Shining a Light on the Orkelljunga Preschool Community

nick pagee

Interaction Design
One-Year Master
15 Credits
Spring 2017
Supervisor: Anne-Marie Hansen
# TABLE OF CONTENTS

**ABSTRACT** ....................................................................................................................... 4

## 1. INTRODUCTION: AIM AND RESEARCH QUESTION ........................................................................ 4

1.1 Introduction to the Health School project ............................................................................. 4
1.2 The prestudy that shaped this thesis ...................................................................................... 5
1.3 Narrowing from the prestudy into the focus of this thesis research ...................................... 6
1.4 The focus of this thesis research ........................................................................................... 6
1.5 Research question ............................................................................................................... 6

## 2. THEORY .................................................................................................................................. 7

2.1 Considering immigrant families in the Örkelljunga preschool community .......................... 7
2.2 The power of play in childrens’ development ...................................................................... 8
2.3 Serving the community means making it accessible ............................................................... 9
2.4 Light and colour: creating a welcoming atmosphere for the community ......................... 11
2.5 Thinking long-term through parametric design .................................................................. 12
2.6 Related works ...................................................................................................................... 12

## 3. METHOD .................................................................................................................................. 17

3.1 Literature review .................................................................................................................. 17
3.2 Participatory design workshops ............................................................................................ 17
3.3 Annotated videos .................................................................................................................. 18
3.4 Hardware & software sketching ............................................................................................ 18

3.4.1 Sketching open-endedness in live prototype design ......................................................... 18
3.5 Field observations: the Örkelljunga preschool .................................................................... 19
3.6 Expert interviews ................................................................................................................. 19
3.7 Design diaries ....................................................................................................................... 19
3.8 Ethical considerations ......................................................................................................... 20
3.9 Project plan .......................................................................................................................... 20

## 4. DESIGN PROCESS ............................................................................................................. 21

4.1 Örkelljunga two-day site visit ............................................................................................... 21

4.1.1 Pre-work: workshop design ............................................................................................ 21
4.1.2 Pre-work: hardware and software sketching of live prototype ......................................... 21
4.1.3 Pre-work: stakeholder sensitization ................................................................................ 23
4.1.4 Participatory design workshop with teacher and children ............................................... 23
4.1.5 Site observation .............................................................................................................. 23
4.1.6 Interview with teacher about preschool pedagogy ......................................................... 27
4.1.7 Interview with teacher about times of day ..................................................................... 27
4.1.8 Conclusion of site visit .................................................................................................. 28

4.2 Industry expert interviews .................................................................................................... 30

4.2.1 Aesthetec Studio ............................................................................................................. 30
4.2.2 Anthony Rowe ............................................................................................................... 31
4.2.3 The Strong National Museum of Play ............................................................................. 32
4.2.4 Design insights from interviews: ................................................................. 34
4.3 Participatory design workshop with architects and health sciences researcher ........................................ 34
  4.3.1 Pre-work: prototype development .......................................................... 35
  4.3.2 Pre-work: stakeholder sensitization ....................................................... 36
  4.3.3 Workshop with Architects ................................................................. 36

5. MAIN RESULTS AND FINAL DESIGN ........................................................................ 43
  5.1 Revisiting the research question: .................................................................. 43
  5.2 Synthesizing insights: .................................................................................. 44
  5.3 Answering the research questions: ............................................................. 45

6. EVALUATION / DISCUSSION ............................................................................... 47
  6.1 Evaluation of design results ......................................................................... 47
  6.2 Recommendations for design process ....................................................... 48
  6.3 Evaluation of method ................................................................................ 49
    6.3.1 Methodological room for improvement: .............................................. 49

7. CONCLUSION ...................................................................................................... 50
  7.1 Looking ahead ............................................................................................ 51

8. ACKNOWLEDGEMENTS .................................................................................... 51

9. REFERENCES ...................................................................................................... 52

Appendix A Health School in Örkelljunga background ........................................ 57
Appendix B Concepts generated in prestudy .................................................. 59
Appendix C Insights from Co-Design Session at Preschool ................................ 69
Appendix D Site observation: morning and afternoon drop-off and pickup ...... 72
Appendix E Site observation for parametric design openings ....................... 74
Appendix F Interview with teacher about preschool pedagogy ..................... 76
Appendix G Insights from interview with teacher about preschool pedagogy ...... 77
Appendix H Written responses from Ann-Christine on time of day and light. ........ 78
Appendix I Email interview: Ann Poochareon, Aesthetec Studio .................... 80
Appendix J Email interview: Anthony Rowe, Squidsoup .................................. 82
Appendix K Interview: Dyson, McCoy: The Strong National Museum Of Play .. 84
Appendix L Insights from discussing parametric input with architects .......... 87
ABSTRACT

This thesis contributed to the regional Health School project, specifically informing the community-building efforts of a preschool in Örkelljunga, Sweden as they seek ways to improve communication among immigrant families and teachers. Using a co-design process with stakeholders including a preschool teacher, architects redesigning the school, and a health sciences researcher, this research investigated how a welcoming atmosphere could be created to act as a social intervention in the redesigned school. Interactive ambient light installations are proposed as a way to create this welcoming atmosphere. Installation design was explored through the lenses of multicultural makeup; play behaviour; accessibility and lighting design. Concluding the design research process, which used methods of participatory design, experience prototyping (Buchenau and Fulton Suri, 2000), and live prototyping (Horst and Matthews, 2016), a set of design principles were distilled for stakeholders.

1. INTRODUCTION: AIM AND RESEARCH QUESTION

1.1 Introduction to the Health School project

In 2017, Malmo University Interaction Design masters students were invited to engage in a regional initiative to redesign a preschool in Örkelljunga, Sweden; a project referred to as Health School. The Health School project is investigating ways digital technologies, diet, social innovation and fitness can help mitigate health issues impacting the school and those similar to it. This research project includes a diverse group of civil, commercial and academic stakeholders, exploring many themes aligned with the project. Problems the Health School project seeks to address range as widely as mental health; child obesity, diabetes and social issues related to increasing immigration. The Health School brief (Appendix A) suggests these might be addressed through researching social innovation, accessibility, physical education, dietary education, and gamification as learning incentive, listed in Appendix A:

Örkelljunga municipality is in the planning stage for constructing, in the first stage, a pre-school...to develop new ways to meet the challenges that the future society is facing. The idea is to build in sensors, measurement technology, eHealth in everything....

...The school can from the start have built-in sensors and tools that are easily accessible and useful in teaching children where their own actions becomes information that may affect the teaching and development of the business...

...Through various efforts to "gamification" we can meet children's need for play but also affect behavior and learning.
(U. Bengtsson, personal correspondence, 2017)
1.2 The prestudy that shaped this thesis

A prestudy was conducted that led to the research topic of this thesis. Participating in this Health School project, from February to March of 2017, five Malmo University interaction design students conducted fieldwork to develop concepts addressing an area in need. This research shall herein be referred to as the prestudy. See Figure 1 illustrating the relationship of the prestudy to this thesis.

Örkelljunga preschool is described as a “socially deprived area” (U. Bengtsson, personal correspondence, 2017) (see Appendix A), and prestudy site visits revealed that a factor in this – aside from being a remote, lower-income area – is a growing population of immigrant families who do not speak Swedish or English. This dual communication gap (linguistic and cultural) is causing challenges for teachers, children and parents and as such was identified as an opening for design investigation. This opening led researchers to focus said prestudy on stimulating social interactions between teachers at the school and the immigrant children and parents. This focus led to the development of eight simple concepts for bridging linguistic and cultural gaps, listed in detail in Appendix B.

Inspiring many of the concepts from the prestudy was a stakeholder vision for the redesigned school to include a multi-use community space that could be welcoming for all, Swedish and immigrant families alike. A teacher working with immigrants and an architect working on the preschool redesign envisioned this shared space could bring together parents, children, teachers, and the community to mingle during the day and in the evenings through special events. The resulting concepts generated from the prestudy included play-based installations that could serve in this space. Stakeholders expressed interest in how these installations could act as social 'ice-breakers’, to make community members feel welcome, and to create an atmosphere of social interaction and play among families.
1.3 Narrowing from the prestudy into the focus of this thesis research

This thesis carries on the research of the prestudy, but narrows to consider an interactive installation in the shared community space of the redesigned preschool. In the prestudy, stakeholders felt a light installation (e.g. an interactive LED installation, see section 2.6) could help children and parents feel more at ease in this space by creating a welcoming atmosphere. The stakeholders resonated with other installation elements from the prestudy such as tangible interfaces to promote exercise, and themes that encouraged play, and so these are collectively being considered in this investigation.

1.4 The focus of this thesis research

This research – building on the prestudy – investigates how an installation in a shared community space can contribute to the Örkelljunga preschool community by considering: a) this community’s multicultural nature; b) play behaviour; c) accessibility, and d) lighting and aesthetic elements.

This thesis research was done to aid the ongoing redesign of a preschool in Örkelljunga. It works directly with a preschool teacher at the school, the architects leading the redesign of said school, as well as a health sciences researcher from Malmo University involved in the Health School project. The school is in the beginning stages of design and will not be built for some time after this thesis is completed, so the results of this thesis will inform the stakeholders as they continue. This research prioritizes delivering findings about designing installations for preschoolers to the stakeholders involved in the redesign. Throughout, research choices and methods are based on this practical end goal.

1.5 Research question

The main overarching research question this thesis aims to answer is: how can a welcoming atmosphere be created for multicultural community members of a preschool that encourages playful interactions and possibly stimulates communication?

Sub-questions informing the exploration include:

1. How does Örkelljunga’s community, notably its multicultural makeup, influence the conceptual or content possibilities for a permanent installation?

