BIOPHILIC LIVING
A BEHAVIOR RESPONSIVE ARCHITECTURE
GÉZA FISCHL
To my children, Gréta and Simon
## ABSTRACT

## INTRODUCTION

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ABSTRACT

Biophilia is a human tendency to interact or be closely associated with other forms of life in nature. Consequently, biophilic living is related to an ecological perception on how humans are fascinated aesthetically as well as related physiologically and psychologically to nature and how humans value their surroundings. In order to move toward biophilic living, one should behave more pro-environmentally and find fascination in the environment while discovering ways to increase participation for the ecological values. When an architecture strengthens pro-environmental behavior and ecological responsiveness, it demonstrates an ability to alter its form due to behavioral stimuli and continually reflect the environmental conditions that surround it.

In this thesis, an exploration of a behavior responsive architecture is described through a proposed theoretical model, a site-specific direct architectural intervention, and a speculative design. The architectural strategy used was the concept of a living lab in the form of a winter pavilion which aimed to bring people together and increase awareness of biophilia. One of the primary function of a living lab is to disseminate knowledge and host innovative discussions about how biophilia could be approached and appreciated in the everyday life.
The scope of this thesis is limited to the city of Umeå in the north of Sweden. The location- and season-specific winter material - snow - was used and even up-cycled from a nearby place for building a living lab. It was hypothesized that a low-tech, stand-alone behavior responsive direct architectural intervention is capable of stimulating awareness of biophilic living of individuals and their pro-environmental behavior intention positively. Furthermore, it was speculated that an urban square scale architectural intervention could have long effect on pro-environmental intention and in the same time transforming the spatial quality of the square to more biophilic. The testing of behavioral intention and the evaluation the living lab results from findings supported the hypothesis.
INTRODUCTION

This introduction provides a summary of theoretical constructs on how biophilic living can be understood and which factors can contribute to developing biophilic living as a concept for architectural intervention.

I. Responsive architecture

Responsive architecture refers to a class of architecture or building that demonstrates an ability to alter its form and to reflect continually the environmental conditions that surround it. This flexibility can be due to material and/or functionality affordances, that are in response to environmental variations or the alteration of needs of its inhabitants.

Most of the buildings are less obviously responsive; therefore we might even consider them as static and passive. The static and fixed aspects of buildings basically support human survival and maintain core body temperature while providing a comfortable indoor climate. Some of the basic functions in buildings’ responsiveness are, for instance, the ability to adjust thermal comfort in terms of opening or closing doors or windows in the same time as adjusting daylighting. The human need for stability must, therefore, be incorporating a certain type of flexibility as well, otherwise, the maintenance of human equilibrium would not be possible to achieve. This constant maintenance of equilibrium is governed by our human behavior, in which people either try to adapt themselves to the environmental variables or they make sure that the environment adapt to their needs. This adaptation technique is paramount not only for individual purposes but also for living together in a social context. The social sphere, the coexistence is regulated by adaptation, in which the built environment refers to the personal or architectural features that are permitting or inhibiting behaviors. In coexistence theory, the factor of convergence is a behavior or act of becoming more alike as the interaction progresses, while divergence is the opposite of convergence, hence becoming more dissimilar regarding behavior or act. Mirroring is understood as a personal (may be environmentally induced) behavior, that becomes identical to the other’s behavior and compensation is an act of a person (may be environmentally induced) that reacts dissimilar to another’s response. Finally, reciprocity implies that a person reacts or behaves (may be environmentally induced) in a similar way to another person’s reaction in its environment.

The coexistence theory and behavior responsiveness is organically connected through responsive architecture. The term responsive architecture was first introduced by Negroponte (1975), who coined the term during the late nineteen sixties when spatial design problems were being explored by applying cybernetics to architecture. His intention with restorative architecture was to integrate the computing power of early computers into built spaces and structures, and thus a more adequate building performance could be achieved. His work impacted the field of architecture in a technical, functional, and actuated direction. According to Sterk (2003) for Negroponte, the responsive architecture is a function of intelligence. He believed “that the integration of artificial intelligence into architectural environments is critical to producing a responsive architecture that is capable of performing adequately” (p.87). This adequate performance is approached through the recognition of “intelligence is required to identify the context of an event and the appropriateness of a response” (p. 87). He further categorized its actions as reflexive and simulated depending on the manifestation of responsiveness. Thus, for instance, walls that move when touched or change its color belongs to reflexive action while simulated action is described when a room emulates an environment for entertainment purpose. Furthermore, these actions are both divided into
operational and informational responses, wherein operation response is performance oriented, while informational is simply the temporary control of the same transaction. Sterk (2003) summarizes as Negroponte’s responsive architecture “does not suggest how these architectures may actually be built—although he does favor the use of soft materials and structures (such as inflatable membranes) over hard materials and structures (no examples of hard materials are given).”

After Negroponte’s contribution, new types of responsive architecture have emerged rather as aesthetic creations and not as functional ones.

Projects like Blur Building (Diller Scofidio), Aegis Hypo-Surface (dECOi) and the Fresh Water Pavilion (NOX) are the well-published typologies for responsive architecture. Each of these projects monitors fluctuations with the environment and alters its shape in response to these changes. The Blur project emphasizes on the characteristics of a cloud to change its form while blowing in the wind (Figure 1). The Aegis Hypo Surface (Figure 2.) is a programmable facade, while the Fresh Water Pavilion (Figure 3.) project features a programmable audio–visual interior. These are the evolving fields of responsive architecture in practice and research. Traditionally, responsive architecture aims to refine and extend the discipline of architecture by improving the energy performance of buildings with intelligent technologies and reflect the technological and cultural conditions of that time.

**Remarks on responsive architecture**

Responsive environments are rapidly developing due to the computational power of the intelligent systems. An earlier used high-tech solution seems a low-tech approach today and that is why it can gain access for disseminating. However the temporally accessible seasonal materials which surrounds us had not been explored for architectural responsiveness. Responsiveness would mean in this context to use the material inherent quality to make the interaction affect the user in a much profound manner:

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2. **An ecological approach to environmental perception**

Gibson (1950) developed the direct perceptual theory, or the ecological approach, to perception (Rosch, 1996). Gibson (1950) argues that
A person-environment interaction requires the dualism coming from the role of an observer and the environment. Conversely, there are no differences between the perception of “here” and “there”, because these two contain a continuous flow of surfaces, which extends from one to another. This is explained through the ecological optics, which does not contain the abstraction of “empty space” described in physical terms, but a gradient of features including environmental details. These environmental details are substances such as clay, steel and glass, and also surfaces such as floors, walls, and ceilings (Gifford, 2002). Therefore, information can directly be extracted from the surrounding without even using cognitive efforts.

As opposed to the ecological approach to perception, the Brunswik lens model (Brunswik, 1956) is originated in a careful weighing of distal and proximal environmental stimuli, that goes through several layers of evaluation before the subject can appraise an ecologically valid decision about the surrounding. This evaluation model is useful for decision making based on a careful assessment procedure.

The word, affordance designates the ecological approach to perception as a phenomenon, when some behavior directly can be derived from the environment, hence, this information are ecologically connected to each other. An example of such affordances is the ground that supports, the enclosure that gives shelter, and the elongated objects that can be used to strike with. In terms of architectural applicability and human performance, Gibson (1950) discussed the way architects were introduced to design. He insisted that design professionals’ perceptions about color, form, and shape of a place were the driving force for the design, instead of allowing laypersons’ perspectives to be developed. Conversely, by allowing users to contribute to the architectural design, would engage ecological perception of the surrounding to be appreciated even more by affording instantaneous cognition and hence would limit the designers’ self-anchored design motivations. This ecological approach to environmental perception may help to understand biophilia hypothesis in the built environment.

**Remarks on ecological perception**

There seem to be competing ideas about environmental perceptions and it is more likely to be decided across disciplines, however in architecture one should be able to understand the connection between duration and effects.

### 3. Biophilia hypothesis

Biophilia is a term coined by Wilson (1984), he describes biophilia as an “innate tendency to focus on life and lifelike processes” (Wilson, 1984, p.1), “innate emotional affiliation of human beings to other living organisms” (Wilson, 1993, p.31) or “inborn affinity human beings have for other forms of life an affiliation evoked, according to circumstances, by pleasure, or a sense of security, or awe, or even fascination blended with revulsion” (Wilson, 1994, p.360). In a later publication, *The Biophilia Hypothesis* (Kellert & Wilson, 1993), contributors investigate the validity of Wilson’s biophilia hypothesis, which entails that biophilia is evolved by natural selection in a cultural context. Hence, evidence for biophilia as envisioned by Wilson is insufficient and cannot be tested easily. Since its conception, the term biophilia has rarely been used in scientific articles. Instead it was approached by the ecological perception that refers to increasing evidences on how humans are fascinated aesthetically, related physiologically and psychologically to nature and animals as well as how humans value their surroundings (Simaika & Samways, 2010). The exploration of this approach is extracted from Kahn (1997).

**Aesthetics and habitat**

It is widely accepted that human beings lived on the savannas of East Africa for 2 million years and this environment had contributed to humans’ individual and group survival due to its landscape. It is often mentioned that body of water, tree canopy or tall grass provided prospect and refuge for certain activities. Consequently, this is where Wilson
(1984) originates his biophilia hypothesis, namely that the characteristics of savanna had been imprinted in our genes. Along with this notion, the Kaplans (e.g., Kaplan and Kaplan, 1989) for instance, have proposed that in general, people would choose natural environments more often than built environments, and built environments with water, trees, and vegetation more than built environments without such features. Consequently, results showed that respondents in their study highly appreciated environmental features such as waterscapes with low intensity. These findings include landscapes such as “parklike or woodlawn or savanna” (p. 48). Less appreciated landscapes were found for settings that were blocked, such as a dense vegetation dominating a scene. Cultural investigation of environmental preferences by other researchers continue to support this finding (see Ulrich's, 1993, review).

Research by Wohlhill (1968) had suggested that middle levels of complexity would explain a positive preference to environmental features. Along this investigation, the Kaplans (1989) found incomplete evidence that people would actually dislike places with low complexity, however, high complexity would not automatically result in increased preference. Furthermore, four factors were introduced by the Kaplan’s (1987). These are included in the preference matrix to characterize immediately and predicted information in terms of its understanding and exploration (Table 1). One dimension of this matrix is the “Understanding” versus “Exploration” distinction. The other dimension describes the time needed for processing environmental information.

This matrix coexists with the model of Berlyne’s (1971) collative stimulus properties. At least two of these dimensions (complexity, coherence) are similar to Berlyne’s (1971) collative properties. A distinction between the Kaplan model (1987) and the Berlyne (1971) perspective, is that Kaplan’s (1987) emphasize the informational content of a scene in an ecological/functional sense as one basis of preference judgments (Cupchik & Winston, 1996).

A study referred by Kahn (1997) reported a positive finding of the savanna hypothesis among children aged between 8-11 years. In their study, children were asked to rate five different biome stimuli, such as rain forest, mixed hardwood forest, boreal forest, East African savanna, and desert. Furthermore, it was found that older children would equally prefer hardwood surroundings and savanna-like environments.

Physiological and psychological well-being

As the biophilia hypothesis postulates, the human evolution has been affected by the natural surroundings, that in turn promoted human survival and reproductive success. It is consequently assumed that human physiology and emotional well-being have been profoundly influenced. Ulrich (1993) for instance, had shown that stress reduction is one of the major benefits while inhabiting wilderness, especially those that resemble savanna. Generally speaking, stress reduction happens in the absence of stressors. However, as a complementary area to environmental stress research, the restorative environments have been investigated for fostering recovery processes (Hartig, Böök, Garvill, & Olsson, 1996). As an alternative framework to stress recovery is Ulrich’s (1991) psycho-evolutionary approach that is concerned with the individuals’ threatened well-being. The evolutionary approach postulates “that immediate, unconsciously triggered and initiated emotional responses – not ‘controlled’ cognitive responses – play a central role in the initial level of responding to nature and have a major influence on attention, subsequent conscious processing, physiological responding and behavior” (p. 207-208).

<table>
<thead>
<tr>
<th>Characterization of information</th>
<th>Understanding</th>
<th>Exploration</th>
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<tr>
<td>Immediate</td>
<td>Coherence</td>
<td>Complexity</td>
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<tr>
<td>Inferred or Predicted</td>
<td>Legibility</td>
<td>Mystery</td>
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On the contrary, Berlyne’s theory (1971) emphasizes the importance of information in aesthetic judgments.
Support for this was found in laboratory studies in simulating natural and urban environmental settings and connecting them to emotional and physiological responses. As Hartig et al. (1996) stated, in their study, “more beneficial changes were seen in the self-reported positive and negative emotions of participants who viewed slides of natural scenes” (p. 380).

Furthermore, showing an accident film prior to a 10-minute natural simulation resulted in the fastest return of post-stress recovery, measured by monitored muscle tension, skin conductance, and pulse in comparison to an urban environmental setting.

In Kaplan and Kaplan’s (1989) literature review, it was concluded that people with access to nearby natural settings have been found to be healthier than other individuals. This positive effect was further seen in “increased levels of satisfaction with one’s home, one’s job, and with life in general” (p. 173). They also share their thinking about technological advancement and nature: “nature may be readily replaced by some greater technological achievement. Viewed as an essential bond between humans and other living things, the natural environment has no substitutes” (p. 203).

**Affiliation with animals**

Since biophilia is introduced as an affiliation with life and lifelike processes, and the biophilia hypothesis talks about natural environments, then animals and their connection to human evolution could be investigated as well.

As a starting point in Melson’s article (2013, p. 93-118.) many animal species inhabit various places and have diverse relationships with humans. One of the most common example is tropical fish, which can be viewed as pets in an aquarium tank, but also as wild animal in the Caribbean coral reefs which is their native habitat. Another contradicting example how humans see animals is when they are kept in zoos or nature parks, not to mention research facilities. In these specially designed environments the animals exist in total dependence on humans, yet being portrayed as wild. Furthermore, rabbits or other farm animals which are being kept for their fur, meat and other benefits for humans are not particularly seen as pets but so-called domesticated animals, that reflects a utilitarian perspective on natural resources. A contact with wild animals always occurs within a specific environmental context, varying in its wildness or wilderness. Humans when visiting natural settings, like parks and nature preserves, usually would go for an immersion experience of nature, even though these environments might have been transformed by design to maintain a feeling of wildness or wilderness.

As a contrast to nature, in urbanized and industrialized societies much less immediate and extensive contact is made with wild animals. The contacts are limited to an attempt for interaction, or observation of wild animals in parks, nature preserves, zoos, aquariums, bird sanctuaries and such designed environments. For instance, Turley (2001) estimated that children account for 37% of all visitors to designed wilderness settings. In general, children often feed wild ducks at a park or handle under adult supervision, a wild animal as an art of a nature education program. Additionally, many families observe wild birds at backyard bird feeders, see squirrels, porcupine, frogs and other creatures around the neighborhood and discover that they involuntarily share their homes with ants, spiders, and flies. Such everyday encounters with wild animals illustrate that even in the most urbanized environment, children can have contact with wild animals. Because of the cultural constructions of wild animal, that is to strengthen the stereotype of large mammals in wilderness settings, these encounters with insects and smaller mammals and such are rarely thought of as wild animal experiences.

As Kahn (1997) suggests, similarly to landscapes, human contact with animals seems to promote physiological health and emotional well-being. There is a mounting evidence on animal-assisted therapy within the last three decades. Early studies supporting (i.e., Barke & Dawson, 1998) the health benefits of companion animals have emerged and
findings for cardiovascular effects are often the focus. Stress and anxiety are considered contributory factors to cardiovascular disease. Investigators generally hypothesized that companion animals serve to lower levels of stress and anxiety. Currently, animals are purposely included in treatment through various interventions broadly known as animal-assisted therapy which aims the use of trained animals in facilitating patients' progress toward therapeutic goals.

