straw Bales
  South Wall = 9 whole bales plus 5 half Straw Bales
  East Wall = 2 whole bales plus 0 half Straw Bale
  West Wall = 4 whole bales plus 0 half Straw Bales

Total number of bales to be used = 203
(Including 5% for under estimation)
As the straw bales are 500mm high (as used) and the lower height is 2200mm, we use 4 courses of full height bales and then make custom bales to fit the 200mm gap. These custom bales have been counted as ‘half bales’ in the count above.

Other custom bales that are required in the upper level in the north and south walls have been counted as full bales.
Nåntuna-Lund Stuga
Straw Bale Design
6th April 2014
New Building – Straw Bales
Water Tank Room at the north of the new building to house... the water tank – a 3000liter plastic tank, plus plumbing, pumps and filter.

- Dimensions at the base of the tank room are 2400mm x 4750mm
- Base to be made out of concrete – can this be incorporated as part of the foundation for the main house?
- Will need to be dug down, requiring water protection and insulation. Removal of large rocks likely
- Rest of structure will be made of timber (170mmx45mm), with clay-straw insulation between posts, clay plaster and timber clad.
- Roof to be of the same tiles as the main house. Roof joists at 600mm center's, insulation between will be standard cellulose insulation.
Greywater Greenhouse at the southwest corner of the new building to house the greywater filtration system – a 1200mm wide bed of soil, sand and gravel, with a depth of 1200mm and a length of 5200mm.

- Dimensions at the base of the Greywater greenhouse are 2500mm x 5400mm
- Base to be made out of concrete – can this be incorporated as part of the foundation for the main house?
- Will need to be dug down, requiring water protection and insulation.
- Removal of large rocks likely
- Rest of structure will be made of timber (170mmx45mm), with double glazing between posts,
- Roof joists at 600mm center’s
Planning Permission Submitted

Appendix G

Ben Owen
Master Thesis in Sustainable Development

Autonomous House in Sweden

Context is King: A Case Study of an

for New Main Stuga