2. How can playfulness help encourage social connections?

3. How can diverse abilities, learning styles and cultures be served?

4. How might lighting impact the social atmosphere?

5. How can parametric design principles help sustain interest in, and engagement with this installation over the long term (i.e. as a permanent installation)?
2. THEORY

Theoretical insights are included here to inform stakeholders on how an interactive installation can create a welcoming environment for the community through considering multiculturality; play behaviours; accessibility; and lighting.

2.1 Considering immigrant families in the Örkelljunga preschool community

As outlined in the prestudy, there is a population of immigrant families enrolled in the Örkelljunga preschool, where language barriers contribute to ongoing social issues. This section aims to sensitize design research to some dynamics of the experiences of immigrant families, but as outlined in section 3.8, this thesis does not focus on them. Nor does it specifically investigate interactions between families and teachers beyond making design assumptions about how an installation can create a positive social atmosphere for the community.

In her report *The Impact of Discrimination on the Early Schooling Experiences of Children from Immigrant Families*, Adair finds immigrant children’s experiences in their earliest school years are significant factors in their future academic, emotional and social development (Adair, 2015). She notes negative impacts from discrimination that immigrant children can face, via treatment from others such as peers and teachers (Adair, 2015, p. 1) as well as institutionally (2015, p. 1). Adair reports “[t]eachers are often unable to communicate and engage with immigrant parents...many immigrant parents either feel intimidated or believe it is inappropriate to approach the teachers” (Adair, 2015, p. 2). Adair finds that this lack of connection prevents parents from representing their children’s interests at school, or promoting learning and social engagement at home (2015, p. 2).

Adair makes recommendations for improving communication with immigrant families, focused on “equalizing relationships with parents and communities” (Adair, 2015, p. 2) and increasing sensitivity to cultural nuances (2015, pp. 2-3). Referencing and summarizing Souto-Manning (2013), she finds educators “need more experience in diverse communities, experience that would best include everyday interactions and community events” (Adair, 2015, p. 17). She also states that “[a]mid the discrimination faced by immigrant families in the larger society, schools and early education programs could provide safe and comfortable settings for children of immigrants” (Adair, 2015, p. 16).

The research of Gonzalez, Eades and Supple aims to “help the school community improve its ability to work with students from immigrant families to enhance students’ personal/social outcomes” (Gonzalez, Eades & Supple, 2014, p. 100). They offer activities and tools teachers can use to construct a sense of community in multicultural contexts (Gonzalez et al., 2014). Sharing and celebrating the differences in cultural identities is a core theme of these recommendations (Gonzalez et al., 2014). One suggestion adaptable to preschool settings describes how parents of immigrant children be involved in creating posters of their respective cultures, which can then be shared in a school setting (Gonzalez et al., 2014, p. 105-6). Gonzalez et al. suggest this sharing of cultures amongst students provides “knowledge that is essential to understanding, accepting, and respecting ethnically diverse communities” (Gonzalez et al., 2014, p. 106).
Given the array of cultures in the Örkelljunga school, there is potential to set a welcoming atmosphere called for by Adair (2015) and stimulate intercultural sensitivity through recommendations of Gonzalez et al. (2014).

2.2 The power of play in children’s development

The positive impacts play can have on children’s social, cognitive, physical and emotional development have been established (Sutton-Smith, 2001; Goldstein, 2012; Pellegrini, 1987; Anderson, Moore, Godfrey and Fletcher-Flinn, 2004). Play scholar Sutton-Smith, discussing play as it relates to children’s development states “play skills become the basis of enduring friendships and social relationships and also offer a way of becoming involved with other children when shifting to new communities” (Sutton-Smith, 2001, p. 44), and goes on to suggest the same is true for adults (2001, p. 44). Psychologist Goldstein states that play “increases brain development and growth, establishes new neural connections, and in a sense makes the player more intelligent” (Goldstein, 2012, p. 5).

Sutton-Smith explains how elusive a definition of play can be, describing many types and categories (2001, pp. 3-5). Forms of play according to Sutton-Smith range across an overlapping spectrum of activities (2001, pp. 4-5), including what he labels Mind or subjective play, Solitary play, Performance play, Playful behaviours, Contests and more (Sutton-Smith, 2001, pp. 4-5). Other theorists give accounts of specific forms of play and respective benefits, e.g. Pellegrini’s investigation into the physical and social benefits of Rough-and-Tumble play (Pellegrini, 1987), and Rosen’s findings that helping disadvantaged kindergartners improve their socio-dramatic play improved group problem-solving abilities (Rosen, 1974, p. 920). Furthermore, as preschoolers develop, Anderson et al. report that from “ages 2 and 6 children’s play behaviour changes from predominantly solitary activity towards greater involvement and cooperation with peers” (Anderson et al., 2004, p. 373).

Faced with this spectrum of development and styles, the question arises: how to design a preschool installation for specific play behaviours? Here Bekker, de Valk and Eggen’s research on children’s play in interactive environments is illuminating. They examine a range of “ambient interactive playful solutions” (Bekker, de Valk & Eggen, 2014, pg. 266), noting ways they can be embedded in e.g. walls and floors (2014) and how they relate to various forms of play “including physical play, social play and communication, music creation, creativity and storytelling” (Bekker et al., 2014, p. 266).

Bekker et al. find research on play behaviour is abundant, but not accessible to designers (2014, p. 264). She aims to remedy this through her toolkit: the lenses of play (2014); which “support designers in taking diverse play perspectives into account when developing intelligent play solutions for children” (Bekker et al., 2014, p. 264). Bekker et al. developed this through user-centered design with children and finds the lenses bring differing perspectives into designing playful interactions (2014, pp. 264-5). Bekker et al.’s lenses of play focus on open-ended play, forms of play, stages of playful interactions, and playful experiences (2014, pp. 267-71). Given the cultural
diversity of children in the preschool, and the early stage of this research, open-endedness in play seems well-suited to many interpretations, and as such Bekker et al.’s lenses are applied throughout the design process.

Play behaviour may also be able to help build cross-cultural relationships in the Örkelljunga preschool. Discussing how pervasive play behaviour is, and that it is observed in dogs and other animals, Huizinga suggests in *Homo Ludens*, that play behaviours are “older than culture” (Huizinga, 1998, p. 1). Goldstein, noting studies comparing play behaviours internationally states “children from all cultures tend to play in similar ways and at roughly similar ages” (Goldstein, 2012, p. 34). Discussing Bateson’s theory of there being a signal exchange about play that is necessary in order for participants to begin (Donaldson, referencing Bateson, 2000), play specialist Donaldson recounts his experiences:

As I played I found that this nonverbal message was understood by all children, regardless of their culture or disabilities. I played with children from Mexico who didn’t speak English...I played with children who had autism and various emotional disorders and found that they played like “normal” children...I began to suspect that I was being introduced to a form of intraspecies communication that all young children understand (Donaldson, 1995)

This research supports play behaviour as having a social power to unite people of diverse cultures and languages. Adair finds immigrant parents often feel intimidated in school settings (Adair, 2015). Perhaps able to combat these feelings, play can make people feel more at ease, noted by Brown, co-author of *Play: How it Shapes the Brain, Opens the Imagination and Invigorates the Soul* (2009). In his New York Times article describing the value of play, Lieber references Brown’s findings, summing up that: “[a]nother crucial component, according to Dr. Brown, is play’s capacity to elicit diminished consciousness of self. Or, to put it in layman’s terms, it gives us license to be goofy” (Lieber, 2016, p. 1).

If many styles of play are designed for in the common space, it may not only help childrens’ development, but encourage diverse community members to join together in play.

2.3 Serving the community means making it accessible

The Health School project brief (see Appendix A) calls for Universal Design principles in helping create a place where everyone, regardless of ability (U. Bengtsson, personal correspondence, 2017). According to the Center for Universal Design, these include “Equitable Use; Flexibility in Use; Simple and Intuitive Use; Perceptible Information; Tolerance for Error; Low Physical Effort and Size and Space for Approach and Use” (Connell, 1997, p. 1).

The National Center on Universal Design for Learning presents guidelines stressing the need to provide multiple means of representation; means of action and expression; as well as means of engagement (Rose and Gravel, 2014). Some of the recommendations can inform installation design:
1. To accommodate those with differing sensory abilities, information should be presented through different modalities such as vision, hearing and touch (Rose and Gravel, 2014).

2. Learners “vary in their facility with different forms of representation – both linguistic and non-linguistic” (Rose and Gravel, 2014, p. 1), and a “picture or image that carries meaning for some learners may carry very different meanings for learners from differing cultural or familial backgrounds” (Rose and Gravel, 2014, p. 1).

An installation must support many senses, but also choose content open to multiple interpretations from different learners and cultural backgrounds. Further to designing for culturally diverse settings, in *Using the universal design for learning framework to support culturally diverse learners*, Chita-Tegmark et al. stress “[p]eople from different cultures may learn the same things, but they may learn them differently [and that]…different cultures cause us to see and understand the world differently” (Chita-Tegmark et al., 2011, p. 18). Örkelljunga preschool handles diverse learners as well as diverse cultures. The design choices outlined in section 4.1.2 use this theory in selecting content for an installation to be as open to interpretation as possible.

In *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies And Emerging Applications*, Bruckman and Bandlow stress that to make designs accessible for children, designers must be aware of their psychological and physical differences, as well as how their abilities change as they age (Bruckman and Bandlow, 2003, p. 429). Referencing Jean Piaget (1970), Bruckman and Bandlow describe his theory of the stages of children’s development. The children of the Örkelljunga preschool fall into what Piaget categorizes as a *preoperational stage* between two and seven years (Piaget, 1970, cited in Bruckman and Bandlow, 2003).

Bruckman and Bandlow explain that in this preoperational stage:

1. Attention span is short and children “can only hold one thing in memory at a time” (Bruckman and Bandlow, 2003, p. 430).
3. “They have difficulty with abstractions” (Bruckman and Bandlow, 2003, p. 430).
4. Regarding dexterity, children have difficulties with input devices that require fine motor skills (2003, p. 430).