Other early animal related experiment (Katcher, Friedmann, Beck & Lynch, 1983) found that watching an aquarium resulted in significant decreases in blood pressure below the resting level in both hypertensive and normal subjects.

In general, over the decades, it has been found that experience with animals positively affects human health and wellbeing. Kahn (1997) review of reports emphasizes that people who have organic or functional mental disorders as a consequence of Alzheimer's disease smile and laugh more, and become less hostile to their caretakers and more socially communicative when animals enter their lives.

A number of studies show similar findings with autistic children. Through interactions with animals has been shown that autistic children have more focused attention, social interaction, positive emotion, and speech. Similar results have been found for people with various functional mental disorders. Moreover, according to Katcher and Wilkins (1993), “all the desirable responses to animals in therapeutic situations reflect the influence of interaction with companion animals within the general population” (p. 180–181).

Values of nature

One of the most accepted typologies on how humans appraise nature is presented by Kellert (2005) throughout a set of emerging investigation. These typologies depict a range of physical, emotional and intellectual assertion of the biophilic tendencies.

Referring to Kahn (1997), (1) the utilitarian value emphasizes the material benefit that humans derive from exploiting nature to satisfy various human needs and desires. (2) The negativistic value emphasizes feelings of aversion, fear, and dislike that humans have for nature. (3) The dominionistic value emphasizes the desire to subdue and control nature. (4) The naturalistic value emphasizes the desire to subdue and control nature. (5) The ecologistic-scientific value emphasizes the systematic study of the biophysical patterns, structures, and function of nature. (6) The aesthetic value emphasizes a primarily emotional response of intense pleasure at the physical beauty of nature. (7) The symbolic value emphasizes the tendency for humans to use nature for communication and thought. (8) The humanistic value emphasizes the capacity for humans to care for and become intimate with animals. Finally, (9) the moralistic value emphasizes the right and wrong conduct toward the nonhuman world.

As an explanation for these values, Kellert suggests that in earlier times many utilitarian activities (e.g., the ability to identify and pick edible berries) provided an unequivocal adaptive advantage by increasing the likelihood of survival (e.g., by increasing nutritional intake). Similarly, the negativistic value presumably helps keep humans a safe distance from dangerous parts of nature, such as poisonous snakes and spiders, large predators, and precipices. The aesthetic attraction to varying species and landscapes may reflect a recognition of the increased likelihood of finding food, safety, and security in nature. Naturalistic experiences often reduce stress, sharpen sensitivity to detail, enhance creativity, provide intellectual stimulation and physical fitness, and so on. Even the moralistic value, may provide the adaptive advantage by fostering certain forms of kinship, loyalty, and cooperation.

Based on this typology, Kellert investigated a wide range of differences in values toward nature by age, culture, education, income, ethnicity, gender, and place of residence (urban/rural).

In terms of culture, Kellert (1996) conducted a series of cross-cultural studies in Japan, Germany and
These findings must be seen with caution and bearing in mind that these differences are more like indicators of the differences with a certain degree of freedom. For instance, in Japan he found that in comparison to American populations, the Japanese scored high on a dominionistic value of nature and wildlife. That is, Japanese often aimed to manipulate and control nature, and to cultivate preferred natural elements. Hence, traditional Japanese “nature appreciation activities—bonsai, haiku, flower arranging, the tea ceremony, rock gardening—reflect a refined appreciation of nature, even at times its veneration, but also a belief that wilderness requires the creative hand and eye of humans to achieve its perfection” (Kellert, 1996, p. 139). Consequently, Japanese were less interested in wild nature and ecological processes, and showed limited support for wildlife conservation and protection. On the contrary, Germans expressed more moralistic and ecologistic values, and a greater willingness to subordinate practical needs to maintain conservation of nature and protect wildlife, than Japanese. Furthermore, Germans appeared to romanticize wilderness, in spite of the limited contact with it. In short, cross-cultural variability of nature values emerged in relation to conservation.

**Radical biophilia**

Radical by definition (Merriam-Webster Dictionary, 2016-02-04) means relating to or affecting the fundamental nature of something. Earlier, biophilia has been introduced as a scientific construct that is possible to describe by certain factors and typologies that are represented in an anthropocentric perspective. Now emphasis of investigation is moved away to see what critical thinkers might have to say about the issue of environmentalism and deep ecology in relation to biophilia. In a recently published essay by Kopnina (2015), the highlights, challenges and contradictions, as well as possible direction was described as an alternative environmental conservation strategy.

Starting with an inquiry by an environmental anthropologist (Milton, 2002), why some people in western societies grow up to be nature lovers, that is to actively be concerned about the welfare and future of plants, animals, ecosystems, and nature in general, while others seem uninterested or even tend to disrupt any relations with them? An answer on this is given by conservation psychologists which postulate that child development in early age is sensitive on nature exposure and contact with animals through outdoor activities (i.e., Wells & Lekies, 2006). Yet, Kopnina (2015) is not convinced. She suspects that there must be more behind when someone who grew up next to a forest does not react upon the logging of the same forest. Her investigation turns to the strength of commitment that is indicated in different cultural contexts. In the US for instance, defenders of nonhumans are treated as high-security threat (e.g., Switzer 2003) and with animal rights activists identified as terrorists (e.g., Churchill 2004). The US antiterrorist laws may also be applied to the radical environmentalist that impose property damage and causes violence against bystanders. In spite of the political marginalization, radical environmentalists have succeeded to shed light on problems that moderate environmental organizations failed to unravel (Arnold 1997). Furthermore, it seems that national wealth is negatively correlated to environmental awareness in developed countries, meanwhile, rich people also seem to behave less pro-environmental than the poor (Dunlap and York, 2008).

Kopnina (2015) summarizes her strategy for dealing with biophilia in different cultures. Her underlying view is that anthropocentric industrialism suppresses the environmentalists who need to implement some changes. First, environmentalists have to be able to talk to the public and power holders, thus, openness and pragmatism, especially in communication with conservation critics need to be retained. However, there is still a need to present a unified front against the deeply entrenched rationality of anthropocentrism that is shared by conservation critics. Cultural alternatives present in traditional cultures as well as committed environmentalism can be drawn upon to inspire such unity. Crist (2012, 150, emphasis in original)
reflects that “hope lies in humanity’s coming to realize the immensity of what we are irretrievably losing, which is not resources. Hope lies in the fact that we are native to the Earth: we have the potential of understanding that we are losing our own family.”

Remarks on biophilia
If biophilia is inside us so to speak, we breathe through it, then why are we behaving so cruel to our own environment and the living things surrounding us? Do we perceive and understand that way we affect or surroundings? If yes, then is it possible to evoke biophilia by means of architecture?

4. Behavior and contextual factors
Nowadays humans experiencing a serious and potentially catastrophic global environmental change that is one of the important challenges to overcome on the way to sustainability. On the individual and social level, pro-environmental behavior has been investigated in a wide range of social science disciplines including economics, sociology, anthropology, and environmental psychology.

This review of the literature on environmental behavior aims to introduce three of the most influential theories to a moral norm that mediate individual pro-environmental behavior. The approach is presented in Turaga, Howarth and Borsuk (2010) about pro-environmental behavior:

**Norm-activation theory**
One of the explanations of the norm-activation theory is outlined by Schwartz (1977) as a sequence of cognitive steps involved in the moral decision-making process of an individual. This social-altruistic value orientation model is originated in the altruism to another human being. First, the activation, then obligation, defense, and finally the response steps. The activation step is about to recognize the need, through stimulating problem awareness, which is the consequences of not acting pro-socially for others or for other things one values (De Groot & Steg, 2010). The activation step is accomplished when the individual ascribes responsibility to him/herself to take action. This step generates feelings of moral obligation due to the activation of personally held moral norms (Turaga et al., 2010).

In the moral obligation step, the norms are constructed in specific action situations and reflect the expectations that people hold for themselves. Hence, the model recognizes that these self-expectations are derived from socially shared norms: “individual expectations arise or are learned from shared expectations in social interaction, and they are modified in the singular interaction history of each person” (Schwartz, 1977, p. 353). A violation of a person’s own norm would result in the feeling of guilt, self-deprecation, or even loss of self-esteem while conforming and reinforcing moral norms would result in feeling of pride, enhanced self-esteem, or feeling of security.

Towards a pro-environmental behavior, we are aiming at performing an altruistic act, that in turn would, unfortunately, take a toll on one’s self in terms of social, physical and psychological resources. However, if the altruistic act is not performed in spite the person’s norms are activated, it would also result in a feeling of guilt, self-deprecation, and loss of self-esteem. In order to avoid the unwanted outcome, the defense step would preserve the person’s integrity by assessing the cost of action. Consequently, in the response step if the costs of
performing the act are as high as (or more than) the costs of violating the activated personal norms, then the person would need to reassess and reset the situation in order to compensate the activated norms and avoid taking action (Turaga et al., 2010).

The relative importance of how people get attached to particular values and norms would inherently be activating each person on a different level, which in turn would result in alternative activation level to moral obligation when the same situation is assessed. Empirical research on the application of norm-activation to pro-environmental behavior has been two faceted. Initially, household behaviors such as littering, yard-burning, buying lead-free gasoline, household energy conservation, and recycling were investigated. Then investigation turned to behavior that supports for environmental protection, such as signing a petition for tougher environmental regulations and willingness to pay extra taxes for environmental protection.

**Value-belief-norms theory**

While the norm-activation theory on pro-environmental behavior assumes altruism/concern toward other human beings as value orientation which makes it relevant for norm construction in the context of environmental behavior; the value-belief-norms theory (e.g., Stern et al., 1993) argues, that an altruism/concern to nonhuman species originated in biospheric value orientation, and norm-based self-interest (egoistic value) would also be able to guide individuals pro-environmental behavior. Moreover, these two personal norms (biospheric and egoistic values) would be activated in the same way in which altruistic personal norms are activated in norm-activation theory. Hence, people’s personal norms are activated when they believe that environmental conditions have consequences to the object of one’s self or other human being or nonhuman species which they value and that they can take action to reduce those consequences to the aforementioned objects (Turaga et al., 2010). The way the hypothesized causal chain works in the value-belief-norm theory refers to move from a relatively stable, central elements of personality and belief to a more human-environment context that concerns a valued object and a responsibility for the action which in turn activating a sense of moral obligation that creates a condition to act.

Empirical research on pro-environmental behavior distinguishes among four areas of applications: (a) environmental activism, where humans have active involvement in environmental organizations and demonstrations, (b) non-activist behaviors in the public sphere, which include environmental citizenship behaviors, (e.g., petitioning on environmental issues and supporting policies in order to protect the environment), (c) private-sphere environmentalism such as green consumerism, and finally (d) other environmentally significant behaviors including individual behavior in organizations.

In the previous paragraphs, two major theories of pro-environmental behavior were introduced. What is still underrepresented in these field of research in general, according to Turaga et al. (2010) is the effect of the contextual factors for pro-environmental behavior. In the third, the theory of planned behavior in contrast to the emphasis on moral considerations in norm-activation models, it adopts a rational decision-making framework.

**Theory of planned behavior**

A central issue in this theory (Ajzen, 1991) is the individual’s behavioral intention, that is assumed to capture the motivational factors which influence behavior (Figure 4). In general, the stronger the behavioral intention to perform an act, the stronger the possibility of actually performing that behavior. However, perceived behavioral control may interact with the causality of behavioral intention to actual behavior. As a consequence, the perceived behavior control illustrates the ease or difficulty with which the person can perform a behavior. This is in accordance with two other individual factors, namely attitude and subjective norms toward a behavior. In general, the more favorable are the individual’s attitudes and subjective norms toward the behavior, the stronger is the behavioral intention. Beliefs, in general, play an important role in this framework.
The three corresponding beliefs for attitude, subjective norms and perceived behavioral control are *behavioral beliefs*, *normative beliefs*, and *control beliefs* respectively. Each belief has an outcome or an attribute associated with the performance of act. In case of the behavior belief this outcome can be originated in all individual beliefs that shapes attitude. For normative belief, it is shaped by important individuals or groups that approve or disapprove of performing a given behavior, while control beliefs refer to the actor’s perception of resources and opportunities available to perform the behavior.

**On contextual factors**

Researchers in social sciences used to relate to architecture and design in general as it was mainly engaged with contextual factors. Consequently, social research methodology is lacking the evidence for behavior modification due to the quality of the built and natural environment as contextual factors. A review by De Groot & Steg (2010) on the topic of environmental behavior and the contextual factors was applied as a guide to shed light on the existing efforts on research with contextual factors. As a result of the review, the lack of methodology in this matter is clearly palpable. Continuing the line of thought with pro-environmental behavior it is obvious, that human behavior does not depend on personal traits and motivation alone.

Different contextual factors may facilitate or constrain environmental behavior and influence individual motivations. For instance, the availability of recycling facilities, the quality of public transport, the market supply of goods, or pricing regimes can strongly affect people’s engagement in pro-environmental behavior. In some cases, constraints may even be so severe that behavior change is very costly and motivations make little difference in the environmental outcome. So, it is not only important to consider intra-personal factors such as attitudes, norms and control, but also contextual factors such as physical infrastructure, technical facilities, the availability of products, and product characteristics.

The first two theories mentioned earlier (norm-activation and value-belief-norms theories) do not include contextual factors as an independent element for decision making in pro-environmental behavior. Meanwhile, the theory of planned behavior is only concerned with the individual perception of contextual factors that is embedded in perceived environmental control.

In summary, the contextual factors were found to be investigated in four different modes of interactions. Firstly, when contextual factors would directly affect behavior. Herein, the environmental affordances plays a vital role in performing the act. Secondly, when contextual factors would mediate environmental behavior through motivational factors, such as attitudes, affect, or personality norms. This mechanism can be illustrated through an introduction of a positively perceived contextual attribute that in turn would positively increase attitude (due to convenience) and this attitude would in return enhance pro-environmental behavior. Thirdly, contextual factors may moderate the relationship between motivational factors and behavior, and the effects of contextual factors on behavior may depend on personal factors. This kind of agency on pro-environmental behavior necessitates a strong belief system in environmental concern otherwise it would fail to achieve the desired behavior. Lastly, the contextual factors can be directed through goal oriented framing on which type of personal motivations would most probably be affecting behavior. In this mechanism, the goal of a contextual attribute is set, frequency or mode of use would be a determining factor for deliberating or prohibiting pro-environmental behavior while emotional activation would certainly happen.

De Groot & Steg (2010) further describe the need for a systematic approach to clarify the effects of contextual factors on pro-environmental behavior including motivational systems. This should preferably be done - as they say - in collaboration with architects, urban planners, industrial designers and technologists who do explicitly consider the effects of contextual factors. These investigations may lead to intervention programs aimed at behavior changes.
Remarks on behavior

There are studies which postulate that a behavior can be changed by means of altering one’s attitude, norms and beliefs, which is in line with what architecture is experimenting with the whole time, therefore it seems logical to introduce a method for stimulating behavior change through affecting one’s behavioral intervention.

5. From sustainability to sustainable health

Over the years, it has become palpable that sustainable design presses new demands on architects and planners to broaden their expertise to embrace environmental engineering, ecological ways of construction, efficient infrastructure, and unique urban development projects (SAR, 2010). It has also become clear that characteristics like how a building’s spatial hierarchy is organized, or daylighting, or design effects on indoor climate and energy performances are all important architectural considerations. The building method, materials and construction technology predetermine the carbon footprint of the building and its life cycle. The use of urban space is associated with land efficiency, therefore, a balance between the area of agricultural needs and local livable space minimum is essential. Infrastructure as a whole requires optimization in efficiency and a decrease in waste production.