Installation concepts and interfaces should therefore be made simple and should not use text. Regarding dexterity, this suggests designs should assume users do not have well developed fine motor skills, but given that children are learning, this may be an opening to incorporate motor skill development.

Further to interface design and motor control, according to the Association of Childrens Museums, installations must be “built and maintained to withstand heavy interactive use with the development process addressing preventive maintenance” (Association of Childrens Museums, 2012, p. 3). This suggests that mechanical controls such as knobs and buttons should be avoided in favour of sensors that can be embedded into durable materials and operate without physical wear and tear, e.g. distance sensors, or the Microsoft Kinect sensor. While distance sensors do not require fine motor skills, they also do not offer tangible hands-on interaction, so to address multi-
modality, perhaps conductivity can be embedded into tactile materials that encourage physical handling, but in a durable form.

This research was not able to address design implications for those with differing abilities within the time frame. For those continuing this research, many resources can provide insight into the needs of those with differing abilities, e.g. Scott’s *Designing Learning Spaces for Children on the Autism Spectrum* (Scott, 2009) which deals with issues such as proxemics, or *Designing for disabled children and children with special educational needs* (Education Funding Agency, 2014).

2.4 Light and colour: creating a welcoming atmosphere for the community

It is well established that lighting can be key in creating dramatic effects. Designers Karlen et al state lighting “completely changes how an occupant experiences a space” (Karlen et al, 2012, p. 3), and that it “leads a person instinctively through a space, and...can quickly and simply change the atmosphere of a space and how a person feels while in it” (Karlen et al, 2012, p. 3). A light installation in the shared community space of the preschool may be able to imbue a sense of welcome, addressing some of Adair’s (Adair, 2015) findings about tense interpersonal relations between immigrant families and teachers (Adair, 2015).

In *Designing with Light*, Livingston describes how light influences viewers’ impressions of a space and how designers can shape these (2014, p. 159). He discusses a study at Kent State University into how lighting provides cues to occupants of a space. Livingston cites Flynn in describing how various lighting arrangements produced consistent perceptual responses (2014, pp. 160-166), of note that “[i]lluminating the walls consistently increased impressions of pleasantness and spaciousness, and improved perceptual clarity” (Flynn, 1973, cited by Livingston, 2014, p. 166). Livingston proposes Flynn’s research means lit spaces are experienced as shared social spaces (2014, p. 166) and that occupants tend to have similar responses to lighting conditions (2014, p. 166).

Livingston advises that “[r]elaxation is reinforced by nonuniform perimeter lighting, especially on walls, lower light levels, and warm sources of light” (Livingston, 2014, p. 167), seen in Figure 2. Reflecting on a light installation for the preschool, using nonuniform perimeter lighting, embedded in or lighting the walls could be considered for creating a welcoming atmosphere of pleasant and relaxing impressions.

---

![Figure 2. Reinforcing impressions of relaxation. (Livingston, 2014, p. 168)](image-url)
Livingston discusses how colour is associated with meaning internationally (2014, pp. 262-327), noting “[c]olor is now frequently seen as an integral part of architectural and lighting designs” (Livingston, 2014, pp. 310-11). Useful when thinking of the cultural makeup of Örkelljunga preschool, he discusses how colours can be associated in diverse cultures, e.g. below describing the colour blue:

- **North America**: Trustworthy, soothing, depression, sadness, conservative, corporate
- **Western Europe**: Sky, fidelity, serenity, truth, reliability, responsibility
- **Russia**: Hope, purity, peace, serenity
- **China**: Sky, water
- **India**: Heavens, love, truth, mercy

(Livingston, 2014, p. 317)

Livingston concludes “there is no such thing as color-coded emotions or universal responses to color, but multiple sensory and environmental signals can be combined to guide impressions” (Livingston, 2014, p. 317), citing examples such as how sounds, props or environmental cues can help articulate meanings when used with various colours (2014, pp. 317-18).

It is possible that a light installation could have therapeutic effects. Livingston (2014) details how light is used therapeutically to address Seasonal Affective Disorder (SAD), “a kind of depression caused by inadequate or ill-timed exposure to light” (Livingston, 2014, p. 578). Geddes discusses how common light-therapy is in Scandavia, noting that in southern Sweden "an estimated 8 percent of the population suffer from SAD, with a further 11 percent said to suffer the winter blues” (Geddes, 2017, p. 1). Livingston notes light therapy “involves exposure to a very bright light source (2,500 to 10,000 lx) with a high color temperature (over 5,000K) in the morning” (Livingston, 2014, p. 578). An installation could produce these light specifications for the morning drop-off times at the preschool, benefitting the community by potentially combatting depression.

2.5 Thinking long-term through parametric design

This installation is envisioned as permanent, so this research must consider how it can maintain aesthetic appeal and engagement over time. In *Elements of Parametric Design*, Woodbury explains that instead of designers having to alter a design manually to create changes (2010), with parametric design “the designer establishes the relationships by which parts connect, builds up a design using these relationships and edits the relationships by observing and selecting from the results produced” (Woodbury, 2010, p. 24). Instead of programming an installation with predictable patterns, input parameters unique to Örkelljunga could be chosen. These might include weather patterns, changing seasons, ambient noise, or even social media data to create a sense of dynamism and ongoing change.

2.6 Related works

Ambient and abstract light installations create welcoming atmospheres and play-based interventions in many public contexts including building lobbies, outdoor art installations, childrens
museums, and science centres. These examples are intended to sensitize project stakeholders to the wide range of spatial configurations, play-based interactions, and social behaviours that can be encountered in light installations.

**Title**: HALO.

**Artist**: Tangible Interaction.

**Links**: video link and project website link.

![Figure 3. Halo. Source: photo provided to researcher by artist, courtesy of TIFF, 2014.](image)

This light installation promotes movement and dance using computer vision to sense and respond to human movement, and warms the space with rich colour palettes and dynamic animations.

**Title**: Forest.

**Artist**: Micah Scott.

**Links**: video link.

![Figure 4. Forest. (Smith, 2015).](image)

FOREST creates a welcoming atmosphere for a lobby while promoting tactile physical engagement using the movable light spinners to move ‘light fluid’. The distribution of spinners served many heights and invited collaborative play.
Title: Nature Trail.
Artist: Jason Bruges Studio.
Links: video link.

Created as “a distraction artwork helping to create a calming yet engaging route that culminates in the patient’s arrival at the anaesthetic room” (Bruges, 2012, p. 1). This installation helps relax and inspire children under stress and promotes playful inquiry. It is age appropriate for young children and invites touch by embedding the lights in the walls at child height.

Title: Smile Cubes.
Artist: Aesthetec Studio.
Links: project website link.

These light cubes can act as childrens’ furniture, or be stacked by children into many configurations. These create a warm glowing effect in spaces while promoting physical play and social interactions.
**Title:** Water Light Graffiti.

**Artist:** Antonin Fourneau.

**Links:** [video link](#).

Figure 7. Water Light Graffiti. (Fourneau, 2017).

This installation promotes free play drawing and painting, using only water as the “paint”. Here people are encouraged to co-play across the surface, using a novel water-based interaction that relates to themes in natural sciences and environment.

**Title:** Marshmallow Clouds.

**Artist:** Tangible Interaction.

**Links:** [link to video](#) and [link to project website](#).

Figure 8. Marshmallow Clouds. Source: photo provided to researcher by artist, courtesy of TIFF, 2015.

Marshmallow Clouds are inflated ‘clouds’ that light up when people pass under. Aside from bringing warm colours and a sense of child-like whimsy into the space, it promotes physical play and often inspires co-play amongst parents and children and other people who approach it.
Teachers at the preschool envision a light installation supporting dramatic learning activities and community performances. This installation, designed to support performances. Of interest to stakeholders, the artist notes this installation “simultaneously forms an urban wall with the ability of creating an intimate space” (Skouboe, 2013).

This installation allows a wide range of play, allowing tactile interactions, co-building, and open-ended directions for interpretation through colour and shape. These lights can change colour through touch, and be arranged in any way, allowing children to explore shapes and patterns through free-form visual composition and self expression (Coelho, 2017, p. 1).
Title: Sound Clouds.
Artist: Tangible Interaction.
Links: project website link.

Figure 11. Sound Clouds. (Beim, 2011).

Sound Clouds combines audio with an abstract ambient light installation inspired by themes of nature (the winter rain of Vancouver). Sound Clouds encouraged physical play and discovery as well as augmenting the space through a playful visual and auditory atmosphere.

3. METHOD

This research is intended to inform stakeholders redesigning a preschool. It is not within the scope of this research to create or recommend final concepts; rather it is to begin exploring the design implications of an interactive installation for those who will continue this research. This is done through the methods below:

3.1 Literature review

This project began with a literature review to become sensitized to the social issues relating to immigrant families in schools, play behaviours, and how these relate to lighting.

3.2 Participatory design workshops

Participatory design methods were used to bring diverse stakeholder perspectives together with design considerations. This is only the start of research on an ambient light display, for a preschool that is still in the preliminary design stages. Binder et al note that co-design methods are “a way to meet the unattainable design challenge of fully anticipating or envisioning use before actual use takes place in people’s life-worlds” (Binder et al., 2011, pp. 157-8). Brandt, Binder and Sanders suggest this is done through participation with the community so their perspectives go “hand in hand with the making of things that make the community imagine and rehearse what may be accomplished” (Brandt, Binder & Sanders, 2012, p. 148). Participatory design workshops involved stakeholders in imagining possible futures.

Rehearsing these futures involved the use of Star and Griesemer’s concept of boundary objects (1989). Brandt et al. explain boundary objects “are to be understood as objects that can give
meaning to different participants even though that they have different professional practices and professional languages” (Brandt et al., 2012, p. 148). Brandt et al. note boundary objects act as social bridges, “incorporating different interest groups so that they can contribute to the design process” (Brandt et al., 2012, p. 149). In this research, an interactive light tool and accessory materials became boundary objects for enacting play and lighting scenarios, see section 4.3.1.

3.3 Annotated videos

Prior to each stakeholders meeting, annotated videos were created to sensitize the participants to the possibilities of children’s interactive light installations and to demonstrate use of the boundary objects.

3.4 Hardware & software sketching

To allow participants to share their visions of lighting in real time, hardware and software sketches were produced. These resulted in interactive lights that could be manipulated with hand-held controls, allowing participants to engage in real-time enactments. Buchenau and Fulton Suri (2000) describe this as experience prototyping: “a form of prototyping that enables design team members, users and clients to gain first-hand appreciation of existing or future conditions through active engagement with prototypes” (Buchenau and Fulton Suri, 2000, p. 424).

Further to prototypes and stakeholders, Horst and Matthews observe that the required technical skills can be barriers to participation (2016, p. 632). They define the live prototype as “an interactive prototype that permits real-time modifications to its interactivity within a collaborative session” (Horst and Matthews, 2016, p. 632) in order to “serve as platforms for active involvement and participation in the development process with different stakeholders” (Horst and Matthews, 2016, p. 641). The light tool developed in section 4.3.1 is a live prototype that allowed multiple simultaneous participants real time involvement in concept exploration.

3.4.1 Sketching open-endedness in live prototype design

Designs for play must be sensitive to style of play. Bekker et al.’s lens of open-ended play (Bekker et al., 2014, pp. 267-8) is applied in the designing an interactive light tool, seen in Figure 14. Bekker et al. describe open-ended play experiences as a balance between completely open free play and games that have rules, where there may be some structure, but by leaving some aspects intentionally undefined, children can have more control in how they interpret and respond (2014, pp. 267-68). She states that in open-ended play, “rules and goals are not predefined by the designers but become meaningful during play” (Bekker et al., 2014 pp. 267-68), and that designers must decide on the balance of structure. The content of this light tool is undefined colour and animation, to allow children of diverse cultures and learning styles open interpretation (see section 2.3).

Gaver et al. advise designers should not strictly enforce structure in the design (2007, p. 6), but rather consider that “ludic designs must somehow encourage people to create and explore for themselves” (Gaver et al., 2007, p. 6). Gaver et al. caution “designs to support ludic engagement must offer situations and resources that people can appropriate themselves, flexibly and provisionally, through their actions and interpretations” (Gaver et al., 2007, p. 6). This perspective
relates directly to the population of Örkelljunga preschool through the findings of Chita-Tegmark et al. who discuss how different cultures interpret things differently (Chita-Tegmark et al., 2011), and further supports constraining content to be abstract and non-figural.

3.5 Field observations: the Örkelljunga preschool

A forty-eight hour site visit observed the daily cycles of the school to become attuned to the needs of the community. A co-design workshop is described in section 4.1.4. In addition:

1. Interviews were conducted with a teacher.

2. Parametric design techniques were considered through time spent immersing in the local environment to gather possible themes for an installation. The preschool playground boasts an abundance of natural features, and Brewer, Williams and Dourish find that situational context is important in designing ambient displays (Brewer, Williams and Dourish, 2007). They note:

   [n]aturally occurring sources of ambient information are in a sense ideally suited for their situations. Both the sound of rain and shadows from the sun are inherently wed to their location; hearing rainfall means that it is raining right here. They are integrated into their surroundings, or rather, they constitute the surroundings.
   (Brewer, Williams and Dourish, 2007, p. 4)

3.6 Expert interviews

Best practice interviews were conducted with leading developers of childrens’ installations.

3.7 Design diaries

Design diaries allowed interviews, field notes and ongoing sketches to be captured, seen in Figure 12. Annotated design sketches and notes could thus benefit from the design synthesis process of Kolko’s abductive thinking (Kolko, 2010) wherein diverse information sources and diagrams externalized alongside each other could “push towards organization, reduction, and clarity” (Kolko, 2010, p. 15).

Figure 12. Pages of design diaries capturing interview notes, sketches and design synthesis.
3.8 Ethical considerations

In her *Frameworks and Ethics for Research with Immigrants*, Hernandez, Nguyen and Saetermoe present a variety of the ethical considerations in field research concerning immigrants and their children (Hernandez, Nguyen & Saetermoe, 2013). These range as broadly as being mindful of the “heterogeneity of immigrant lives, adequate representations of immigrant communities, and researcher privilege” (Mahalingam, 2013, p. 25) to “the need to ensure the safety of research participants, retain the integrity of their experiences, and uphold methodological rigor” (Nguyen, Hernandez, Saetermoe & Suarez-Orozco, 2013). Nguyen, Hernandez, Saetermoe & Suarez-Orozco (2013) caution researchers must be attentive to linguistic heterogeneity and possible migration-related sensitivities that could be impacting immigrants both psychologically and physically (Nguyen et al, 2013, p. 3). Cultural probes (Gaver, Dunne & Pacenti, 1999) or interviews could have been helpful to gain a sense of immigrant families’ perspectives, however, between the ethical concerns and the time constraints of this research, the decision was made early on to avoid interaction with immigrant families.

3.9 Project plan

The design process was structured around co-design sessions with stakeholders, following a path of becoming sensitized to the issues, doing preparatory work for each session, hosting each session, and design synthesis. Figure 13 illustrates process flow. Descriptions of each step are available in sections 3 and 4.

Figure 13. Process Plan. Click this link to view an expanded version of this diagram.
4. DESIGN PROCESS

This section will report on the design process and synthesize outcomes from:

1. A site visit to Örkelljunga preschool.
2. Expert interviews.
3. A co-design workshop with architects and a health sciences researcher.

4.1 Örkelljunga two-day site visit

A two-day site visit to Örkelljunga preschool was planned, involving the following steps.

4.1.1 Pre-work: workshop design

This site visit included plans for a participatory design session meant for one to three teachers, but upon arrival—at the request of the teacher—this was adapted to one teacher, and preschool children. The intent of this workshop was for adult participants to imagine how interactive lights can shape social experiences within the common space. This workshop was structured to a) help participants imagine scenarios and b) for each, discuss what they envisioned while enacting using an interactive light tool described in Figure 14. E.g., a scenario prompt would be given: “it is early in the morning”, and then participants discuss while animating the light tool in ways they felt appropriate.

4.1.2 Pre-work: hardware and software sketching of live prototype

An interactive light tool was constructed to allow participants to express their visions for lighting behaviours. Bekker et al.’s lens of open-endedness relating to play (2014) informed the design of this tool. Bekker et al. suggest that leaving experiences undefined allows end users freedom to imagine and interpret (2014, pp. 267–68). Using this light tool, participants could alter three traits in ambient interactive light installations: colour, size and movement. In line with Gaver et al.’s advice to leave room for exploration in ludic designs (Gaver et al., 2007), rather than dictate rules or the meaning of colours, this tool allows participants to decide what playing with arrangement, colour, size, and movement means. This open-endedness is hypothesized herein as also allowing for diverse interpretation based on culture or learning style (see section 2.3). The video in Figure 14 show the ways this light tool embraces open-endedness.
This prototype was constructed using open source hardware and software sketching tools described in Figure 15. Arduino handled input, while Processing handled animation. A Fadecandy light controller acted as a layer between Processing and LED strips to send data in a way that allowed the lights to be separated physically while connected in the same display space.
4.1.3 Pre-work: stakeholder sensitization

An annotated video was sent in advance to sensitize participants to interactional possibilities in childrens’ light installations (see section 2.6). This video demonstrated a range of differing interfaces, play behaviours, material formats, light behaviours and social contexts, as well as a demonstration of the light tool.

4.1.4 Participatory design workshop with teacher and children

The workshop intended for adults was changed at the last minute to include children. This came at the request of the teacher who proposed it would be fun for the children and germane to research.

This brought the chance to test open-endedness in the light tool design and see how this directly related to childrens’ play. The children were diverse in makeup, with both girls and boys, as well as Swedish and many nationalities represented in immigrant students. Two play sessions with the light occurred, one with a group of seven children aged 3-4 years, and another group of seven aged 4-5 years. To test whether open-endedness would stimulate children to project their own imaginations on to what was happening in the lights, no specific explanation was given to them, and they were encouraged to play freely, but were asked to describe what they imagined. The children found the light tool engaging and spent time sharing the controllers, becoming engrossed in the ways they could manipulate the lights. Due to limited space, the light configuration was fixed in a triangular shape, seen in Figure 16.

![Figure 16. Layout of light tool at co-design session.](image-url)

Students were free to play with the lights and share with the group what they imagined. Some children imagined a game, others thought they were flying planes or helicopters. The teacher (Ann-Christine) made various sized light blobs and colours and asked the children what kind of animals they might be. See Figure 17 for a video reenactment of several play results.
When seeing a tiny red dot, one girl thought it was a ladybug, another girl found a yellow dot to be a spider, and a larger yellow dot to be a very large spider. In this fashion, a small green line became a grasshopper to one child, and a frog to others. The children went on independently in this way coming up with their own creatures ranging from wriggling blue worms to green kangaroos that jumped across the displays. Ann-Christine suggests to the children that they can make the lights look like a rainy day, and the children take turns doing this. The children carry on making other weather types.

The older group had more language ability and were able to pick up the concepts and share their thoughts more easily. The children again liken it to vehicles and games, but they also assign significance to the intersection point and ends of the triangle, noting how the vertex was the ‘goal’ or scoring area they needed to reach, at other times racing around the perimeter to be on one side or another. The children decide it is a fun game to use this point to make blue and purple ‘kiss’ in the joint where the lights come together.