A common way to understand sustainable development is a process or evolution, in which the development of any social, economic and environmental elements meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, et. al., 1987). The Brundtland’s Commission introduced this principle for the World Commission on Environment and Development in 1987 (Brundtland, et. al., 1987). Furthermore, professional bodies acknowledge that sustainable development has implications in the interaction between professionals and society. This is particularly the case for the built environment professions, such that buildings have major environmental, economic and social impacts (Colantonio, et. al., 2008).

To exemplify, buildings are major emitters of carbon, which contribute to global warming. In a report by the Building Research Establishment (2003), the combined energy used in constructing, occupying and operating buildings would account for 50 percent of carbon emissions in the UK. In another report by United Nations Environment Programme (UNEP), “buildings are responsible for more than 40% of global energy used, and as much as one-third of global greenhouse gas emissions, both in developed and developing countries” (UNEP, 2009, p. 8). From a global perspective, the built environment becomes a major contributor to global environmental issues with great impacts on nature.

Several building performance models are capable of predicting the energy performance of a building. The most well-known systems are BREEAM (Building Research Establishment’s Environmental Assessment Method), LEED (Leadership in Energy and Environmental Design), and Green building. The Swedish Environmental Protection Agency argues that to combat climate change, national climate policies must be developed in correlation with international climate agreements. According to Pérez-Lombard, Ortiz and Pout (2008), buildings in developed countries contribute between 20-40 percent of the total energy consumption, which has exceeded other major sectors such as industry and transportation.

The majority on sustainability can be described through three key approaches. The first approach is concerned with definitions of sustainability. The second approach focuses on establishing what is unsustainable in a reductive sense, hence, how to make practices more sustainable and how to evaluate sustainable outcomes. This approach operates with checklists, indicators, triple-bottom-line accounting and ecological footprints (Wackernagel & Rees, 1996). It is based on the notion that there is sufficient knowledge about the planet and people (e.g., Redclift, 1996). The third approach discusses sustainability as a dialogue by defining and controlling the planned changes and developments (e.g., Sandilands, 1996).
In an article by Glavic and Lukman (2007), high importance was given to sustainability-oriented terms in order to classify definitions in clarifying ambiguity and for examining the connection between the domain of social, economical and environmental considerations. Their pyramid of sustainability development model is an evolutionary, self-improving concept that advances over time. The levels of sustainability development are entailing principles, approaches, sub-systems and on top, policy. Among these levels, altogether forty-two (42) sustainability-oriented terms were investigated and located into an equilateral triangular pyramid (regular tetrahedron) space, which represent the economic, social and technological aspects of sustainability on the base while sustainable policy on the apex. In their model, sustainable development is seen in a time domain, which necessitates continuous development in all four aspects (base and apex) of sustainability.

Kjærgard, Land & Bransholm-Pedersen (2013) postulated that “the concept of sustainable development is more than just sustainability. While sustainability is frequently understood as properties of, or indicators of, program implementation, sustainable development is a process towards a new normative horizon and implies a paradigm shift from a development based on inequity and overexploitation of natural resources and environmental services, to one that requires new forms of responsibility, solidarity and accountability” (p. 559).

Furthermore they point out that the concept of health is undergoing a series of development, therefore, it is better understood more than just the absence of disease. Health is part of the social dynamics of the social organization, lifestyles, and patterns of consumption and influenced by the bio-physical environment. Human health is determined by a social and economic system, the bio-physical environment and the person’s individual characteristics and behaviors. Health promotion indicate a paradigm shift from understanding as the absence of disease to a socio-ecological understanding, focusing on strength, resilience and assets to health. A development is sustainable, when human needs like jobs, food, energy, water and sanitation are fulfilled. Other basic human needs are housing, water supply, sanitation and health care. The two concepts complementing each other.

Attempts have been made to integrate health issues and sustainable development already in the late 1990s. The WHO Healthy Cities Project pointed out first that human health and sustainable development are linked together. This report explores health and sustainable development in European’s cities and towns, and postulates that health is just as important objective for people as sustainable development. The contribution of the Healthy Cities Project was an integrated framework, in which sustainability and health promotion, involving collaboration and citizens’ involvement became the driving initiative (Hancock, 1996).

A conceptual model of sustainable health in this thesis is built upon the pyramid model of sustainability (Figure 5). In this sustainable health model, the economic, social and environmental factors are also the cornerstones of individual, community and the sustainable health system. In order to advance toward sustainable health in general, the country level strategy needs to promote value measurement and value-based decision-making (evidence-based approach), innovative
delivery system, propagate healthy lives and invest in disease prevention. In other words, the aim is to shift healthcare out of hospitals into communities, stimulate innovation through greater competition in delivery, introduce more humane care into healthcare, and invest in behavioral change and prevention to diminish demand (World Economic Forum, 2013).

The WEF further suggests that no matter how lean and efficient, a healthcare system cannot be sustainable unless the growing demand for healthcare is decreased. Expectations toward healthcare are increased as people go through the stages of growth in Maslow’s hierarchy of needs. These expectations are independent of the health system, yet increase the burden on it, which is driven by unhealthy lifestyles and aging. Meanwhile aging itself is unavoidable, the promotion of healthy lifestyles can lead to a longer, healthier, and more productive lives. People often find it hard to quantify the value of their health until it has been diminished or impaired in some way. For good health to be secure and sustainable, human behavior needs to be influenced rather than directed. Accordingly, behavioral change requires a variety of actors and institutions to help people towards healthy living. Sustainable health systems depend on sustained health at home and in communities, well before the healthcare system, as it is currently known. Cultural norms, urban planning, the environment, choices in food and drink, how children are parented and educated, personal and professional development throughout our lives and work-life balance must evolve to make a new age of healthy behaviors. Consequently, architecture must find a biophilic design process that builds healthy cities and countries that are fit for the future.

Health risks

According to WHO (2009), risk factor can be any attribute, characteristic or exposure of an individual that increases the likelihood of developing a disease or injury. Today, health risks are in transition due to an aging population that succeeded “against infectious diseases; at the same time, patterns of physical activity and food, alcohol and tobacco consumption are changing. Low- and middle-income countries now face a double burden of increasing chronic, noncommunicable conditions, as well as the communicable diseases that traditionally affect the poor” (p. 5). The role of these risk factors is important for developing clear and effective strategies for health strategies. In Sweden, the general health of the population is shown in Figure 6. Over 70 percent of the Swedish population feel they are in good general health and those with good health has increased since 2004. Even so, there are differences between gender, education levels and socio-economic groups. It is common for men to report good health more often than women. The proportion of good health increase with higher

Figure 6. State of good general health in Sweden across municipalities (Retrieved from SCB Geoatlas during autumn of 2015).
Figure 7. Risk factors of health in Sweden across municipalities (Retrieved from SCB Geoatlas during autumn of 2015) and an interval based connections of risk factors for Umeå municipality.
education and is most common among middle and higher officials.

In addition to a general perspective, several risk factors were portrayed parallel in order visually assess the possible associations among the risk factors (Figure 7). Altogether twelve risks factors were found through SCB database (2015) such as:

**Risk for alcoholism:** The total alcohol consumption has increased over a longer period. In 1996, Swedes drank on average 8.0 liters of pure alcohol annually per person while 15 years and older drank 9.9 liters today. Alcohol consumption and binge drinking have decreased slightly since 2004. A new estimate suggests an average of the proportion of children and children with families of hazardous use, abuse or dependence on alcohol, drugs or medicines is about 17 percent.

**Smoking daily:** Smoking affects almost every organ in the body and causes 58 different diseases with sharply increased the risk of lung cancer and diseases of the heart, blood vessels and lungs. Passive smoking involves the same type of health risk. Quitting smoking gives a clear improvement in health. The consumption of cigarettes for those who smoke are on average 11-13 cigarettes per day. For those who smoke a lot, the daily consumption is at least 20 cigarettes.

**Snuffing daily:** Snuff is a controversial tobacco use where scientific research has long been neglected. Moist snuff increases the risk of cancer of the pancreas, heart attack, fatal stroke, increased blood pressure, permanent and repairable oral mucus membranes. Some indications are that snuff increases the risk of cancer of the esophagus and stomach, metabolic syndrome, a disorder of metabolism that leads to obesity, hypertension, diabetes and heart/vascular disease.

**Tobacco use:** The proportion of female daily smokers has decreased by 8 percent between 2004 and 2015, among men, the decrease is 5 percent. Among women and men, it is most common to smoke in the age group 45-64 years. It is less common to smoke daily among those with tertiary education than those with less.

**Obesity:** The proportion of obese (BMI 30 or higher) in the population has increased from 11 percent in 2004 to 14 percent in 2015 and this trend follows the same pattern for both men and women. However, it is much more common among men to be overweight or obese (BMI 25 or higher).

**Overweight:** Overweight is a health risk, however, it may differ from what is known in everyday speech when we say that someone is overweight, fat, or chubby. Morbid overweight is about quite a few extra kilos, which is a significant difference yet it does not fit into today’s very thin ideal body that appears in the media and fashion world. In order to assess the importance overweight, health risks must be in relation to body length and weight.

**Eating fruits and vegetables as advised:** Good eating habits are one of the prerequisites for good health and important for our well-being. Good eating habits are to prevent obesity and cancer and reduces the risk of cardiovascular disease, type 2 diabetes and high blood pressure. For intake of fruit and vegetables, it is recommended for adults to eat 500 grams of fruit and vegetables per day.

**Eating fewer fruits and vegetables:** There seems to be a willingness or desire to increase the intake of fruits and vegetables. Of those in the population who eat little fruit and vegetables are 71 percent of women and 62 percent of men who want to eat more fruits and vegetables. 11 percent of them believe they need support in order to increase their fruit intake. The proportion who say they need the support is greater in economically vulnerable groups, and among those who receive a disability benefit compared to other groups.

**Sedentary during leisure time:** Research shows that sedentary activity must be seen as a risk factor. This means that we must begin to take into account two different behaviors. First, we have regular physical activity as a health factor and sedentary as a risk factor. It means to promote physical activity while sedentary should be advised against.

**Physical activity:** Physical activity and inactivity have many effects on human health and on public health in general. Physical activity is defined as any
kind of movement that increases energy expenditure. Health-enhancing physical activity improves health but may inflict damage. Physical inactivity is a risk factor for diseases such as cardiovascular disease, obesity, type 2 diabetes, musculoskeletal diseases, mental illness and cancer.

**Low social participation**: The forms of social participation may vary between different age groups, different educational levels and between different socioeconomic groups. Individuals with high social status tend, for instance, to participate in activities and contexts that require more physical resources, and they also have greater access and opportunities to various activities.

**Gambling**: Generally, gambling is prevalent among older than younger. Those who play the most have high school education as their highest level and those who play least are with higher education. Participation increases with the income, however, it declines slightly in the highest income group.

The color coded intervals comparison of risk factors for Umeå municipality showed that the area of interest might be a good example in the North where health risk factors are moderate and even underrepresented among the inhabitants. Consequently, the city may offer a learning platform for promoting pro-environmental behavior through sustainable health in the built environment.

This conceptualization implies that the demands in the Brundtland Commission (1987) report on sustainable development must be extended with the health concept. Health and sustainability must, therefore, be seen as a duality in which each element creates and conditions the other. Consequently, sustainability must be conceived in a health perspective and health must be conceived in a sustainability perspective (Kjærgard et al., 2013).

**Remarks on sustainable health**

The issue of sustainable health is closely related to biophilia and the perception of our own environment. Prevention of health risks is only one of the area which affects our everyday behavior. If we are able to change our life in order to sustain our health, then we can change our environment to support this life change.

6. **Patterns of biophilic design**

Due to systematic observations of environmental qualities and its relation to human behavior changes, there is an increasing interest in understanding biophilia in architecture, psychology or neuroscience. The engagement to biophilia is constantly evolving and the review of the state-of-the-art concept for a so-called pattern language to biophilia can contribute to a summary of knowledge in the field. First, a definition of environmental quality needs to be made. Thus, it refers to “the sum of the properties and characteristics of a specific environment and how it affects human beings and other organisms within its zone of influence” (Browning, Ryan & Clancy, 2014; p. 18). Biophilia is an essential component of environmental quality and in this manner it is equivalent concern with air quality, thermal comfort, acoustics, the importance of daylight, materials toxicity, air, water and soil quality, to include human biological health and well-being. The major difference of biophilia and the other environmental factors is that the measurement of biophilia is not standardized or curated with the same manner as the other concerns. Therefore, the operational definition and the measurement for biophilia rely on a subjective synthesis of measurable and unmeasurable factors. According to Browning, Ryan & Clancy (2014, p. 21) the “purpose of defining these patterns is to articulate connections between aspects of the built and natural environments and how people react to and benefit from them.” Furthermore, each pattern is divided into several descriptive elements like experience which is a brief on how the pattern might impact the way space feels; evidence that relates human psychobiology to nature and the built environment; and application which gives reference to actually built examples. These identified patterns of biophilic design by Browning, Ryan & Clancy (2014) are briefly reviewed in this thesis:

**Visual connection with nature**

**Experience**: A good visual connection with nature
feels comforting, it contributes to one’s attention and can be stimulating or calming. Promotes sense of time, weather and perception of other living things.

Evidence: Research on visual preference and responses to nature views indicates stress reduction and more positive emotional evaluations while improving concentration and recovery rates. Stress recovery from visual connections with nature have been reported through lowered blood pressure and heart rate; reduced attentional fatigue, sadness, anger, and aggression and by improved mental engagement/attentiveness, attitude and overall happiness. There is evidence found for stress reduction related to both real nature and its visual representation. Visual access to biodiversity is found to be more beneficial to our mental health than access to land area (Browning, Ryan & Clancy (2014) indexed as P1).

Non-visual connection with nature

Experience: A good non-visual connection with nature feels fresh and well balanced; the ambient conditions are perceived as complex and variable but at the same time familiar and comfortable. Sounds, aromas, and textures are reminiscent of being outdoors in nature.

Evidence: Research on reductions in systolic blood pressure and stress hormones have as the base for this pattern. The impact of sound and vibration on cognitive performance and perceived improvements in mental health and tranquility are the related evidence for non-visual sensory interactions with non-threatening nature (Browning, Ryan & Clancy (2014) indexed as P2).

Non-rhythmic sensory stimuli

Experience: Non-rhythmic sensory stimuli feels as good when there is a brief distraction to something special, something fresh, interesting, stimulating and energizing.

Evidence: Research on looking behavior, particularly periphery vision movement reflex has its origin for this pattern. Investigations considered eye lens focal relaxation, heart rate, systolic blood pressure and sympathetic nervous system activity; and observed and quantified behavioral measures of attention and exploration. Human response to probabilistic movement of objects in nature and momentary exposure to natural sounds and scents have shown to support physiological restoration. For instance, when eye muscles stay contracted for more than 20 minutes at a time, fatigue can occur due to contracted eye muscles, manifesting as eye strain, headaches, and physical discomfort. A periodic, yet brief visual or auditory distraction that causes one to look up for more than 20 seconds and to a distance of more than 7 meters allows for short mental breaks in which the eye muscles relax (Browning, Ryan & Clancy (2014) indexed as P3).

Thermal & airflow variability

Experience: A good thermal & airflow variability provides a refreshing, active and comfortable feeling, that is of both flexible and controllable.

Evidence: It is derived from research measuring the effects of natural ventilation, its thermal variability, worker comfort and well-being as well as productivity. It also considers human physiology and perception of temporal and spatial pleasure, the impact of nature in motion. It is found to have a growing discontent with the conventional approach to thermal design, which focuses on a narrow target zone of temperature, humidity and airflow while minimizing their variability (Browning, Ryan & Clancy (2014) indexed as P4).