Some of the children become engrossed in changing the colours to suit their whims, while other children find the interplay of the two lights mimics their outdoor physical play, with one child stating “we are pretend fighting like on the playground”. After leading another weather enactment, we play a game with the children, drawing pictures of food and then they collaboratively act out what the foods look like on the lights. E.g., when shown a picture of a strawberry with a small green leaf and a large red berry, two children adjust their controls to make a small green light atop a big red light, which becomes a fun game that the children carry on independently.

To stimulate thinking about movement, the older group of children were shown pictures of animals and asked to use the lights to show the class how they might move. A crab becomes a medium sized red light blob that (with sound effects from the child) moves back and forth, while a fish becomes a long blue line that swooshes smoothly around the triangle shape.
4.1.4.1 Co-design with Ann-Christine

During these sessions, Ann-Christine is inspired with ideas on how she could incorporate the light tool into her lessons and the school common space.

She notes:

1. This would be useful for their lessons on colour, and that it would be a stronger link to pedagogy if children could discover colours outside and transfer them in the lights.

2. She envisioned this as a large wall-sized area for many social and pedagogical purposes. For the wall-sized light, she described how the lights could mimic the outdoor weather; how in the morning times the colours could be warm and calm for the parents who have had a tough morning. She also noted how it can support them as dramatic lighting when they do role playing.

3. She also felt there was strong potential for lights to be embedded into the floor to stimulate discovery and exercise.

4.1.4.2 Insights from co-design session at preschool

A table synthesizing observations from this session into design insights is found in Appendix C. These insights (Appendix C) reveal findings related to open-endedness stimulating play, how the configuration of the light tool impacted play metaphors, usability issues, and interface linking to pedagogy.

4.1.4.3 Workshop conclusion

This co-design workshop revealed ways a light installation can stimulate social and play activities within the common space of the new school. Including children in the session was revealing about how open-endedness can stimulate childrens’ play behaviours, which can in turn be linked to developmental and social goals at the school.

- Bekker et al.’s influence of using open-endedness in design (2014) with respect to the light tool proved effective in activating the childrens’ imagination in ways that were open to any interpretation. Despite constraining to only colour, size and movement, the children (of diverse cultures) still imagined and enacted improvised scenarios for what the lights might represent.

- Both teacher and the children imagined this being a larger wall-sized experience. The teacher in particular listed positive impacts that a larger ambient light installation could bring to the social atmosphere, but also imagined desirable play behaviours that light strips embedded into the architecture could bring. There is potential for the installation to incorporate both these elements.
• The live enactment light tool proved generative. Future workshops should continue to use this tool, but it could be adapted to address more reconfigurability and be smaller.

• Child-appropriate materiality and pedagogically-grounded interface choices need to be further considered (e.g. using colour as an input to link interface to pedagogy).

4.1.5 Site observation

Child drop-off / pick-up times were observed to gain a sense of the interactions of immigrant and Swedish families with the teachers. The preschool entranceway most closely resembles the social dynamic of the proposed common area of the yet-to-be-built school; here external community members share the space with teaching staff. A table synthesizing observations into design insights is found in Appendix D. These insights (Appendix D) reveal findings related to lighting at times of day; stimulating play during pickup times; and a possible need for screen-based content.

4.1.5.1 Site observation of the outdoor environment for parametric design openings

Figure 18 illustrates the natural landscape of the Örkelljunga preschool playground. An abundance of trees and skyline vistas dominate the view, while hills create many high and low play areas providing opportunities for discovery and physical activity. The children engage in many different forms of play here ranging from rough and tumble to social role playing both alone and in groups, using many types of play equipment. These natural elements are ripe for consideration as parametric design inputs (see section 3.5). A table synthesizing observations into design inspirations is found in Appendix E. These inspirations (Appendix E) relate to how themes of nature, time, and playground activity can be linked to display content.

Figure 18. Views of the Örkelljunga preschool playground.
4.1.5.2 Conclusion on parametric input design openings

Using the natural environment of the Örkelljunga playground (e.g. trees and clouds) is an obvious choice rich with creative potential that links to lessons teachers lead outdoors about the environment. The software developed for the interactive light tool used in the workshop could be modified to demonstrate how data sources such as video of trees swaying or clouds moving could be rendered dynamically into ambient light animations.

4.1.6 Interview with teacher about preschool pedagogy

An interview was conducted with the teacher to become sensitized to pedagogical goals. Time constraints did not allow for an in-depth curriculum review, however Ann-Christine provided an overview (see Appendix F for an interview transcript). In addition to standard preschool themes (e.g. language, counting, colours, nature, motor skills), emphasis is placed on foundations of social development the children need to serve them as they grow older (e.g. sharing, friendship).

A table synthesizing these learnings into design insights is found in Appendix G. These insights (Appendix G) reveal findings related to how themes of friendship can play into colour mixing; how the installation needs to remain flexible for teachers to reprogram colours; and how floor exercises might inform installation design.

4.1.6.1 Conclusion of interview on pedagogical goals

There are many themes that can be incorporated into a potential play activity, but importantly:

1. Interface and interaction choices should promote or stimulate social development regarding sharing, cooperation, and collaboration.

2. Any ambient light display must be flexible in use to let teachers easily reprogram it to accommodate any lesson they see fit to incorporate light and colour into.

3. Many lessons are taught through role-playing and simple dramatic enactment, which can be supported positively through a re-programmable ambient light display.

4.1.7 Interview with teacher about times of day

Having spent two days observing the school, and sensitizing the teacher to light installations, an interview was conducted on how times of day influence school social dynamics. Examples of social scenarios were prepared beforehand, and the teacher was asked to come up with context-appropriate things the light installation might respond with.

These prompts were discussed in person, and Ann-Christine provided written input following the visit. The prompts were meant as ‘inspirations’ to stimulate imagination. Ann-Christine solicited the input of another teacher and combined their responses, available in Appendix H.
Her answers address many scenarios, but key design insights include:

1. During the early morning drop-off time, ambient light can play a role in helping parents feel calm during what is a stressful time.

2. Ann-Christine strongly encourages elements of co-play, co-creation, co-building with parents, as well as allowing children to write and draw freely onto the light installation (e.g. drawing letters).

3. Ann-Christine feels that musical elements could be helpful.

4. An ambient light installation can support and augment their lessons.

4.1.8 Conclusion of site visit
This research trip provided valuable insight into the design of an installation that can stimulate children’s play behaviours and social connections, and revealed some factors related to accessibility. More information is needed regarding the spatial layout and constraints before further conceptualization can begin. This section will summarize insights gained from this trip and list next steps.

Methodologically, the pre-sensitization video proved useful in giving the participant a repertoire and shared reference they can use in discussions. Use of this technique will be continued. The development of an interactive light tool supported enactment and proved generative in co-design sessions.

This research has shown potential for three different media elements.

1. A wall-size interactive light installation that could:
   1. Provide a social atmosphere sensitive to times of day.
   2. Do so by acting on parametric inputs linked to the natural environment.
   3. Be controlled and reprogrammed by teachers in learning activities.
   4. The suggestion of adding music has potential from the perspective of the teacher, however due to time constraints it will remain outside of the scope of this research.

2. An open-ended playful light experience that can be embedded into walls and floors to stimulate play, discovery and movement.

3. Screen based content:
   1. Culturally relevant education videos that teachers can use with parents who do not speak Swedish or English.
   2. Sharing pictures and cultural materials to promote cross-cultural sensitization in a public display space, as recommended by Gonzalez et al. (2014).
Figure 19 illustrates how each might stimulate social development.

The following summary of insights can inform continued development:

**Childrens’ play:**
1. Open-endedness in content stimulates imagination and play.
2. Neutrality in form might increase cross-cultural accessibility.
4. Contiguous, clear sight-lines are important for this age range.

**Interface:**
1. Further exploration of materiality and the space itself is needed.
2. Interface choices can and should be grounded in pedagogical goals.

To further explore the form, scale and interface of this installation, a co-design workshop will be led with the architectural team redesigning the school. Given the success in acting as a generative research tool, the light tool will be iterated upon and used to lead discussion.
The interactive light tool must be adapted in the following ways to do this:

1. Colour sensing can act as an example of how interface can be linked to pedagogy. This will demonstrate the relationship between interface, space and social dynamics.

2. To allow participants more variation in configuration, shorten the length of each light and introduce a third segment.

3. Some material options should be gathered to test how they mediate the light (e.g. how they diffuse brightness, and how they might inspire child-friendly interfaces).

4. Develop software sketch illustrating the visual effects of parametric inputs such as clouds and trees moving.

4.2 Industry expert interviews

Three interviews were conducted to get best practice insights from internationally acclaimed designers of childrens’ interactive installations. Insights are summarized in the conclusion, and transcripts are included.

4.2.1 Aesthetec Studio

Ann Poochareon, Principal of Aesthetec Studio, specializes in developing interactive installations and digital products for young children. Aesthetec Studio has developed installations internationally at museums, festivals and sciences centres. Ann provides recommendations below on interaction design elements and play styles suited for childrens’ installations. The transcript is available in Appendix I.

Ann recommends:

On interface:

1. Tactility is important.
2. Keep actions and reactions simplified.
3. Interaction has to provide rewards.
4. Children become bored with and abandon things they cannot figure out.
5. Interfaces should be simplified, although she notes that increasingly this age group is versed in multi-touch.
6. Interfaces should be sized appropriately for children and that children quickly identify things that have been sized intentionally for them.
On styles of play:

1. “Run and move is the best thing…it expels energy and parents are happy afterwards…next to that is hand-on interaction…playing with balls or blocks, building things, etc. Also costume and pretend play is big. Simple ideas like musical stairs (notes play when you run up or down the stairs), light up floor, etc. are my first thoughts” (A. Poochareon, personal communication, April 11, 2017).

2. Ann believes tactility and play is more important than use of technology and advises installations need not be digital.