Presence of water

Experience: Feeling of the presence of water is a compelling and captivating experience. Its fluidity, sound, lighting, proximity and accessibility can contribute to a stimulating and/or calm behavior.

Evidence: Researches show that environments containing water would elicit positive visual and emotional responses, reduced stress, increased feelings of tranquility, and lower heart rate and blood pressure. When being exposed to water variability, humans’ concentration and memory restoration increased due to the complex and naturally fluctuating visual stimuli. It also enhanced
perception and psychological and physiological responsiveness when multiple senses are stimulated simultaneously (Browning, Ryan & Clancy (2014) indexed as P5).

**Dynamic & diffuse light**

*Experience:* A good dynamic and diffuse light condition convey expressions of time and movement to evoke feelings of drama and intrigue, mediated with a sense of calm.

*Evidence:* In general, lighting design sets the mood for space and different lighting conditions elicit various psychological responses. Early research showed that productivity is higher in well-lit workplaces, and that children performed better in day lit classrooms with views. Recent research has found a connection for illuminance fluctuation and visual comfort, human factors and perception of light, and impacts of lighting on the circadian system. For instance, higher content of blue light produces serotonin; whereas, an absence of it produces melatonin which is linked to sleep quality, mood, alertness, depression, breast cancer and other health conditions (Browning, Ryan & Clancy (2014) indexed as P6).

**Connection with natural systems**

*Experience:* A good connection with natural systems evokes a relationship to a greater extent, making one aware of seasonality and the cycles of life. This experience is often relaxing, nostalgic, profound or enlightening.

*Evidence:* There is limited scientific documentation of the health impacts associated with access to natural systems. It is suspected to enhance positive health responses whereby seeing and understanding the processes of nature can create a perceptual shift in what’s being seen and experienced. This pattern is describing a strong temporal element, which can be expressed culturally (Browning, Ryan & Clancy (2014) indexed as P7).

**Biomorphic forms & patterns**

*Experience:* A good biomorphic form feels interesting and comfortable, possibly captivating, contemplative or even absorptive.

*Evidence:* Research on view preferences, reduced stress due to induced shift in focus, and enhanced concentration. However, humans believed to have a visual preference for organic and biomorphic forms that is closely related to ecological perception, the science behind why this is the case is not yet fully formulated. While our brain knows that biomorphic forms and patterns are not living things, we may describe them as symbolic representations of life (Browning, Ryan & Clancy (2014) indexed as P8).

**Material connection with nature**

*Experience:* A good material connection with nature feels rich, warm and authentic, and sometimes stimulating to the touch.

*Evidence:* Available research is only beginning to shed light on opportunities for informed design. One such study demonstrated that a difference in wood ratio on the walls of an interior space led to different physiological responses. “The researchers observed that a room with a moderate ratio of wood (i.e., 45% coverage), with a more subjective comfortable feeling, exhibited significant decreases in diastolic blood pressure and significant increases in pulse rate, whereas a decrease in brain activity was observed in large (i.e., 90% coverage) doses, which could be either highly restorative in a space where high cognitive functionality is expected.” (Browning, Ryan & Clancy (2014) indexed as P9).

**Complexity & order**

*Experience:* A good complexity and order feel engaging and information-rich, as an intriguing balance between boring and overwhelming.

*Evidence:* This “has evolved from research on fractal geometries and preferred views; the perceptual and physiological responses to the complexity of fractals in nature, art and architecture; and the predictability of the occurrence of design flows and patterns in nature.” Research has repeatedly confirmed correlations between fractal geometries in nature and those in art and architecture, “but there are opposing opinions about which fractal dimension is optimal for engendering a positive health response, whether an
optimal ratio exists, or if such a ratio is even important to identify as a design metric or guideline.” (Browning, Ryan & Clancy (2014) indexed as P10).

**Prospect**

*Experience:* Space with a good prospect quality feels as open and freeing. In the same time, prospect imparts a sense of safety and control, particularly when alone or in unfamiliar environments.

*Evidence:* Prospect has evolved from research on visual preference and spatial habitat responses, as well as cultural anthropology, evolutionary psychology and architectural analysis. Health benefits are suggested to include reductions in stress, boredom, irritation, fatigue and perceived vulnerability; as well as improved comfort (Browning, Ryan & Clancy (2014) indexed as P11).

**Refuge**

*Experience:* Space with a good refuge feels safe, providing a sense of retreat and withdrawal for work, protection, rest or healing - whether alone or in small groups. A good refuge space feels separate or unique from its surrounding environment; its spatial characteristics can feel contemplative, embracing and protective, without unnecessarily disengaging.

*Evidence:* This pattern evolved from research on visual preference research and spatial habitat responses, and its relationship to prospect. Refuge conditions are important for restoration experiences and stress reduction, which can be realized through lowered blood pressure and heart rate. Other benefits of refuge are suggested to include reduced irritation, fatigue, and perceived vulnerability, as well as improved concentration, attention and perception of safety (Browning, Ryan & Clancy (2014) indexed as P12).

**Mystery**

*Experience:* A space with good mystery has a perceptible sense of anticipation, or of being teased, satisfying curiosity, offering mental denial and reward that compels one to further investigate the space.

*Evidence:* It is largely based on the idea that people have two basic needs in environments: to understand and to explore. This pattern has evolved from research on visual preference and perceived danger, as well as pleasure responses to anticipatory situations. Mystery generates positive pleasure response within the brain that may be a similar mechanism to that of anticipation and curiosity. Benefits of mystery may include improved preference for space; heightened curiosity; increased interest in gaining more information and a greater likelihood of encountering other biophilic conditions (Browning, Ryan & Clancy (2014) indexed as P13).

**Risk/Peril**

*Experience:* A good risk/peril condition feels exhilarating, and with an implied threat, maybe a little mischievous or perverse. One feels that it might be dangerous, but intriguing, worth exploring and possibly even irresistible.

*Evidence:* Risk can be generated by a learned or biophobic response triggered by a near and present danger. This danger, however, is inert and unable to cause harm due to a trusted element of safety. The defining difference between risk/peril and fear is the level of perceived threat and perceived control. Having an awareness of a controllable risk can support positive experiences that result in a strong dopamine or pleasure responses. These experiences play a role in developing risk assessment during childhood. In adults, short doses of dopamine support motivation, memory, problem-solving and fight-or-flight responses; whereas, long-term exposure to intense risk/peril may lead to overproduction of dopamine, which is implicated in depression and mood disorders (Browning, Ryan & Clancy (2014) indexed as P14).

**Remarks on biophilic design**

This is a guideline for implementing changes and hence affect the life of many. How applicable the items are and in what extend evidence-based design can be guaranteeing the reported outcomes, we might never know. However, we should keep in mind the profoundness of the duration of an intervention and the effects it may cause.
The reviewed literature contributed to develop the overall aim, which is to stimulate human behavior change toward a more pro-environmental behavior which facilitates biophilic living.

It is hypothesized, that a low-tech, stand-alone behavior responsive direct architectural intervention is capable of stimulating awareness of biophilic living in individuals and therefore affect pro-environmental behavior intention positively.

Furthermore, it was speculated that an urban square scale architectural intervention could have long effect on pro-environmental intention and in the same time transforming the spatial quality of the square to more biophilic.

The objectives of the study are:
- to establish a conceptual model of behavioral responsive architecture that facilitates biophilic living,
- to identify architectural strategy and site for direct architectural intervention,
- to organize activities in a behavior responsive architectural space for stimulating awareness of pro-environmental behavior,
- to develop a site-specific speculative design that prolongs the investigation period for stimulating awareness of pro-environmental behavior.
Study 1. Questing for biophilia

The main stages of this study were to lay down and test the theoretical concept and create an architectural strategy for the promotion of pro-environmental behavior that supports a biophilic living.

Summary

The first objective of this study was to assemble a conceptual framework in order to visualize the complexity of the subject matter. The second objective was to assess the urban environment through a conceptual model of biophilic living and the third objective was to identify an architectural strategy and find a site for direct architectural intervention.

The first objective was a methodological study, involved different disciplines for describing biophilia and pro-environmental behavior in the field of architecture. The second objective involved an evaluation of behaviors that may be responding to environmental stimuli and therefore could describe a set of pro-environmental behavior as a concept for impacting on a biophilic living pattern. This approach employed a custom made investigation tool that was developed and administered using mobile technology. The collected data applied purposive and participants based data collection method within the inner city of Umeå. It revealed that 15 separate sites could be identified depending on their geographical proximities. Among these sites, there were three sites chosen and visited for gathering further information on the experience and quality of biophilic living. These site visits and analyses enhanced the understanding on what degree biophilic living could be conceptualized, and found in a real-life setting. The decision to work with the selected square (Renmarkstorget) comes from the realization that in order to expose the concept of biophilia it should be put under stress wherein a standing behavioral pattern and therefore its architectural quality should be fundamentally different from what the biophilia concept itself.

The third objective was to identify architectural site and strategy for direct architectural intervention. Initially, a specific site was identified together with the architectural strategy. The strategy employed a Living lab concept, which is flexible enough for delivering the complexity of the biophilic living. In this way, the architectural intervention could be kept as a constant experimentation for co-creation of knowledge and for learning strategies on biophilia. The combination of biophilia and Living lab concept is called URlab (Urban-Research lab), which aims to provide an innovation ecosystem for learning, knowledge generation and distribution within the field of biophilic design, architecture, mental health and well-being.
Introduction

Västerbotten County Council's vision for the year 2020 is to be the world’s leader in healthcare and have the world’s healthiest inhabitants. Therefore, they claim towards a good healthcare, better and more equitable health and health promotion as well as attractive workplaces (VLL.se).

International trend is to advance toward sustainable health, in general, the country level strategy is to promote value measurement and value-based decision-making (evidence-based approach), innovative delivery system, propagate healthy lives and invest in disease prevention. In other words, the aim is to shift healthcare out of hospitals into communities, stimulate innovation through greater competition in delivery, introduce more humanized care into healthcare, and invest in behavioral change and prevention to diminish demand (World Economic Forum - WEF, 2013).

The WEF further suggests that no matter how lean and efficient, a healthcare system cannot be sustainable unless the growing demand for healthcare is decreased. Expectations toward healthcare are increased as people go through the stages of growth in Maslow’s hierarchy of needs. These expectations are independent of the health system, yet increase the burden on it, which is driven by unhealthy lifestyles and aging. Meanwhile aging itself is unavoidable, the promotion of healthy lifestyles can lead to a longer, healthier, and more productive lives. People often find it hard to quantify the value of their health until it has been diminished or impaired in some way. For good health to be secure and sustainable, human behavior needs to be influenced rather than directed. Accordingly, behavioral change requires a variety of actors and institutions to help people towards healthy living. Sustainable health systems will depend on sustained health at home and in communities, well before the healthcare system, as it is currently known, is called upon. Cultural norms, urban planning, the environment, choices in food and drink, how children are parented and educated, personal and professional development throughout our lives and work-life balance must all evolve in a mutually supporting web to create a new age of healthy behaviors. Consequently, architecture must find a biophilic design process that builds healthy cities and countries that are fit for the future.

Biophilia is a term coined by Wilson, he describes biophilia as: “the innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature” (Wilson, 1993, p. 31).

The practice of biophilic design has been growing examples of buildings that seek to integrate natural features and qualities. Features of a good biophilic design can be found at http://biophiliccities.org (Retrieved: 28/04/2016):

Important Ties to Place. There are place-strengthening benefits and place-commitments that derive from knowledge of local nature: direct personal
contact, enhanced knowledge, deeper connections, greater stewardship, and willingness to take personal actions on behalf of place and home.

Connections and Connectedness. Caring for a place and an environment, essential for human wellbeing and in turn an essential ingredient in caring for each other.

A Need for Wonder and Awe in Our Lives. Nature has the potential to amaze us, stimulate us, and propel us to want to learn more and understand our world more fully.

Meaningful Lives Require Nature. The qualities of wonder and fascination, the ability to nurture deep personal connection and involvement, and visceral engagement in something larger than and outside oneself, offer the potential for meaning in life.

My assumption is that biophilic living can be an influence that people should be choosing because of its attractiveness for the future. An architectural design for biophilic strategy is originated in a design of architectural object(s) which build ties to the place, awaken fascination and meaningfulness in one’s life. Their appearance should reflect a biomorphic design with natural materials that facilitates prospect and refuge for both individual and common activities. They are legible, yet mysterious gifts to the city that affords risk to be taken in a safeguarded manner. Their complexity recognizes exterior and interior thermal and airflow issues together with the natural and artificial lighting conditions.

“Urbanists and city planners have special opportunities and unique obligations to advance biophilic city design, utilizing a variety of strategies and tools, applied on a number of geographical and governmental scales.” (http://biophiliccities.org; Retrieved: 28/04/2016). The agenda is one that must extend beyond conventional urban parks, and beyond building-centric green design. It is about redefining the very essence of cities as places of wild and restorative nature, from rooftops to roadways to riverfront. It is about understanding cities as places that already harbor much nature and places that can become, through bold vision and persistent practice, even greener and richer in the nature they contain.

The first objective of this study was to assemble a conceptual framework that is visualizing the complexity of the subject matter. The second objective was to assess the urban environment through a conceptual model of biophilic living and thirdly an identification of architectural strategy and site for direct architectural intervention was performed.

**Methods and findings**

The first objective of the study was that the conceptual model or framework needs to be assembled from several scientific articles and other essays as well as personal influences on architectural-, environmental,
ecological-, design-, economical-, aesthetics-, social- and health studies which were introduced earlier.

The aim with the model was to connect the environmental attributes/patterns or details that are found to be influential for a successive biophilic living and produce a map of human behavioral change that can be stimulated toward a paradigm shift to perform more pro-environmentally.

This framework has its center on biophilic living which is maintainable through the behavior and the environmental context. Now, this model assumes that both systems can be designed and thus influenced in a way that a necessary paradigm shift can be triggered by either environmentally/contextually/architecturally or simply by applying one of the coexistence strategies that may be governing human behavior to a pro-environmental direction. This is shown in Figure 8. It is also assumed in this model, that an organism would be able to modify its behavior towards a more favorable future and be responsive on environmental variations. This would also be

Figure 8. A framework of the connections between behavioral change and biophilic living.
functioning the other way around, namely, the environment would be adaptable to pro-environmental behavior through its material responsiveness.

Another set of methodological issues were addressed by producing a diagram of intended research methods used for surveying the urban environment (Figure 9). This would mainly correspond to the second objective, that is to assess biophilia in the built environment. This chart basically includes three levels of societal concerns. While we architects and researchers tend to work more on the individual level obviously, the community and system level should also be addressed, mainly because the built environment has not only impact on the individual but also on community and social system implications. This chart is an attempt showing what kind of biophilia related information was possible to collect on each societal level. From this, it is also visible that a feedback system needs to

![Figure 9. A set of research methods for surveying on biophilic living.](image-url)
be addressed in order to rewire the knowledge and experience gained through the investigation about biophilia. The model further indicates that a unique architectural acupuncture needs to be invented in order to deal with the many faceted knowledge and learning generated along the way. Later on, this ecosystem was addressed in the third objective where the Living lab concept was introduced.

This model of research methods was tested on the map of Umeå, identifying places which have certain qualities that can be taken into consideration for discussing biophilic living (Figure 10).

Biophilia exists in every human settlement to a certain degree and this investigation is an attempt to unveil some of its main characters. The measures of socioeconomics including salary and loan levels give evidence of the economic stresses that a household may experience. The measurement points for socioeconomics status were taken around (100 m) in every municipality owned green area or park. As opposed to this, a comparative measure was made, for instance, at Renmarkstorget, which is lacking a green area and is in contrast with its aesthetic qualities.

The built environment, in general, is fragmented with the natural or designed greenery. Wilderness is exposed for exploitation at the present time as the city increases its number of inhabitants. Therefore, education of biophilic living and biodiversity in biology and geography is preferable throughout the compulsory study period. These primary education centers are scarcely positioned throughout the city and they do not provide access for site-specific information either.

The network of alternative transportation such as bicycle roads are well maintained and flow measures are regularly taken. The main route in Umeå is an east-west bound traffic with lateral branches. The health consequences of cycling are relevant for biophilic living.

With the number of inhabitants, leisure time activities including walking, hiking and strolling around natural or man-made park and water surfaces are increasing. Umeå has potentials in this matters, however accessing the waterfront in the city needs to be measured, for instance, at Renmarkstorget, which is lacking a green area and is in contrast with its aesthetic qualities.

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With the number of inhabitants, leisure time activities including walking, hiking and strolling around natural or man-made park and water surfaces are increasing. Umeå has potentials in this matters, however accessing the waterfront in the city needs to be further developed.

Biophilic living has an overall connection to sustainable health, that includes mental health and health risks as well. Information about preventive care and how an individual could be engaged needs to be developed and experimented together in a social context. Biophilic living needs to be disseminated through social and physical infrastructure that helps to bring urbanites to closer connection and understanding of nature.

The second objective was to assess behavioral responsiveness to pro-environmental behavior as a concept for impacting on the biophilic living pattern in the built environment. This approach employed a custom made investigation tool that was developed and administered using mobile technology (Figure 11).

The collected data applied purposive and participants based data collection method within the inner city of Umeå. Altogether, 235 ratings were collected for restorative qualities around the inner city. These ratings were from low to high on a five-point scale referring to the degree of restorativeness perceived in a built environment. Hereby, restorativeness refers to the quality of the built environment that is closely related to biophilia with the quality of being able to seek fascination, stress recovery

Figure 10. An investigation of biophilic living indicators across the city of Umeå.
and positive physiological and psychological responses during an effortless encounter within the built environment. Low restorativeness meant, the environment was not particularly restorative, maybe avoidance of such areas could have been preferable. On the other hand, high restorative rating suggests that the environment is encompassing those qualities that is necessary for restoring one’s mental attention resources for enduring daily wear-and-tear (Figure 12).

Biophilic living has an overall connection to sustainable health, that includes mental health and health risks as well. Information about preventive care and how an individual could be engaged needs to be developed and experimented together in a social context. Biophilic living needs to be disseminated through social and physical infrastructure that helps to bring urbanites to closer connection and understanding of nature.

There were 15 separate sites identified depending on their geographical proximities. These sites were the result of a walking around in both densely built urban environments, recently renovated parks and slightly abandoned park. It was found that biophilia through restorativeness was increasing in places adjacent to water features while decreasing in the merely built environment. It was also observed that level of coexistence was mediated through crowding. When the salary and loaning dataset are juxtapositions on biophilic ratings, it is observable that the more biophilic environmental
qualities are found where loan takings are lower, however salary might not be affecting the perception of biophilia. This might be because the raters were not locals, therefore, this observation should not be overemphasized.

Among these fifteen sites, there were three chosen and visited for gathering further information on the experience and quality of biophilic living. These site visits and analyses enhanced the understanding on what degree biophilic living could be conceptualized, and found in a real-life setting (Figure 13).

**Broparken:** This park was inaugurated in 2014 after an extensive makeover. When this visit took place the park was functional and had been used by the people for mostly walking, jogging and sunbathing in the early spring. The park became a designed landscape with many details in material and patterns to be explored. Some old trees are kept for providing continuity of the previous familiarity beside the newly planted ones that rigid orderly made line is frustratingly straight. Most of the buildings around the park are enclosing its boarders and through their aged facades give a sense of tranquility. Activities like sitting, laying on a sunbathing bed, and accompanying children are the most seen activities. The riverbank is uninviting to be explored due to the rocky/gravely side that hinders interaction with the water. The view towards the other side of the river is dominated by high-rise buildings which reverberate the traffic noise from the...
nearby main road. In contrast to that, the bicycle bridge is comforting with its historical appearance.

**Varvsparken**: The park has been around for a long time since it was reshaped or refreshed. The visitors here are mostly bringing their pets for a walk in this autumn period while in the summer this park is famous to provide a playground for boule. The park is well-kept and the vegetation is growing in a wild but controlled manner. Maybe this park has the best view onto the city center across the river and its relative distance from traffic zones makes it less noisy. The birds find it inviting as well. The riverbank is not accessible easily, yet it is projecting a wilderness experience.

**Renmarksstortget**: This might be one of the busiest square in the city, where people are rushing from one store to the next. This was recorded by following consumers over a period of time. There is no doubt that the major activity here is consumerism and quick passing through to get to the nearest
The square is hard to understand, way to complicated just to perceive everything at the first glance. It is enclosed and bordered with buildings of the same height, connecting streets that are providing highways for walking, bicycling and other vehicles. There is no visual connection to natural water, unless we consider the fountain during the summer period. Every segment of this square is for making profit. The only non-profit activity maintained was in the tourist office building and the public toilet in the North end of the square. Trees are mainly birches while there is not a single square meter of green area to be found. The square is full of challenges in terms of pedestrian movements, accessibility to playground and leisure activities that actually would not cost resources for the inhabitants. It is a great physical and mental contrast to be in this place as compared to the previous ones.

The decision to further investigate Renmarkstorget comes from the notion that the biophilia concept should be put to stress in which a standing behavioral pattern and its architectural quality should fundamentally be challenged. The concept of biophilia is not in particularly satisfied within this square and it is assumed to be the proving point for biophilic design in an urban environment. The third objective was to identify an architectural site and strategy for direct architectural intervention that supports pro-environmental behavior in order to foster biophilic living. The larger context of the site is identified as Renmarkstorget, however a more specific location was not yet clear. From the interviews and observation several key issues emerged for being able to narrow it down where the specific location for the direct architectural intervention should take place. The interview conducted earlier on site showed that the Tourist office is going to be moving out in the next six months, thereafter leaving the premises empty. The new function for the building was not yet disclosed on any level to the public at that moment. Guessing that the owner of the building - municipality of Umeå - would like to sell the facility for a developer which might turn the building into a restaurant or maybe demolish it for providing visibility and legibility for their nearby investments which surround this area. The illustration of observed pedestrian and traffic flow in the area is shown on Figure 14. Mainly the ground floor level of the surrounding buildings are supporting consumer behavior, on the upper levels apartments and offices can be found. Consequently, the whole square is functioning as a vending machine for the surrounding shops and stores. Common spaces are outsourced throughout the year to attract many more visitors and buying consumers. The seasons are organized so that the northern part of the square stretching from Kungsgatan to the public toilet and the grill restaurant is used for snow installations. An enormous Christmas tree is at the meeting point of the pedestrian street and the seasonal vending area.

The concept of biophilia is not in particularly satisfied within this square and it is assumed to be the proving point for biophilic design in an urban environment.
The GPS-based tracking of the pedestrians revealed how seldom the center part of vending place and the area in front of the Tourist office is visited. The main movements are beside the buildings that attract attention and provide the channel of quick passing through the square. Leaving the square seems just as important as reaching only the shops and stores.

The shops around the square are mainly not concerned with the concept of circular economy. Their products and services regarded as a linear model of consumption that follows a take-make-dispose pattern. Meanwhile, “a circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims...
for the elimination of waste through the superior design of materials, products, systems and business models” (MacArthur & McKinley, 2014).

In order to bring all the possible aspects of biophilia under an umbrella strategy, a flexible yet concrete enough architectural concept should be invented. The requirement for an appropriate architectural strategy emerged during the observation and survey visits of the inner city of Umeå. The strategy employed a Living lab concept, which is seen as capable of delivering the complexity of the biophilic living concept. In this way, the architectural strategy can be kept as a constant experimentation and co-creation of knowledge and learning strategies on biophilia based on the individual-community-institution partnership. The combination of biophilia and Living lab concept is called URlab (Urban-Research lab), which aims to provide an innovation ecosystem for learning, knowledge generation and distribution within the field of biophilic design, architecture, mental health and well-being.

Living lab is a research and innovation concept. It deals with user-centered, open innovation ecosystem, often operating in a territorial or regional context such as city, agglomeration by integrating concurrent research and innovation processes. A Living lab combines an experiential environment, where users are immersed in a creative social space for experiencing and imagining their future. Living labs are also used by policy makers and citizens for experiencing, exploring, and designing policies and regulations in a real-life scenario.

In the following, I introduce the combination of biophilia and Living lab concepts called URlab (Urban-Research lab), which aims to provide an innovation ecosystem for learning, knowledge generation and distribution within the field of biophilic design, architecture, mental health and well-being. In URlab we co-investigate, co-design and co-stimulate socially and environmentally sensitive projects that aim to increase awareness, pro-environmental behavior and integration of flora, fauna, and fungi into the urban and architectural structure in the heart of the city. The outcome of activities should be measured through the Biophilic living indicators.

Vision: URlab supports individuals, communities and institutions working on equitable, participatory, and sustainable development of biophilia and architecture.

Mission statement: URlab uses architecture and planning discipline to connect UMA faculty, staff, students and other university-based disciplines with civic leaders and residents to co-create innovative solutions to complex challenges of urban sustainability for mental health and well-being.

Underlying assumptions for URlab’s work: Architecture and urban planning is a participatory discipline. Often, marginalized individuals and communities possess critical experiences, insights, and knowledge for addressing systems failures. Collaborative innovation with individuals and communities is an
effective way to generate sustainable solutions to local and regional issues for biophilic design, architecture, mental health and well-being.

**URlab methods:** The vision and mission of URlab are rendered as a working culture that is originated in the co-creation of knowledge, ethical practices and teachings, architectural and urban planning services as well as professional education in the context of Umeå.

This working culture necessitates space for students, faculty, and community members to improve local and regional practice for biophilic design, architecture and urban planning in relation to mental health and well-being through inquiry, dialogue, collaboration, and reflection. Due to this working culture, we generate new and relevant knowledge about biophilic design, architectural and urban sustainability and co-produce theories of community engagement, development, and social change. It is also aimed to prepare architects and planners with the commitment, skills, and agency to lead innovation across sectors and address organization issues.

**Working with communities:** URlab stakeholders such as UMA and UID staff and students begin their work from the close proximity of people living in the heart of the city with limited daily nature experiences, or people living in low-income communities and communities of cultural diversity on the border of society. All these communities may provide key insights into the perceptible and structural problems of biophilic design, architecture and urban planning that Umeå is facing today regarding mental health and well-being. We believe that first-hand experience of living in such conditions is a valuable source of knowledge and it is a learning opportunity for UMA and UID staff and students to investigate closely with community representatives in a collaborative learning process in order to generate new knowledge and innovative approaches to biophilic design, architecture, and urban planning.

As ENoLL (http://www.openlivinglabs.eu) describes the living lab concept, it is “a practice-driven phenomenon, the Living Lab paradigm is constantly evolving and the concept, methods, and tools are being constantly renewed. Whilst maintaining the same principles and foundations, such as user and citizen involvement, open innovation, value co-creation, real-life experimentation and multi-stakeholder and multidisciplinary collaboration, Living Labs are moving from controlled experiments towards large-scale pilots for early adoption and deployment. A Living Lab is not only a real-life research platform. A Living Lab is an innovation instrument that places the citizen at the center of innovation and can better mold opportunities offered by new ICT concepts and solutions to specific needs and aspirations of local contexts, cultures, and creative potentials.” Today, altogether there have been almost 400 recognized Living Labs in the ENoLL network. However, Living labs that are closely working with the concept of biophilia, architecture, pro-environmental behavior are much harder to find. It is possible that there is no such establishment yet. A
handful of research and innovation labs that has a degree of biophilia as a concept for innovation and research are shown in Figure 15.

After the main strategy was implemented in words, namely to use Living lab concept for the biophilic Living lab, a quick upgrade to the methodological tool needed to be done. The main difference here is to describe the “Centrally located architectural ecosystem” as a user-architect interaction space in the built environment from which the concept of biophilic living would arise. The working method for this unit is a looping system of interactions that make the participants work together without hierarchy or physical boundaries. This unit aims to investigate the norms, beliefs and attitude issues for promoting pro-environmental behavior change. Its process should be equipped with learning and knowledge generation for the individual or community in question (Figure 16).
The programming for a biophilic Living lab (URlab) is assembled encouraging interdisciplinary knowledge generation and innovation processes. URlab is involving academics, the local municipality, companies, NGOs, families and children, in particular; the programming proposal for spatial characteristics and functional requirements needed to be detailed accordingly. Spatial characteristics are originated in the notion of biophilic design patterns because the facility should be mirroring the concept that it is intended to disseminate. It is a fundamental approach for a successful biophilic Living lab. Consequently, this means that the existing facility needs to be redesigned/upgraded for accommodating these design features. The spatial requirement describes the type of function (Leading, Following, Grouping, Loner, Watcher, Outreaching, Servant and Worker) which space may embed. The outlined rectangular shapes represent the suggested feature while the filled one is strongly recommending it (Figure 17).
One of the tactics of implementing a strategy for behavior responsive architectural lab is to locate URlab in the former Tourist office building. For this purpose, a spatial requirement analysis was performed through the acquisition of technical drawings. Thereafter, the spatial programming was transformed into a volume based architectural representation which outlined the intention of commitment to transform the facility providing more natural light, biodiversity, green design features and interconnectedness to the natural systems (Figure 18). In general, an architectural design for biophilic strategy is originated in the design of architectural object which build ties to the place, awaken fascination and meaningfulness in one’s life. Its appearance reflects a biomorphic design with natural materials that facilitates prospect and refuge for both individual and common activities. It is legible, yet mysterious gifts to the city that affords the risk to be taken in a safeguarded manner. The complexity recognizes thermal and airflow issues together with the natural and artificial lighting conditions.

### Figure 17. The programming for URlab in terms of participants, activities, spatial characteristics and requirements.

<table>
<thead>
<tr>
<th>Category</th>
<th>Spatial Characters</th>
<th>Spatial Requirement</th>
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<tbody>
<tr>
<td><strong>WHO</strong></td>
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<tr>
<td>Staff and Students</td>
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<tr>
<td><strong>UMEA UNIVERSITY</strong></td>
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<tr>
<td>Staff and students</td>
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<td><strong>CHILDREN</strong></td>
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<td>6-18 years old</td>
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<td><strong>CITIZENS</strong></td>
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<td></td>
<td>Presenting urban, architectural, health and ecological issues</td>
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<td>Discussions on urban future</td>
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<td>Living in the north</td>
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<td>Biophilia</td>
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<td><strong>MUNICIPALITY</strong></td>
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<td>Promotion of biophilic living</td>
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<td>Support for innovations</td>
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<td>Observation</td>
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<td>Social and technical</td>
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<td>meditation and biophilia</td>
<td>Social and technical</td>
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Conclusion

The quest for biophilia culminated into a series of objectives that firstly assembled a conceptual framework, then assessed the urban environment through the very same conceptual model and finally identified strategy and site for a direct architectural intervention together with a programming proposal.

A great array of environmental, design, aesthetics, health, social and economic concerns had to be carefully placed together in order to direct this vast knowledge and innovativeness into a channel of pro-environmental behavior. If we forget about the imminent danger that our lifestyle needs to be shown an alternative direction which is attractive and provides sustainable health and wellbeing for the future, then later we might be forced by external forces to do so. And that may not be that pretty after all. But as of today, we still may have the luxury of taking our time and contemplate about an intelligent change that will also satisfy our poetic sense and abstract imaginations. In this respect, the first study is a leap to this direction, testing its methodological wings and let everyone see if this may produce enough turbulence that would eventually make the URlab fly in a much more poetic sense.