4.2.2 Anthony Rowe

Anthony’s studio Squidsoup has created internationally acclaimed light installations for museums and festivals and is also an interaction design researcher (formerly with the Oslo School of Architecture Centre for Design Research). The transcript of this interview is available in Appendix J.

On the social effects and architectural use of light installations Rowe makes works that are intentionally abstract, finding they can be “mesmerising, entrancing, uplifting” (A. Rowe, personal correspondence, May 12, 2017), and have an ability to “augment and transform spaces in a way that is effective, highly controllable and with no moving parts” (A. Rowe, personal correspondence, May 12, 2017). Sharing insights related to multicultural settings he states “non-lingual attributes of this type of work create a shared experience that can be explored through any form of communication, so …it can help with any language barriers and other issues” (A. Rowe, personal correspondence, May 12, 2017).

Rowe speaks at length about the relationship between light installations and social experience:

[O]ur works are highly social - Submergence, for example, casts light on everyone’s faces, placing people in a SHARED yet slightly strange, and beguiling, environment.

...We've had impromptu parties occur...as well as long periods of sustained contemplation.

...We had some visits by severely disabled kids - it went incredibly well, their carers were very impressed by the effect the work had on their charges.

...I noted two forms of behavioural response - contemplative (wow factor, oo ahh, lying on the ground, as you’d expect in an immersive piece) and social: which often seemed to occur spontaneously, mainly I guess as people there have a shared experience. Social media responses from our installs back this up.

......The level of immersion can be easily controlled and altered using ambient light levels.

(A. Rowe, personal correspondence, May 12, 2017)
4.2.2.1 On parametric design

On parametric design as a technique Rowe states “[a]nything that grounds a work in the real world can only help people understand/feel it” (A. Rowe, personal correspondence, May 12, 2017). Citing how his studio used wind speed and direction in their work Aeolian Light, Rowe found this created a “multimodal connection - you could feel the wind, and also see it as it blew digital artefacts through the installation” (A. Rowe, personal correspondence, May 12, 2017) which links to accessibility-related findings on the needs of diverse learning styles and multimodality. Supporting parametric inputs as an effective way to combat an installation feeling predictable; Rowe adds the use of this type of input means “the space remains the space, but it becomes an ever-changing environment” (A. Rowe, personal correspondence, May 12, 2017).

4.2.3 The Strong National Museum of Play

The Strong is considered a world-leading childrens’ museum and houses the Brian Sutton-Smith archives of play research. The Strong offers “100,000 square feet of dynamic, interactive exhibit space” (The Strong National Museum of Play, 2017), making them ideal consultants for an installation in the Örkelljunga preschool. JP Dyson, Vice President for Exhibits, as well as Deborah McCoy, Assistant Vice President for Education have offered best practices. The transcript of this interview is available in Appendix K.

To learning specialist McCoy, “role play and physical play are very important” (D. McCoy, personal correspondence, May 10, 2017). On designing installations related to these, Dyson describes “Howard Gardner’s Theory of Multiple Intelligences to be a useful framework for exhibit design” (J. Dyson, personal correspondence, May 10, 2017). Seen in Figure 19, Gardner theorized multiple human intelligences (Gardner, 1989), each of which bring “the capacity to solve problems or to fashion products that are valued in one or more cultural settings” (Gardner, 1989, p. 5). Gardner (1989) conducted a study with preschool children to assess them on activities such as story telling, drawing, singing, calculation, etc (Gardner, 1989, p. 8), which led him to conclude that “children ranging in age from 3 to 7 do exhibit profiles of relative strength and weakness” (Gardner, 1989, p. 9). Applying this to design, Dyson advises “it’s a matter of figuring out what a developmentally appropriate level is for that interactive [exhibit] that calls on musical intelligence, bodily-kinesthetic intelligence, etc” (J. Dyson, personal correspondence, May 10, 2017).
4.2.3.1 On the interaction design of accessible children’s installations:

1. Children of this age fail to understand interfaces that require reading (J. Dyson, personal correspondence, May 10, 2017).

2. Dyson advises that designers should be mindful of how different affordances can shape types of play, and suggests promoting open-ended play is best (J. Dyson, personal correspondence, May 10, 2017).

3. Dyson advises to avoid sharp edges and to soften any areas that children might bump their heads through padding or upholstery (J. Dyson, personal correspondence, May 10, 2017).

4. Dyson advises surfaces must be cleanable, stating “avoid painted wood surfaces anywhere where there will be a lot of traffic, so use HDPE or non-painted wood surfaces” (J. Dyson, personal correspondence, May 10, 2017).

---

TABLE 1

<table>
<thead>
<tr>
<th>Intelligence</th>
<th>End-States</th>
<th>Core Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical-mathematical</td>
<td>Scientist</td>
<td>Sensitivity to, and capacity to discern, logical or numerical patterns; ability to handle long chains of reasoning.</td>
</tr>
<tr>
<td></td>
<td>Mathematician</td>
<td></td>
</tr>
<tr>
<td>Linguistic</td>
<td>Poet</td>
<td>Sensitivity to the sounds, rhythms, and meanings of words; sensitivity to the different functions of language.</td>
</tr>
<tr>
<td></td>
<td>Journalist</td>
<td></td>
</tr>
<tr>
<td>Musical</td>
<td>Composer</td>
<td>Abilities to produce and appreciate rhythm, pitch, and timbre; appreciation of the forms of musical expressiveness.</td>
</tr>
<tr>
<td></td>
<td>Violinist</td>
<td></td>
</tr>
<tr>
<td>Spatial</td>
<td>Navigator</td>
<td>Capacities to perceive the visual-spatial world accurately and to perform transformations on one’s initial perceptions.</td>
</tr>
<tr>
<td></td>
<td>Sculptor</td>
<td></td>
</tr>
<tr>
<td>Bodily-kinesthetic</td>
<td>Dancer</td>
<td>Abilities to control one’s body movements and to handle objects skillfully.</td>
</tr>
<tr>
<td></td>
<td>Athlete</td>
<td></td>
</tr>
<tr>
<td>Interpersonal</td>
<td>Therapist</td>
<td>Capacities to discern and respond appropriately to the moods, temperaments, motivations, and desires of other people.</td>
</tr>
<tr>
<td></td>
<td>Salesman</td>
<td></td>
</tr>
<tr>
<td>Intrapersonal</td>
<td>Person with detailed, accurate self-knowledge</td>
<td>Access to one’s own feelings and the ability to discriminate among them and draw upon them to guide behavior; knowledge of one’s own strengths, weaknesses, desires, and intelligences.</td>
</tr>
</tbody>
</table>

Figure 19. Gardner’s seven intelligences. (Gardner, 1989, p. 4)
4.2.3.2 On designing for diverse cultures:

On designing childrens’ installations in multicultural settings, Dyson and McCoy were asked for recommendations. McCoy found the design strategy of restricting content to non-figural colour, size and movement to allow open interpretation made sense to her (D. McCoy, personal correspondence, May 10, 2017). While this is not conclusive evidence of supporting diverse cultural environments, given McCoy is an expert in play-based learning in preschools and that she felt this hypothesis had merit presents an argument for continued inclusion.

4.2.4 Design insights from interviews:

a. Physical play and socio-dramatic play seem to be the ideal play types for preschool children.

b. Multi-modality in engagement, and openness to many learning styles and abilities is key.

c. Several recommendations related to safety, material and childrens’ interactional abilities can inform the architects.

d. Rowe’s findings on parametric ambient displays are comparable to many of the desired social outcomes of the Örkelljunga preschool common space. Rowe presents compelling arguments for architecturally integrated parametric displays, citing benefits of low maintenance, high engagement and evergreen variability grounded in natural themes linked to the preschool (A. Rowe, personal correspondence, May 12, 2017).

e. The design constraints of non-figural colour, size and movement as a way to increase range of interpretation will be applied moving ahead.

4.3 Participatory design workshop with architects and health sciences researcher

The previous workshop in Örkelljunga showed need for three possible media elements in the preschool common space (see Figure 19): a large ambient light display, a simple play piece for children, and a television screen. A co-design workshop with architects redesigning the school was conducted to explore integrating these into the preschool common space. This section describes preparation and outcomes.
4.3.1 Pre-work: prototype development

The light tool used in Örkelljunga was adapted to discuss spatial and material possibilities with the architects, see Figure 20, video of second light tool iteration.

Figure 20. Video demonstrating spatial and material flexibility of second iteration of light tool. Click this link to play video.

The light tool was adapted to be more flexible in use:

1. A third light segment was incorporated to increase spatial possibilities:
   
   a. The lights could be arranged to simulate perimeters, moved horizontally or vertically in relation to each other, or be separated entirely.
   
   b. The third strip of lights was made flexible, for discussing how light might behave around curved architectural features or furniture.
   
   c. A fabric shell was made for this strip to serve flexibility, act as diffusion, and also to suggest many material options.

2. A display system was designed that allowed all segments to be gathered and arranged into one display vs. many segments.

3. To address material variability, a trip was made to the STPLN community makerspace in Malmo which collects recycled materials from local factories for use in children’s activities. The intention was to increase the range of the light tool to act as boundary object (Star & Greismer, 1989) by having different shapes and textures of materials available to pretend with (see Figure 21).
4.3.2 Pre-work: stakeholder sensitization

Two short annotated videos were sent to participants in advance. One video demonstrated light installations across diverse formats (see section 2.6), and a second video demonstrated use of the light tool.

4.3.3 Workshop with Architects

This workshop was conducted with two architects redesigning the preschool (Annika Markstedt and Ann-Sofi Krook of Chroma Architects) as well as a health sciences researcher from University of Malmo (Jenny Vikman).

The workshop was structured into four parts:

1. Introduction.
2. Children’s play with lights, and site visit.
3. Parametric themes from the schoolyard.
4. Spatial and material possibilities.