The base for a direct architectural intervention is set.

Figure 18. Mapping of the existing Tourist office and the proposed volumes and functions for URlab.
Study 2. Testing for biophilia

This part of the thesis is more practical and gives an overview about the hand on experiments and building processes for Urban Research lab. The site is known from the previous study and the whole site was dominated by the winter season.

Summary

The sequel that leads to complete this study can be summarized as a “get dirty” chain of events. The method of investigation sometimes took an unexpected turn, yet it could be organized into elements such as preparation, execution of intervention, activation of the site over an extended period of time and evaluation of the effects. It was hypothesized that an intervention is capable of stimulating awareness of biophilia and contribute to pro-environmental behavioral intention. The preparation phase resulted in a series of tests in which the quality of winter was explored. It was felt, rather than known for sure that using the “building material” provided in winter could be seen as a responsive matter. The intervention phase gained momentum after a legal permit to build and maintain the presence in the site (Renmarkstorget). The Urban-Research lab (URlab) was planned in front of the Tourist office building and became the testing ground for awareness of biophilia, supported by a set of activating events like the Inauguration, Sho(w)rts, and Light painting. Meanwhile, a series of evaluation of the effects focused on the perception of an environmental paradigm shift, partly employing the New Environmental Paradigm scale, personal preferences and stories shared on pro-environmental intentions. The outcomes of these evaluations found to be positive for making awareness of biophilia and rising intention for pro-environmental behavior. Consequently, the testing ground for biophilia proved to be a rich learning and knowledge generating project which outcomes would be possible to use further.

Introduction

This study indeed started earlier than its official description would suggest. A series of hands-on investigation that was bound to the weather conditions have impacted on the development process in terms of hypothesis, aim, and objectives. These two architectural workshops were introduced during the last year of studies and their profound outcome had resulted in the choice of material that was not foreseen before. This unexpected turn of events was welcomed and embraced.

The first workshop resulted in a “Mudcake-ing” exercise wherein the dialog was drifted to the existence of a long winter period when students are supposed to prepare interventions. The mudcake-ing originally came from the notion, that an urban settlement is a way to polished and
organized by the ruling regulations and expectations on how should a city look like. Simply a level of dirtiness was thought to be a fantastic idea to add in order to generate reactions from the public and in a twisted sense upcycle snow for a pro-environmentalist point of view. The title “Mudcake-ing” was to express this as a movement which should be engaged to map and identify those urban sites wherein heavy machinery is used to prepare for transporting the downcycled snow, that is full of contaminants like gravel, salt, and other unwanted materials. Then from these temporary depository sites, the snow is collected and transported to the outskirt of town where it is placed on top of each other, thus creating a permafrost on the ground for the whole year to come, since this snow would practically never melt fully during the summer. The first workshop went as far as reclaiming the “dirty” snow from the permanent depository site and provided a public exhibition of the mixture as a material for intervention. The sketch from the workshop is shown in Figure 19. The intervention was imagined to be an upside-down shelter that could be built and multi-purposely used by the public.

The second workshop aimed to go further in the topic of interest. The main problem the project faced was the scarcity of snow at that time. Basically, there was no snow available for transportation or using for intervention and the weather forecast was not promising for a snowfall either. Fortunately, it was 20-25 °C below zero and the perfect time for experimentation for making snow or ice. Therefore, a high-pressure washer was used on a gardening net that was fastened on a wooden frame (Figure 20). This experimental semi-transparent ice surface then was transported and located on Renmarkstorget, where a pile of show was temporarily
collected. The rapid intervention was to place this ice net on the pile of snow, then provide a stair-like access to the top just right before the ice net. Then from there a slide was prepared to go down again on the main ground. The act of going up, being fascinated with the transparency of the ice net, then sliding down was repeated several times that day. Recording of this can be found here: https://goo.gl/photos/5vWw8N4jMqjMnDvY8

Would this experiment contribute to a pro-environmental intention for the visitors? We might not know the answer for sure. However, it was assumed that people who came close to this ice net and would have contemplated about the details and its structure, the transparency, and fragility they might understand that this simple object is already a complex thing that can exist due to particular reasons. When the circumstances are not met for sustaining the appearance of this object, then the experience would be absent.

The above two examples show that the method of investigation sometimes took an unexpected turn, yet it could be organized into elements such as preparation, execution of intervention, activation of a site over an extended period of time and evaluation of the effects. It was hypothesized that an intervention is capable of stimulating awareness of biophilia and contribute to pro-environmental behavioral intention.

It is hypothesized that a low-tech, stand-alone behavior responsive direct architectural intervention is capable of stimulating awareness of biophilic living in individuals and therefore affect positively their pro-environmental behavior intention.

**Methods and findings**

Traditionally, when a spatial intervention takes place in a city center, a permit is needed from both the municipality and the police authority. In this...
study, both permits were acquired rapidly, due to a close collaboration with the municipality. The process how a permit was obtained is shown on the left.

The preparation phase: A certain negotiation skill was needed from both parties, since features like being able to feed birds and access to reusable snow was declined. Along this matter the project could have faced a dead end especially with the lack of snow provided by the municipality. The conflict was then resolved by a case officer, who could redirect 15 m³ scraped snow from an ice hockey rink to the site and his thoughtfulness was valuable since the snow did not contain salt, which made it possible for keeping the intervention open for an extended period of time. The intervention site was planned to be in front of Tourist office, where the pavement heating was turned off and it prevented to melt the excess snow.

The architectural concept

The intervention is being discussed as an optimum for Urban Research lab wherein we co-investigate, co-design and co-stimulate socially and environmentally sensitive projects that aims to increase awareness, pro-environmental behavior and integration of flora, fauna and fungi into the urban and architectural structure in the heart of the city. The intervention was planned to introduce the act of caring and being responsible for the site. Caring was fostered by the idea that visitors of the site would be leaving a footprint of their existence on the pavilion by modifying its appearance, shape and materiality consistence. The engagement that was needed for this reflective practice was thought of gaining momentum from the visitors beliefs, norm, and attitude that drives behavioral intention.

However, this was an optimistic and abstract concept that needed to be translated into practical terms:

Materials

The basic materials planned to be used were snow, ice and their combinations as well as water in some respect. The connecting matter between these materials would be the temperature difference that shapes and modifies the property of cold matter which in this case can take up various forms according to its external impacts, thus it becomes responsive. Responsiveness is a central part of the concept because this fundamental material property should give rise for pro-environmental intentions. The temperature difference was though to be enhanced by a portable fire pit which in some respect could speed up melting processes and on the other hand, would provide lighting and thermal comfort for the visitors. In addition to this cold matter, wood had to be used for providing a net roof and hold some vertical snow elements on a rope. The gardening net was intended to capture the freshly fallen snow and this way creating a structure that is not flat but responsively accommodating to the gravitational force of the withheld snow. The snowballs were connected to the vertical rope by
applying pressure. The snowballs attached to the rope were planned to fall down now and then and through this process they would give way for newer interaction potentials. The fallen snowballs could be collected again and reused (up-cycled) for other purposes.

**Architectural form**

An early sketch of a pavilion type of snow, wood, rope and net structure was visualized encompassing a rectangular form with a pitched roof. On the corners wooden pillars would support the structure (on the left). This was further developed based on the site properties. During the design process it was understood that a generic shape would be not expressing entirely the site-specific requirements therefore a more site related design concept should emerge. Therefore a juxtaposition of the generic intervention and the Tourist office building was made which was further conceived with a reference to a Norwegian pavilion (on the left). The size of the intervention was set to scale 1:3 compared to the Tourist office as it is shown in Figure 21.
The architectural intervention consists of an exterior and an interior space. The exterior opens up from the South facing the main pedestrian street while across the pavilion there is a walkthrough that is set to resemble the creek that was passing through in this area for more than a century ago. The exterior space is set for a sociopetal and sociofugal interaction where visitors can interact or avoid interaction with each other. The height of the seating arrangement is planned to provide visual access to the intervention for easy surveillance as well as providing prospect and a limited refuge.

The interior space is formulated so that a comfortable seating arrangement could be established resulting a sociopetal configuration with several height difference that facilitates interaction and good visual access to each other. The degree of enclosedness can be regulated by the hanging of the snowballs which are functioning as space dividers, blinds and pendant toys for testing gravity. The ropes when empty they would react on the air pressure and would set the pavilion in a motion that responsive to the external impacts. The shape of the pavilion roof establishes a direct contact to the roof behind and therefore the association to the Tourist office could be draw easier.

The political message this pavilion may carry is that instead of tearing down or selling the municipality owned facility, an entirely new function should be introduced into the urban space. This project might further suggest this gentle observation in a playful but serious manner, like a gift to the citizens as they browsing across the square. It can also be seen as a gift to the municipality which intends to show how would they be thinking of embracing the title of Environmental capital in the coming years. Pro-Environmental behavior could be the mold which is capable of uniting the various actors in the regional as well as on a more local scale. However, this intervention is bound to the winter period, the resurrection of the winter city movement would be a much-appreciated series of action if it had sustainability and biophilia connected to its origins.

*Planned evaluation method*

In terms of expected outcomes, the intervention should fail to reject the hypothesis, hence stimulating the visitors by its appearance and interaction potential that would result in a positive change of environmental behavior. One of the evaluation methods is based on a questionnaire that is planned to be circulated among the visitors and that is how data could be gathered on specific questions. Distributing a questionnaire in the middle of the winter outdoors is not an easy task. Just remember about the pen, paper, a hard top where the answers are given, the level of concentration that may drastically sink when participants cannot work with gloves on. The amount of time one should invest in the response should be within the trade-off meaning no-one should feel discomfort nor answering it in an untrustworthy way. A solution was put forward after a short design process.
that encompasses items from the New Environmental Paradigm (NEP) scale (Dunlop, 1978), a pair of questions about the attention restoration quality of the intervention and a pair of demographic questions. Altogether nine questions were asked and graphically placed on an enneagon shape, so when the answer is indicated the paper can be easily torn at the wished answer. No pen is needed for answering, no removal of glows is necessary. The shape of the survey and the questions are shown in Figure 22. Note, that a mean value of the questions from the NEP scale is as well as the restorative value are generated. The questionnaire was planned to be available online providing with a QR code on the side of the intervention.

**Intervention**

The building process took five days in total, which was possible to execute due to a helping hand by a fellow student. Due to the low temperature on that week, it was only possible to work 4-5 hours a day, then a prolonged warming period needed to be inserted. During the building several people approach the site and was curious about what we are building. This is when we had to learn to explain in plain language (in Swedish) what and why are we building this "snow sculpture". The easiest way to keep interested informed was to explain the intervention as a snow
pavilion (Figure 23.) that is going to host some events later on which can be visited eventually. Some people wanted a more detailed explanation however it was not possible at the beginning since the URlab has not shown a recognizable face yet, therefore, it was difficult to relate to it. We tried to build a closer relation with the Tourist office but it was proved to be a one-sided love. Activities like warming up snow for being able to form the snowballs and occasional body warm ups took place, meanwhile some chatting about the process happened. Interestingly, they wanted us to place

Urban Research lab on Facebook. Altogether 68 followers were recorded, which created the most 1000 reaches. Link to the page is available at: https://www.facebook.com/UrbanResearch-lab-989313081148203/?ref=bookmarks.

Figure 23. Diagram of the modified snow pavilion.
an information sheet on the side of the pavilion which explains what we are doing. Obviously, they have been asked by the visitors. During the construction phase, the process of building was continuously updated on a Facebook page. Short notes and pictures were uploaded and spread.

Activating site 1:

**Inauguration.** On a Friday afternoon, the site was officially opened. For disseminating this information, personal meetings, and Facebook messages were sent out. Approximately 40 people showed up during the two-hour-long inauguration period and these were mostly students of UMA and teachers and friends (Figure 24). The second largest group was the children between 2-7 years. Other people approached the site as well, due to the crowd it caused from afar. The pre-test environmental paradigm questionnaire was collected from 21 participants (3 male, 18 female; median age=21-30) and the following results were interpreted. Participants tended to be more concerned with environmental issues and render a more biophilic belief ($M=3.6$ on a 1-5 Likert scale, where $1=$Least biophilic belief and $5=$Most biophilic belief), while a positive preference ($M_{\text{Fascination}}=4.38$ on a 1-5 Likert-scale where $1=$Strongly disagree and $5=$Strongly agree) was
indicated by the appearance of the URlab. This is seen as a sort of baseline measurement for the later activation processes. Biophilic belief was understood as a combination of responses through the fragment of the New Environmental Paradigm scale, which direction is set for a nature driven environmental perspective rather than a human-dominated utilitarian view on nature. This thesis is not aiming for scientific analysis for these collected data, however, it could be seen from the questionnaire results that participants had a strong feeling about the impacts on humans on the environment and quite mixed about humans capability to deal with their situations.

A post-test evaluation result was calculated on the answers involving 11 participants who followed the process of intervention either on site or through Facebook. The biophilic belief had been slightly heightened ($M_{\text{Biophilic belief}} = 3.74$ where $1=\text{Least biophilic belief}$ and $5=\text{Most biophilic belief}$) as well as the mean Fascination value ($M_{\text{Fascination}} = 4.64$ on a scale $1=\text{Strongly disagree}$ and $5=\text{Strongly agree}$) became higher compared to the pre-test values (Figure 25.).

![Figure 25. Pre- and post-test of Biophilic belief and Fascination about the Snow pavilion (1=Strongly disagree and 5=Strongly agree).](image)
Activating site 2.

**Sho(w)rts.** The objective of this event was to show a 3-5 minutes films of animals and plants that are threatened to be extinct within the next 100 years (Figure 26). The screening of life forms found in a teaspoon of oceanic water projected on a snow wall aimed to express the scale and level of vulnerability humans tend to forget in the everyday life. This performance was meant to affect our attitudes and intention to make a personal paradigm shift towards biophilic living. The younger generation was only interested in a fairy tale that was shown for 7 minutes. They would rather play with the snow, making snowballs and therefore experience the URlab as a playground extension adjacent to the other playground setting.

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Leaflet for inviting people to the event.

Figure 26. Activating the Snow pavilion with short films.
Activating site 3.

Light painting. The objective of the light painting event was to visualize animals and other life forms, which the person would like to see that particular moment in the city center of Umeå (Figure 27). This performance aimed to build upon the effects of the short films and the produced drawings which appeared on the photos were hypothesized to be the representation of a radical biophilic living concept. Well, this performance tended to be more like fun and seemed to produce many another kinds of representations for preferred objects and things, than it could be directly connected to biophilic living.

Native birds migrating during the winter season.

Leaflet for inviting people to the event.

Figure 27. Activating the Snow pavilion with light paintings.
Effects of activations

Any evaluation of architectural intervention could be scrutinized in several ways. In our case, the evaluation of effects during the project period were both qualitative and quantitative in nature. You can find more about the procedures under Planned evaluation method. The presented results from the pre-test and post-test on the perceived fascination and biophilic belief had shown that there was a slight increase in the perception of both measures. However, the surveys were not scientifically scrutinized but artistically “dirty” investigations, the main findings would be favorable when we want to motivate, that the intervention actually reached its intention.

The notion of biophilic belief which is a generated value from the first five questions of New Environmental Paradigm scale corresponds to an individual’s current environmental paradigm in terms of environmentally ethical and environmentally considerate perspective on resources, values and consequences of human action rather than promoting a human-centered view on nature domination and its utilitarian benefits. This value may also indicate the behavioral belief as a precursor for behavioral and intention.

Figure 28 gives a summary of effects that were measured through the internet based survey, distributed through Facebook (1=low and 5=high). The architectural feature of supporting pro-environmental behavior seemed to be stable across the length of the project, meanwhile, vulnerability and fascination varied. The vulnerability was understood as an indication on how fragility of the environmental situation could be perceived at the given activation period. While it is the highest during the inauguration event, it gradually decreased, yet stayed very high indeed. The perceived fascination under the duration of the project was steadily increasing and indicated a
fulfillment for effortless attention to the events and the architectural intervention. The extent in which these events took place was perceived differently, due to the nature of activation. While the pavilion had a specific feature for projecting short films, the light painting was more independent from the location. The open-ended question on how would you describe the effect of this intervention as a reflection on how this snow pavilion and/or the activities might have triggered feelings for pro-environmental behavior: The following answers were collected:

Response 1: I am planning to grow vegetables in the back garden. I will put all the fruits from our garden into jars in form of jam (pear, sour cherry, plums) for the winter use.

Response 2: The melting of the snow pavilion reminded me of global warming.

Response 3: I want to design more sustainable structures.

Response 4: I started looking for birds, taking pictures and researching about them. Were those in danger? Why are they so difficult to see? Is it possible to have birds around in winter? Which species are still growing and living in urban sites? Both events: The Snow-Pavilion and Light Painting trigger out those questions and I started paying more attention to what surrounded us in town.

Response 5: I was inspired at my workplace to reproduce a similar info material like the one we received from the creator of the pavilion. I also heard from a co-worker from another department that they thought the idea of spreading information on a similar format would be a perfect solution.

Response 6: My wife folded origami cranes and hang them in the kitchen window. Our kids helped her and enjoyed it (mentioned as Example 1).

Response 7: I started planning a greenhouse for growing vegetables in our backyard (mentioned as Example 2).

The majority of collected narratives were relating to a pro-environmental behavior (growing and managing own food, being a more environmentally conscious person, reflecting on the current situation in terms of biodiversity). Other results may contribute to strengthening the perception of a fact, such as global warming and a minor tactical step would trigger a more efficient organizational communication which in turn may promote a flow of information on pro-environmentalism in the future.

**Conclusion**

Intervention. Duration. Effect. Around these three evaluative properties of a direct architectural project was organized. The intervention was motivated by the need for providing a space that would facilitate pro-environmental behavior using responsive material quality (up-cycled snow) and inherent structural detail (rope and snowball) that would generate interaction with the visitors and provide a place for retreat and prospect...
together with fascination and reflection. The location of the intervention proved to be a successful one, it supported the described concept on each level of activation.

Duration of the intervention was estimated to be around 3 weeks, highly depending on the weather condition, which was in the beginning appropriate for the building, but later on due to the rise of temperature caused minor deteriorations on the snow pavilion. Although the visitors were encouraged to maintain the quality of the environment, at least by adding snowballs onto it, this was not seen as a main activity, rather used as a playground by the children visiting the site. The length of the intervention provided possibilities for experimentation on how to extract pro-environmental intentions from the visitors. For this purpose, two separate, yet interconnected events were organized in the snow pavilion. The events were tested each evening after the inauguration for assessing the technologies and procedures used.

Effects of the show pavilion project are many faceted. In short, it proved to a successful intervention by eliciting the intention for pro-environmental behavior. These were reported by some of the followers of the project from Umeå and even from Budapest, Hungary. The biophilic belief which explains an individual's current environmental paradigm in average may have shifted more to a less human oriented and rather environmentally ethical and considerate perspective due to this project.

Finally, the snow pavilion project opened up a window of opportunity for being able to influence individuals’ environmental concern and through a behavior responsive architecture during winter time. The seasonal temporality of a series of direct architectural intervention in the future could be the testing ground for introducing biophilic environmental design and a wider aspect of pro-environmental behavior without engaging the community in a design that would not deliver the expectations. The concept of winter city movement would be a possible branding umbrella for testing. The set of interventions applying, for instance, additive technology would provide a design approach towards the design patterns of biophilia (i.e., biomimicry) that was unseen earlier for a winter city concept.
Study 3. Planning for biophilia

The final study on biophilic living consist of a season and site-specific speculative design originated from the previous studies which aim to stimulate awareness of pro-environmental behavior by employing architectural design tactics.

Summary

A speculative design for promoting pro-environmental behavior on a city square was proposed. This intervention was imagined during the winter season on the site identified earlier. The primary concept for continuing this experimentation was to find a flexible platform for testing ideas for winter biophilic design. It was also imagined that citizens might be looking at this intervention as an attractive way of reintroducing the square as more than just a transportation route or shopping hub. Lastly, these interventions could give a cost effective testing ground for biophilic design concepts and later on this could give a base for a more permanent structure supporting biophilia.

Regarding technological development, additive approach was taken into consideration, because of its possibility to produce visual appearance which is effortless to make and is also recently experimented with on a larger scale. The behavior responsiveness of material for additive manufacturing would be further evaluated when water or up-cycled snow is used. A technology that may produce this additive building is not part of this speculative design. The architectural concept is originated in the transformation of the standing behavioral pattern to a more biophilic one. Hence, linear consumerism, which dominates the site today would be complemented in order to give the focus for the center of circular-economy. It is imagined to be a permanent Urban Research (UR) lab in the former Tourist office building which programming and description were introduced in Study 1. The proposed URlab is enhanced with a winter skin structure to reposition the architecture of the existing building and start a discussion on the quality of the square about pro-environmental issues.

Introduction

Winter is a season of the year when the Sun rays reach the least the surface of the Earth, therefore, it is characterized by freezing temperature, snow as precipitation and longer darker periods during the day. It is culturally different when winter starts or ends, and some are defined based on weather: “The earliest sunset and latest sunrise dates outside the polar regions differ from the date of the winter solstice, however, and these depend on latitude, due to the variation in the solar day throughout the year caused by the Earth’s elliptical orbit. The Swedish meteorological institute (SMHI) define winter as when the daily mean temperatures go below 0 °C for five consecutive days (Wikipedia, Retrieved: 5/5/2016).
From an ecological perspective, the term hibernal describes wither period the most accurately. This is the period of biological dormancy each year which dates vary according to local and regional climates in temperate zones of the Earth. To survive this time of the year, animals have different strategies to adapt themselves including migration, hibernation, food storing, physical alteration such as an increase in fur type and density or color. Animals may even use snow as insulation for protection against the harsh environment. Some annual plants never survive winter, while others would not be able to complete their life cycle without it. Small perennials insulate themselves under the snow while others go partially dormant only on the top.

The typical weather in Umeå according to WeatherSpark (2016), - based on the historical records from 1991 to 2012 - is a humid subarctic continental climate with cool summers and no dry season. The area within 40 km the airport weather station is covered by forests (62%) and oceans and seas (37%). Over the course of a year, the temperature typically varies from -12°C to 20°C and is rarely below -23°C or above 25°C.

The cold season lasts from November 17 to March 15 with an average daily high temperature below 1°C. The coldest day of the year is February 9, with a mean low of -12°C and high of -4°C. Over the entire year, the most common forms of precipitation are moderate snow, light snow, moderate rain, and light rain. Moderate snow is the most severe precipitation observed during 27% of those days and it is most likely around January 31, when it is observed during 37% of all days. Light snow is the most severe precipitation observed during 23% of those days with precipitation. It is most likely around January 27, when it is observed during 31% of all days.

During the cold season, which lasts from November 17 to March 15, there is a 72% average chance that precipitation will be observed at some point during a given day. When precipitation does occur it is most often in the form of moderate snow (46% of days with precipitation have at worst moderate snow), light snow (37%), light rain (6%), and moderate rain (6%). The likelihood of snow falling is highest around January 27, occurring in 71% of days. The season in which it is relatively likely for snow to fall spans from October 21 to April 27. The season in which snow is relatively likely to be on the ground spans from October 13 to April 23. The snow is typically at its deepest on March 17, with a median depth of 35.8 cm; the depth exceeds 68.8 cm only one year out of ten.

As a conclusion about the weather condition around the city of Umeå, it can be said that statistically there are approximately 5 months of the year where snow is anticipated on the streets and the most probability for an average depth of snow is around 35 cm in March. This condition allows us to think that a winter intervention may contribute to long-term behavioral intentions toward biophilia. Recent experiences on global warming are further motivating the needs for human behavioral change. The proposed
interventions will deteriorate due to the fluctuations of temperature and to various types of precipitations. However, these conditions are not seen as purely aesthetically unpleasant events. On the contrary, these events are the reminders that people should be accepting and learn to experience them differently.

A note on culture

The experience of rural culture of the north of Sweden is first approached through Erskine’s interpretation (Collymore, 1982). As Erskine describes since the 1950’s that nordic nomad culture is excellently adapted to the weather conditions and climate, however, this nomadic life collapses when the native people are being fascinated by the southerners way of living. Furthermore, those from the South do not find other than hunting and sporting interesting in the indigenous culture. The choice, however, to stay outside of the city culture is a conscious one for a non-indigenous person, yet always longed for his whole family. Architecturally, there is a conflict of tradition and innovative features. The climate conscious design what the indigenous people have practiced for centuries collided with the imitative copying of the southern lifestyle resulting planning mistakes and irrelevant features like pergolas. The quest for natural resources brings more people to the North, mostly the men who finds interest for staying and the women loosing interest for enduring the dark and unsocial environment. Recently, the perception of the nordic culture might have changed. As my reflection of this topic is, that certainly there are plenty of rural areas from where indigenous people along with the first, second or third generation of settlers are still leaving because of the diminished economic and industrial production. Yet, there are few cities that are capitalizing on this trend, and Umeå is one of the most notorious example of how to attract people living in so-called isolation to a hub for life. At least that is the promise everyone believes who moves away from the North. At the same time, it is still very attractive for a southerner to come to a nordic hub, where old meets new, rural with a high-tech city and due to ICT, people are more connected than ever. The social isolation is less prominent which make life bearable, the economic possibilities are almost limitless. I would like to include a story from a survey of mine in order to emphasize one thing, namely, the importance the collective memory of a place. However, it does not connect to the winter culture directly, yet winter is a season and as such the collective memory of a winter is fading, changing and remembered in some cases:

“Dagny is like a boss: By the corner of Scandic Plaza, she was talking to a friend, then almost runs. Umeå was a small friendly and beautiful city 45 years ago, when she moved up here. The reason was the university, where she studied. She lives in a building nearby the river, built in 1938. She gets too much noise in
the head nowadays, due to the reconstruction of the beach-line. She likes walking along the river. There were many boats before which made everything cozier. **Odéon** as a movie theater is long gone, in spite of protests that she organized. The major once said: “Man kan inte spara alla gamla jävla hus!” – One cannot save all the f@cking buildings. She was thought to be a boss by many, but actually she never was. She likes Gammlia, because it is less disturbed by developments. City planning she finds interesting, and Umeå is the city of birches – did we know that? Umeå had this idea to be bigger than Sundsvall so lately they even move the city library to this new place that she gets frustrated with. Umeå first city architect should be remembered more: quality and beauty is important for us. Today the city architect is serving other’s interests. Nowadays there are many great cultural events in the opera and Folkets hus” (The full poster of city memories (2014) can be found in the Appendix).

**Additive manufacturing**

The technology that builds 3D objects layer-by-layer using various materials, like plastics, concrete or metals is called additive manufacturing. In our case, the material would be snow or reclaimed snow with a certain degree of pollution. An overview of additive technology helps to position the snow printer in the array of technological possibilities that are just imagined at the moment.

So far the only commonality in all additive technology is the use of CAD software in order to produce 3D models to be printed. There are several subsets to this technology like 3D printing, rapid prototyping, and direct manufacturing. These differ in terms of scale, speed and material use, yet the field of applications are limitless.

One of the examples of addictive manufacturing is the SLA or Stereolithography printing that utilizing laser technology to cure layer-upon-layer of photopolymer resin (polymer that changes properties when exposed to light). The build occurs in a pool of resin due to the directed laser beam that cures the model layer by layer. The process repeats until the model is completed which is fascinating to watch.

The fused deposition modeling or FDM is a process which uses thermoplastic, a polymer that changes to a liquid when heat applied and solidifies when cooled. The material is injected through nozzles onto a platform. The nozzles trace the cross-section pattern for each particular layer which is calculated by a special application. The thermoplastic material hardens prior to the application of the next layer. The process repeats until the model is completed.

The multi-jet modeling or MJM is a rapid prototyping process that provides a smooth, high-resolution, hard plastic model. The process consists only of UV bulbs and photopolymer materials that is similarly to an inkjet printer, capable of applying small jets to a layer of thermopolymer.

Another technology called 3DP is around from 1987, this involves building a model in a container filled with powder of either starch or plaster.
based material. An inkjet printer head shuttles applies a small amount of binder or glue to form a layer. Upon application of the binder, a new layer of powder is swept over the prior layer with the application of more binder. The process repeats until the model is complete and there is no need for supportive structure, whereas this is the only process that builds in colors.

Finally, a conceptual snow printer could use a jet streamed nozzle that with the help of a super-coolant could produce sub-zero material out of water that would function as adhesive to the reclaimed snow which can be transported through augers to its location of use.

**Architectural pavilions**

An architectural pavilion may refer to a temporary construction that is either located apart or in conjunction with a main building. Mostly it is understood as an object of fascination and creativity.

Mackenzie (2011) summarizes the purpose and beliefs of a pavilion as “a poignant cultural expression of who we are” (Retrieved from http://artguide.com.au/articles-page/show/whats-in-a-pavilion, date: 13/5/2016). Furthermore, he continues, “What is this ambiguous building type, which typically sports little more than an open, flexible and empty space, yet accommodates almost any form of human activity? Historically, pavilions have served as places of prayer, sport, entertainment, art and of course, romantic liaisons. Yet this ability to accommodate many different purposes does not mean that pavilions are neutral, non-descript zones or blank sheets of paper. The opposite is the case. Around the world pavilions rank amongst the most revered forms of architectural expression.”

An internet search was performed in order to find contemporary pavilion structures that are representing an environmental care and certain degree of biophilic design. The main choice of database was inhabitat.com which features environmentally sound architectural and design solutions, concepts and alike. Using a two keyword combination, environmental and pavilion, there were several hits already which resurfaced in this thesis. The samples shown here are representing a review of architectural methods and materiality with a concept description.

1. “Designer Ehsan Jahani created the Stars Pavilion, a freestanding, temporary structure with a simple but flexible design. Shaped like stars, the artistic and modular pavilion was recently recognized as one of the winners of the international London pavilion competition. The proposed pavilion would be primarily built from sawn timber and nylon rope, both inexpensive and durable materials that are locally available in London.

2. Toronto-based PLANT Architect unveiled two weathered steel pavilions that provide shelter for bird watchers at the spectacular East Point Park Bird Sanctuary. The shape of the new structures is evocative of flight, and they are laser-cut with intricate patterns that reference sunlight filtering through tree branches. The architects designed the Bird Blind pavilions in order to enhance the East Point bird-watching experience. A network of rehabilitated
The Bird Blind pavilions

trails leads to and from the pavilions, which act as a shelter, gathering space, and vantage point for Lake Ontario and pond views.