4.3.3.1 Introduction and theory

As introduction to the session, participants were presented with and discussed findings from the theory informing this research (see section 2), i.e. experiences of immigrants; the therapeutic effects of play; cross-cultural accessibility; and lighting.

4.3.3.2 Children’s play with lights, and site visit

In introducing the live light tool, participants were shown the scenarios children imagined in section 4.1.4 – e.g. how lights became insects or creatures – to stress the role of the lights as an enactment tool rather than as concept. The controls used were the same as in the prior workshop. Participants took turns playing with the lights, and were shown how children formed games around the intersection points (e.g. jumping over hills). These intersection points were arranged in many configurations to discuss possibilities and significance of each (see Figure 22).

Figure 21. A sample of the materials gathered to combine with lights.
During the play session, participants discussed findings from the site visit to Örkelljunga preschool. These discussions were intended only to sensitize the participants, however some actionable outcomes emerged:

1. Any lighting elements (theme and interface) must be linked to pedagogy. E.g., children search the environment to find coloured objects, and then use these with a colour sensor as an input to the lights.

2. The lights need to remain flexible at all times to be reprogrammed by teachers.

3. Participants found the idea of leaving form abstracted only to colour, size and animation was a sensible way to approach diverse interpretations.

4. Discussing the potential for lights to combat Seasonal Affective Disorder, this was deemed as relevant to the overall Health School research project, however one of the architects recommended that it should gradually build in intensity over time.

4.3.3.3 Parametric themes from the schoolyard

The light tool was reconfigured into single display mode to demonstrate parametric display, seen in the video in Figure 23. The participants unanimously agreed the demonstrations of clouds and trees blowing in the wind made a compelling case for using parametric inputs and ambient displays.

A table synthesizing observations into design insights is found in Appendix L. These insights (Appendix L) include a consensus on linking an ambient display to themes of nature; and discussions on how the lights might become multi-use.
4.3.3.4 Spatial and material possibilities.

This part of the workshop was intended to become sensitized to the architectural vision as well as discuss materiality in order to inform interface and interaction scenarios. Discussion centered on the preliminary sketches of the floorplans, specifically on the common space where public, teachers and children all meet, shown in Figure 24.

The floor plans were discussed in relation to ways families and teachers can come together in the common area. It was stressed by the architects that the floorplans we discussed were preliminary and could not be considered final in any way, but discussions still revealed insights relevant to the installation design:
1. The common area (at this time) connects three other spaces, wherein the overlaps of the spaces provide areas suited for what Livingston describes as nonuniform perimeter lights to create feelings of relaxation (Livingston, 2014), as seen in Figure 25.

![Figure 25](image1.png)

**Figure 25.** Illustration of placement of nonuniform perimeter lights. *N.b., this figure was prepared following the session and is only intended to illustrate a discussion concerning how Livingston’s (2014) theory of lighting placement related to existing floorplans.*

2. There was agreement that a private area for parents and teachers to watch videos on a screen (in their language) would be beneficial. Screen placement was also discussed for sharing images and symbols from diverse cultures to address recommendations about intercultural sensitization made in section 2.1.

4.3.3.5 Materiality and light

Workshop materials provided lenses on how lights and interfaces might feel, be shaped, or how the arrangement of lights could inspire play behaviours, seen in Figure 26.

![Figure 26](image2.png)

**Figure 26.** A line of green lights in the middle of this image shine through wooden veneer (acting as floor or wall). The other materials adjacent were intended for imagining other behaviours e.g. lights hiding under some areas, or tracing around curved architectural surfaces and furniture.

One concept discussed was a ‘playful path’ of lights that might wind through the spaces and help stimulate physical movement and discovery. In this case, wooden veneer was laid over the lights and participants were asked to pretend that the lights were under the floor or in the wall; see video in Figure 27. The architects advised the floors will not allow embedding strips underneath, but suggested circular LED light pots could be sunken into the floor and interspersed.
Figure 27. This video illustrates how the light tool and additional materials – in this case veneer acting as a floor or wall surface – allowed live enactment of interaction scenarios, generating a concept dubbed the ‘playful path’. Click this link to play video, note that this video requires audio.

The new school will accommodate more students, separated by age into buildings (all connected by the common room), prompting a suggestion that this ‘playful path’ in the floor might guide children to the appropriate spaces. See Figure 28 for variations on the playful path concept. The same three constraints of light, i.e. restricting to colour, size and movement, can be applied to the spots along the path, e.g. light can change in diameter instead of length, and move from spot to spot instead of back and forth as well as change colour, blink or fade.

Figure 28. Legend: 1. A child finds that as they approach the playful path, a light nearest them comes alive, and might hop to the next light to entice them to move. 2. Playful paths used as way-finding tool; each child would know what colour house they belong to, and use the lights to guide them back to their groups.

While this playful path holds promise, this concept runs counter to the finding that children have an easier time when they see clear connections between the lights (i.e. continuous or connected lines maintains a sense of causality). This concept should be tested with children to reveal if they create entirely different games with distributed floor lighting. Distributing them but maintaining simple
behaviours open to interpretation (e.g. colour, size and movement) may inspire children to create playground-style games in the vein of tag, or hopscotch, unlike the games they imagined in the light strip form.

4.3.3.6 Conclusion of workshop:

A positive outcome of this workshop was group cross-sensitization. This led to consensus that installation concepts and interfaces need to be linked directly to pedagogy and health benefits, and that technologies need to be flexible for teacher use. Conceptual openings tied to the environment were identified (e.g. ‘windows into nature’). Positive response to a parametric display linked to themes in nature may relate to Rowe’s (A. Rowe, personal correspondence, May 12, 2017) findings that using parametric themes gives users conceptual grounding to help them appreciate abstracted content.

Shortcomings of this workshop included running out of time to engage more with materiality and spatial scenarios.

Multi-use scenarios envisioning the lights as portable turned out to be a recurring theme. The participants concluded the lights should be considered as “portable multi-use tools” serving:

1. **Communication**: helping address social issues through creating atmosphere, and stimulating play and socialization.

2. **Education**: if the lights are multi-use and portable, they can be used in group lessons and activities.

3. **Community Events**: Creating atmospheric lighting for performances and other community events.

It is the opinion of this researcher that while the participants made valid points, the conclusion that the lights should be portable multi-use tools addressing both ‘on the wall’ and ‘off the wall’ scenarios requires evaluation:

1. From the perspective of installation design it may be asking too much of a concept to be all things at once, i.e. act as both ambient lighting at some times and then be movable to become activity stations at another. Physically moving the lights into diverse positions on and off of walls could become tedious and pose challenges related to wear and tear.

2. Portable multi-use scenarios complicate childrens’ interaction and interface design. The lights would have to support diverse interactions while preventing children from changing them or using them in unintended ways.

3. A permanent ambient light installation can have lasting social effects in multilingual settings, be easily embedded as architectural lighting and not require daily maintenance. Ambient installations were also seen by the architects and health scientist to have merit.
when demonstrated as parametric ‘windows into nature’, placed according to Livingston’s (2014) theory on how impressions of relaxing atmosphere can be created.

4. This issue might be solved through another stakeholder workshop. By asking stakeholders questions in the matrix of Figure 29, answers could be used to evaluate merits of either scenario.

<table>
<thead>
<tr>
<th>What if all components are movable?</th>
<th>What if an ambient display is fixed, but playful lights are movable?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>What if a play installation is</td>
<td>What if all components are</td>
</tr>
<tr>
<td>fixed but ambient lights are</td>
<td>fixed?</td>
</tr>
<tr>
<td>movable?</td>
<td></td>
</tr>
</tbody>
</table>

Figure 29, evaluation matrix to explore impacts of lighting formats.

Methodological outcomes:
The live tool was useful in that it could be reconfigured into the ambient display mode (or vice-versa) in a matter of seconds, allowing the light to reshape itself to suit the flow of discussions. It served well in discussing colours and simple behaviours in real time. Changing the shape and applying diverse materials in real time generated many design possibilities.

Materiality was discussed but time did not permit for discussion beyond those materials depicted in Figure 26; we were not able to discuss how lights might be embedded into e.g. furniture, or how materials impacted interface. Another workshop should be held on these matters.

One improvement for future workshops in this format would be the inclusion of small figurines such as LEGO figures. These would have been useful in imagining the figurines as users, and enacting scenarios.

Next steps for design.
This workshop revealed the need for:
1. Additional material and interface investigations.
2. Technology probes embedded in the preschool.
3. Further evaluation of portable lights vs. fixed installations.

Follow-up workshops with the architects should continue discussion on spatial arrangements, and materiality as it relates to both architecture and interface:
1. More spatial discussions are needed to explore questions such as, e.g. what does it mean to have paths vs. circular spots or what if the lights were in the furniture?

2. Material discussions could explore questions such as: how do lights interact with and shine through other materials, and how does this relate to play, or how does it change play when lights have hiding places?

3. The light tool used simple sliders and knobs; but as materials change, so must interfaces, raising questions such as how can children control colours or movement using only a Kinect or distance sensors? The light tool should be adapted to include differing kinds of sensors (including the colour sensor) that can act as inputs to enable experimentation.

4. As the distribution of lights change, so do the play metaphors, so in each possible arrangement, the question must be asked how does this change play?

Lastly, the concepts discussed for parametric displays, (e.g. ‘windows into nature’) are not at a stage to be further refined without field testing. Technology probes left in the preschool could be a next step.

5. MAIN RESULTS AND FINAL DESIGN

5.1 Revisiting the research question:

In this section, insights will be synthesized and the research questions will be answered.

This research was intended to give stakeholders insight into: how can a welcoming atmosphere be created for multicultural community members of a preschool that encourages playful interactions and possibly stimulates communication? While this research is still in the beginning stages of exploring this, the answer may lie in the intersection of cultural sensitivity, play behaviour and interaction design choices, see Figure 30.