3. The UK pavilion is one of the first pavilions to open at Milan’s 2015 World Expo and we are buzzing. Designed by Wolfgang Buttress, BDP, Tristan Simmonds and constructed by Stage One, the soaring 1,910 square meter pavilion simulates a real beehive. “Grown in Britain and Northern Ireland,” the pavilion also expresses the role research and technology can play to address food security and biodiversity. And bees, as we all know by now, are absolutely central to this conversation. The pavilion follows a typical honeybee’s daily exploits through orchards, meadows and other landscapes. Their focused meandering to collect pollen and nectar to feed the colony and produce honey. This gentle experience culminates in a 14-meter cubed sculptural element that uses light and sound to mimic the busy interior of a real hive packed with hundreds of busy bees. Comprised of 169,300 individual aluminum components and assembled in 32 dizzying horizontal zig-zagging layers, the sculpture captures the essence of a swarming hive. But the heart of the visitor experience lies in the nucleus of this hive lit up with pulsating LED lights attuned to a real bee’s hive located nearly 1,000 miles away in Nottingham. This allows the visitor to identify with these hard-working pollinators and frankly, it’s hard to not be emotional about the numerous ways in which our lifestyle has been detrimental to their survival.

4. Dutch architecture firm UNStudio completed the theme pavilion for the 2014 International Horticultural Expo currently being held in the Chinese province of Qingdao. The design, which was realized three years after its selection in a 2011 competition, merges science and nature to follow the expo theme “From the Earth, For the Earth.” The pavilion buildings are arranged in the shape of a flower and mimic elevated landscaped plateaus to complement the surrounding mountainous landscape. The Theme Pavilion’s cluster of buildings is arranged in the shape of a Chinese rose and each building is likened to petals connected by internal and external walkways. “The flowering out concept is integrated into the design of the Theme Pavilion as a gesture of communication,” says Ben van Berkel, the principal architect at UNStudio. “Similarly to how it occurs in nature, the action of flowering out in architecture attracts and invites through the senses. It alludes to the notion that a building can open itself up and encourage public interaction.”

5. iWeb is a UFO-shaped pavilion that is being rebuilt by two robots at a new location at Delft’s Technology University. Using the principles of swarm behavior (swarming is a collective behaviour exhibited by entities, particularly animals, of similar size which aggregate together, perhaps milling about the same spot or perhaps moving en masse or migrating in some direction) managers, architects, urban planners and project developers will all benefit from the improved communication and sharing digital information through five large screens and a multi-channel audio system inside the
space. This working environment will enable experts to make fast and informative prototypes of organizational diagrams, spatial designs, planning schemes and project development concepts while saving resources, time and money. An icon for innovation, iWEB was first unveiled at the Floriade World Exhibition in 2002.

6. Montreal’s Biosphere Environmental Museum Resides Inside Massive Buckminster Fuller Geodesic Dome: Montreal’s Biosphere is in fact a museum dedicated to the environment. Originally built as the United States’ pavilion for the 1967 World Fair Expo, the dome was repurposed into a museum in 1990. The interactive museum initially showcased the water ecosystem of the Great Lakes region, but has since expanded to encompasses environmental issues such as climate change, air, eco-technologies and sustainable development. The Biosphere is one of the only museums of its kind, dedicated solely to the environment and environmental education. Each of the halls in the museum are dedicated to a series of rotating exhibitions, such as recycling, water issues of the world, and even trash trackers, which teaches visitors just what happens when they throw something away. up-cycled

7. Burton Street Peace Garden’s Learning Pavilion: This interactive learning pavilion made from discarded objects found on-site was built during a 10 week design-build course this last summer in Asheville, North Carolina. Students from three regional universities (North Carolina State, Appalachian State and Virginia Tech) worked in conjunction with the Asheville Design Center to build the pavilion for the Peace Gardens. The pavilion utilizes solar passive design and rainwater harvesting, and it is currently used by the community for education programs and workshops. Giant Texaco signs, ironing boards, windows, screens and other found objects decorate the artistic and functional shed, which cost less than $4,000 to build.

8. Sou Fujimoto’s Nebulous 2013 Serpentine Gallery Pavilion: This year’s pavilion strikes a delicate balance between nature and the works of man. Built from a network of steel beams, the geometric structure is almost cloud-like, and from a distance it appears as though mist were rising off the floor of the Kensington Gardens. Fujimoto designed the naturally day lit structure to allow visitors to feel as though they were in nature even while protected inside the pavilion. The 2013 Serpentine Gallery Pavilion is made up of complex geometric network of 20 mm steel poles. The delicate, lattice-structure occupies 350 square meters of lawn in front of the Gallery and provides room for café tables and seating as well as terraced steps at both entrances to provide extra seating for events. Completely transparent, the naturally day lit space is merely a thin barrier between the interior and the surrounding gardens.”
**Methods and findings**

**Location**

The scale of this speculative design encompasses the entire length of Renmarkstorget that is centrally located in Umeå and it is 182 meters long and 15-33 meters wide (appr. 6050 m$^2$). The purpose of this study is to form a temporary structure during the winter period that would enhance pro-environmental behavior with some feature that might be beneficial in other seasons as well.

The method of investigation departed from the historical landscape around the existing square which involved a brook that shaped this area significantly. From the 1890s city plan, it is visible, how the resurrected settlement had decided to occupy the creek banks after the devastating city fire. The property lines were made following the direction of the brook and resulted into a bottleneck formation towards the South end of the square. Today, this brook is running underneath the surface in a channel and a fountain is one of the reminders of it. This may be accounted as a non-visual connection to nature, however, there are several other routes which could be leading to a nearby ecologically valid representation of nature. Access to natural water flow is also possible through these routes while the seasonal fluctuations can only be observed in a limited view (Figure 29 and 30). The organized few number of birch trees are the only annual reminders of nature for visitors and the inhabitants. The snow that may eventually fall on the square can be melted away immediately, due to the heated pavements.

This square has a complex shape which prevents surveillance of the whole environment at once when someone is outside of its center. From any lateral position, there are blindspots which may be seen as an inviting mystery effect or as a risk for potential danger. The visual arrangement of the spatial hierarchy is a strong concept for the square. It is separated in two areas adjacent to the center and they function differently too. A third area on the North side is working more like a blockage in the traditional city tissue. We cannot talk about biomorphic form other than the triangulated building that follows the old stream as reference. Neither the urban planning or the buildings represent natural mimicry on a fascinating level. Furthermore, it is also difficult to talk about the concept of refuge since the only place to retreat ourselves during the winter is the shops. The square is lacking the ability to maintain interest and fascination for further exploration unless we also lack the need for such activities. This built environment is highly technical and covered with hard and artificial surfaces which satisfy the maintenance perspective, but fails to be other than a transportation zone for cyclists and pedestrians. The hard surfaces do not dampen the reflected noise on the square, therefore, vehicle noises and human shouting can be heard. Similarly, singing of birds are reverberating the area even if it comes from a loudspeaker. Traces of animals on the square is
visible during winter when footprints are left in the fresh snow. Mostly pets such as dogs leave their tracks behind while birds are frequently attracted to nearby trashcans.

**Concept**

The concept of a biophilic strategy is expressed in the design of an architectural object which builds ties to the place, awakens fascination and meaningfulness in one's life. The appearance of this architectural object should reflect a biomorphic design with natural materials that facilitates prospect and refuge for both individual and common activities. It is legible, yet mysterious gifts to the city that affords the risk to be taken in a safeguarded manner. In its complexity in this environment deals with the exterior and interior thermal- and airflow issues together with the natural and artificial lighting conditions. Urbanists and city planners have special opportunities and unique obligations to advance biophilic city design, utilizing
a variety of strategies and tools, applied on a number of geographical and governmental scales. The agenda is that one must extend beyond conventional urban parks, and beyond building-centered green design. It is about redefining the essence of cities as places of restorative nature, from rooftops to roadways to riverfront. It is about understanding cities as places that already harbor much nature and places that can become natural (whiter or greener) and more diverse again.

Based on the investigation and site visits described in Study 2, the concept of a winter intervention emerged. Taking into account that the standing behavior pattern on the square is mainly consumerism, the GPS-based pattern of movement served as an inspiration to bring a linear movement into action. The three “serpentes” which sometimes follow or cross the tracked consumer movements were strategically placed along the entire length of the square and intersected by pedestrian and cyclist movements. The idea that these serpentes should play a diversion from consumerism surfaced. Transforming this two-dimensional approach to a spatial character, the design concept needed to take in an additional consideration which became the visual accesses between the shop entrances which was regulated according to how well that particular shop might perform on biophilia. The guides on biophilic living/consumerism would be either granting or hindering visual access to certain parts of the neighboring environment. However, the only building that should be visible from as many places as possible is the Urban Research lab (URlab), because it would host events regularly on knowledge generation and co-learning on biophilic living and circular economy, hence creating a living example of biophilia. The facility of URlab at the present state would already be able to host such events yet a transformation of its interior and exterior would be preferable and more in line with the biophilic design patterns.

**The serpentine**

The serpentine is produced from the combination of snow and super-cooled water as adhesive. The choice of materiality lies in the notion that this serpentine should be responsive to behaviors and promote pro-environmentalism. Visually, the serpentine is made of natural materials, that is locally available. By following the serpentes, the visitors may direct themselves to more nature like environments such as parks and the Ume river. Human tactile sense is stimulated by the temperature of the serpentine and its pressure responsive feature would behave as the person in contact wants it to behave. The smell of this structure is not as outstanding as a treated wooden surface and therefore, it would let the senses to focus to other more relevant cues, like temperature and visual appearance. Layers of material differences would further enrich the visual appearance of the serpentes (Figure 31).
Figure 31. Development of the concept for winter biophilia at Renmarkstorget, Umeå.
The appearances of these serpentine installations are highly non-rhythmical which would always provide stimulations to the senses. Opaque and transparent surfaces, material differences due to temperature change, the installation is always exposed to the natural elements. As the visitors move on the site, their view is constantly changing and making the installations expose different views. The biomorphic shape of certain installations may increase fascination and make them imagine as they were part of a natural phenomenon. The physical transformation of the material provides a safeguarded risk-taking experiences especially when the installations are
used as primitive shelters. Variations the biomorphic shape can be seen in Figure 32, 33 and 34.

The original purpose of URlab was to create an environment in which we co-investigate, co-design and co-stimulate socially and environmentally sensitive projects that aim to increase awareness, pro-environmental behavior and integration of flora, fauna, and fungi into the urban and architectural structure in the heart of the city. The skin project as a representative of this thinking was planned to introduce the architectural transition for the site from a highly linear consumption based pattern to a more nature centered fascinating alternative that acts as caring and make a responsible shift towards biophilic living.

The skin

The main feature of this skin project is, of course, the “facelift” that was given to the site. The existing building has to meet the appearance and fascination expectation that biophilic living would be for the future. For this purpose it was suggested to transform the existing building into a pavilion, that would serve as the attraction point and source for fascination and “out of the ordinary” feeling which leaves the visitor of the site with the intension to change behaviors through the experiences it may provide. The functionality of the pavilion would build on the application of media surfaces and visitors interaction with Renmarkstorget. Interactions through the serpentine and the nearby shops the skin can be excited for attracting attentions and deliver a message for a biophilic living, diversity and caring. Hence, the project would heavily build upon the sensor based feed-backing systems that made responsive architecture a buzzing area of investigation.

Since this is a speculative project the opportunity to extend the initial
understanding of behavior responsiveness needs to be made. The details of how the skin could be made into a behavior responsive surface may be already demonstrated by some existing pavilion project like the UK pavilion in Milan, that mimic a living beehive through technology.
The urban structure around the site has been introduced earlier; yet a volume analysis would be helpful to understand why does this pavilion need to be the size and form it appears. In Figure 35, a schematic analysis is presented, focusing on the verticality and node characteristic of the site. A simple but straightforward analogy between a monumental urban site and the existing tourist office had been drawn. However, our site is not fitting in the block structure that is so apparent to the whole city, today it is definitely projecting a weak center point for the square. The intention with the skin project regarding the repositioning of the site was to increase verticality and its visibility among the city blocks. The shape of the skin is originated in the serpentes as they meet at this point (Figure 35-38).

This pavilion of biophilic living enables the visitors to walk under the skin and get engaged with activities. Emphasizing on an unseen view on the
square and its immediate neighborhood would be expected to give fascination and exciting new thoughts for appreciating the environment.
Conclusion

This design exercise provided many interesting insights for a site-specific intervention. Generally, it helped further to concretize an extremely broad concept such as biophilia and opened up a view of this biophilic design concept not yet explained or seen before. The use of winter as the main source of materials and activities for embracing biophilic living was tested and scaled up to an urban level. The complexity of the site required a specific approach in which a set of serpentines describing movements through the square were established and then intersected with the visual connections from the shop entrances. The only clear view was directed toward the Urban-Research lab, which was fitted with a temporary structure called the skin, and preferably made the existing building more flexible, fascinating and functional for the biophilic living concept.
This thesis aimed to investigate how human behavior change can be stimulated toward a more pro-environmental biophilic living. The strategy to this aim was through the concept of responsive architecture that would support pro-environmental behavioral intention.

The objectives of the study were:
- to establish a conceptual model of behavioral responsive architecture that facilitates biophilic living
- to identify architectural strategy and site for direct architectural intervention and to organize activities in a behavior responsive architectural space for stimulating awareness of pro-environmental behavior and biophilia
- to develop a site-specific speculative design that prolongs the investigation period for stimulating awareness for pro-environmental behavior and biophilia

This thesis contributed to a conceptual model of behavioral responsive architecture that facilitates biophilic living. The literature review stated that a behavioral change may be induced by the contextual factors, but this might be not as rapid and straight-forward as other personal interactions. The person whose behavior is subjected to change must intuitively understand and react upon the environmental design which surrounds him/her and therefore, he/she must be able to question its design intention. Now, this is the point where responsiveness comes to play and would make it a pervasive environmental perception toward biophilia. The first and immediate environmental perception is built on the affordance qualities while later on this process would reach the cognitive level where intentions for choosing an alternative way to biophilic living are made. The difficulty is to grasp the attention of the people and start involving him/her in this cooperative play for exploring the setting and give space for reflection to his/her future. As time is an essential factor for an intervention, the process of behavior change can be speculated on different intensities. However, the society is prone to behavioral change and it is discussed in this thesis through the health risks, when an intention is affected externally, it may be seen as negative or even as a forceful. Meanwhile when this change comes from inside the person it most probably will succeed. The positive example of a changed behavior would, later on, generate the standing pattern of the ecological coexistence for biophilia in the designed environment.

Secondly, a direct architectural intervention was carried out for testing how well this conceptual model may be functioning in reality. Would it be possible to elicit biophilia in people and would this intention persist after the duration of the intervention as well? Finding an appropriate site and form for the intervention took time and efforts to execute. At the time of the
intervention, it was not as clear as it is today, that the existing behavioral pattern (consumerism) was mostly challenged by people who did not have a goal-oriented stay on the site, but rather a more reflective and surveying attitude for interaction. The architectural intervention was site-specific and using the quality of snow as a behavior responsive matter. This way the interest in the intervention was possible to maintain. However, temperature played an significant role in regulating the responsiveness, the deterioration of the intervention had elicited thoughts and not only acts which are in line with biophilia. The site activations had contributed mainly to draw attention from other purposes and challenge the physical and mental status quo.

Thirdly, the speculative design for a long term intervention during the winter period seems an unusual move in visualizing biophilia. Mostly we can find delicately designed green buildings and ecological solutions when we browse for examples of biophilia. By using winter season as the main period for intervention, the challenge to produce a temperature dependent installation arose. Technologically, additive manufacturing was considered for the production of temporary structures, even though this snow printer is not yet invented. Another issue was the appearance of an existing building on the site. The imagined cooperative research and learning center had to be upgraded for the task of hosting a complex spatial function and match the theme with its appearance. The proposal for this was a temporary grid structure with an outer skin that tests this site and redefines the city center. As these sketches developed, it became obvious that how limited in terms of biophilic potential this existing square is. It is only a speculation that a pavilion type of experimentation would be an appropriate method for unveiling the potential for biophilic living.


Poster of city memories.