![Influences On Socially Conducive Atmosphere For Orkelljunga Preschool Light Installation](image-url)
5.2 Synthesizing insights:

Insights have been gathered, however these must be shared in a simple way stakeholders can easily refer to as they continue this research. Without continued experimentation, it is premature to develop installation concepts embodying these insights, or to make broader statements on them than are made in section 5.3. However, design insights and principles should be distilled along with a sense of how they related to the core themes of this research: namely the community; play behaviour, and interaction design for light installations. Stakeholders can use these principles to inform their ideas regardless of the conceptual direction, financial constraints, or technological challenges they may encounter. To this end, Figure 31 maps these insights and principles in relation to the influences shaping a light installation (note a link is included to an expanded view below).

Figure 31. Design Principles Mapped To Situational Influences At Orkelljunga Preschool. Click this link to view expanded diagram.
5.3 Answering the research questions:
This section considers the main research and sub-questions. Recommendations are made for additional research needed in section 6.2.

*How can a welcoming atmosphere be created for multicultural community members of a preschool that encourages playful interactions and possibly stimulates communication?*

The theoretical findings, interviews and fieldwork comprising this research make a strong argument for a welcoming and playful atmosphere being created through an ambient light installation. The ways this welcoming atmosphere can be created are addressed through answering the research sub-questions:

1. **How does Örkelljunga’s community, notably its multicultural makeup, influence the conceptual or content possibilities for a permanent installation?**

Örkelljunga as a community is doing an exemplary job of welcoming and integrating a large influx of immigrant families from many diverse cultures. But the challenges faced by teachers and families in communicating without shared language are palpable. Similarly, the stressors faced by immigrant families (Adair, 2015) feel real when seen first hand. I would stress to the stakeholders that not only should the primary goal of this installation be to ease this tension and broadcast a sense of welcome, but to take heart in the many theorists who support this being an effective strategy (see section 2). From here it can build from that foundational level into stimulating meaningful, long-term social connections that will help integrate Örkelljunga’s multicultural families. Livingston and Rowe share how use of lighting can create a sense of welcome, a shared social space that brighten peoples’ lives (2014; 2017). But even lighting must contend with how cultures simply interpret content and colour differently (Chita–Tegmark et al., 2011, Livingston, 2014). This research tested a hypothesis informed by open-endedness in design (Bekker et al., 2014; Gaver, 2007) that the multicultural makeup of the preschool influences content possibilities towards using abstracted content limited to colour, size and movement. Theoretical insights also show that this multicultural makeup means even more reason to design playful behaviours into the space as play has the power to transcend cultural divides (Donaldson, 1995). Many glowing examples of installations in a similar vein to both abstract content and play behaviours (see section 2.6) can offer proof that these installations truly create a feeling of “special place” and can set a bar for those carrying on this research.

2. **How can playfulness help encourage social connections?**

Having spent two days playing with the children of the Örkelljunga preschool, I find no reason to argue with the host of theorists in section 2.2 espousing the role that play takes in building social connections. I played, pretended, sang, danced, role-played, rolled on the floor, held hands, learned new words, ran screaming around the playground, fought epic play fights, and in each case I went in a stranger but left with a new (remarkably: non-English speaking!)
friend. The playfulness and colours of the light tool alone were enough for me to be transformed in the children’s minds from “who is this strange grown up” to earning almost immediate legendary status, because the lights were truly magical to them. The children could not get enough of playing with them, and they exhibited many styles of play even while sitting in one spot (section 4.1.4). Aside from this, parents often come to the school with siblings in tow and they have nothing to do – and children this age do not need a similar culture to begin playing together. Having a play installation in the common space of Örkelljunga doesn’t even have to be digital to hear it from Poochareon (A. Poochareon, personal communication, April 11, 2017) who has designed countless childrens’ play experiences, so there is no excuse for this not to be incorporated as a lasting social intervention.

3. How can diverse abilities, learning styles and cultures be served?

Having been sensitized to the theoretical exploration and community of this research, it is my sense that serving diverse abilities, learning styles and cultures comes first from a place of acceptance that we are all different. And then a recognition that supporting these differences is hard; but lastly, that it is absolutely vital if we are to make a difference in the lives of the people we are ostensibly trying to help. Making assumptions about how anything is interpreted or used seems to always be proven wrong (at least in this researcher’s case), and this is complicated by how the possibilities for better serving all these diversities seem enormous.

This said, many theoretical (see section 2) and best practice recommendations (see section 4.2) have been presented, and seem like solid footing for this installations’ continued journey on the path to being accessible in design. An overwhelmingly positive reaction in the co-design session from children of many cultural backgrounds (who did not all share languages) may mean that the constraint of abstract non-figural content has merit.

Diverse abilities mean we must not assume conceptual comprehension, motor skill or many other things we take for granted (Rose and Gravel, 2014; Bruckman and Bandlow, 2003) and we must always accept that children and those of different cultures and abilities see things differently than we may (Chita-Tegmark et al. 2011; Bruckman and Bandlow, 2003).

4. How might lighting impact the social atmosphere?

I witnessed first hand the alluring, magical and transformative power of light, colour and movement to transfix and inspire groups of children of diverse ethnic identities in the workshop testing the lights for play behaviours. The glow of the lights and the sound of laughter soon brought other teachers into the space to learn more. It was obvious the power light has to shape the social atmosphere of a space and echoed (in miniature) the looks of glee, wonder and social engagement seen on the faces of those playing with light in section 2.6. For the benefit of those continuing this research, they have more than just my witness account to go on. Livingston, Rowe, and others are seasoned, celebrated experts in their fields and give us reasons for assurance that an ambient lighting installation can create a transformative social atmosphere (2014; 2017). Lastly, it is possible that by addressing Seasonal Affective Disorder, lighting could even help ward off “the winter blues” (Geddes, 2017, p. 1) which may feel
compounded for those undergoing the stressors Adair describes (2015).

5. **How can parametric design principles help sustain interest in, and engagement with this installation over the long term (i.e. as a permanent installation)?**

While it may be described as “socially deprived” (U. Bengtsson, personal correspondence, 2017), Örkelljunga is immeasurably rich in natural beauty. Those lucky enough to live there take pride in the sweeping Scandinavian vistas, the natural lakes around every corner, tree lines stretching as far as the eye can see, and the abundant wildlife big and small bounding about. It is this natural beauty or situational context that Rowe (A. Rowe, personal correspondence, May 12, 2017) suggests can give a much-needed conceptual grounding for abstract displays so that people appreciate them – and what better theme than something the community already knows and loves? The preschool pedagogy is steeped in natural science and environmental themes (see section 4.1.6), and nature is always changing; there’s always something outside to see. An abstract (i.e. sensitive to diverse interpretation) ambient display can keep the common area feeling as fresh as the outdoors while tying into pedagogy and outdoor play for years to come. Those who tested the parametric ‘clouds’ demonstration of the light tool (see section 4.3.3.3) discussed it as having real potential for sustained engagement (though abstract, the content remained mesmerizing to stare at). But as will be suggested in section 6.2, bringing the skies and trees inside is only the beginning of how children could use simple sensors while exploring the natural beauty of the playground to keep the display as engaging on day 365 as it is on day 1.

6. **EVALUATION / DISCUSSION**

This main results of this research reveal many design implications for light installations (see section 5), which can in turn address social issues and aid in childrens’ development in the Örkelljunga preschool community. This research was done via co-design (and other) methods discussed in section 3. This section will analyze the final design outcomes and make recommendations for design activities addressing areas still in need.

6.1 **Evaluation of design results**

It is the opinion of this researcher and the stakeholders involved, that the results of this research embody a useful contribution to the overarching Health School regional research project (see Appendix A). The stakeholders involved (architects, a preschool teacher and a health sciences researcher) have been active contributors, and the insights presented here are actionable with respect to the design of the community space. In this respect, the research results (see section 5) are timely and appropriate in scope and form given the preliminary stage of the architectural planning.
This research supports the stakeholders’ vision for the common space to be a place of lasting social intervention. It does this by providing insights they can apply in designing for factors related to multicultural users; play; as well as accessibility.

6.2 Recommendations for design process

While some outcomes can be seen as positive, this research project operated under severe time constraints, and many areas remained unaddressed. To be of use to stakeholders, these are framed as recommendations.

1. **For the time being, the ambient light installation and a play intervention should be explored separately.** This research has revealed many uses and benefits of both ambient light installations as well as play-based light installations (see Figure 19, and Figure 31). However, it is still unclear whether creating a one-size-fits-all system can be both – see section 4.3.3.6 for the argument of respective merits and possible solutions.

2. **Continue fine-tuning the relationship between spatial, material and lighting concerns to their respective play opportunities:**

   a. Workshops have shown potential for embedding play-centric lights into the floors and walls, but the circular shape of the lights proposed by the architects will change the play metaphors. A co-design workshop at the preschool could test how children play with them. Design principles related to restricting content to colour, size and movement could be adapted to circular format. E.g., light movement would now need to be considered as moving from one light to another vs. along rails, and size might come through concentric rings vs. linear scale.

   b. Previously described in section 4.3.3.6, follow-up workshops with the architects should explore spatial arrangements and materiality as it relates to play and interface. Spatial discussions can identify areas where lights can be placed and considered for how they might shape the play metaphors.

Material discussions can inform lighting design as well as play metaphors and interface choices. In particular material workshops could engage with samples of materials recommended for children’s installations by Dyson (J. Dyson, personal correspondence, May 10, 2017).

Interfaces not only change based on spatial distribution and material, but in turn they shape play behaviours and play metaphors. The stakeholders have not yet been sensitized to a range of other inputs coming from sensors such as depth, biometric, pressure or capacitive sense, etc. A live prototype workshop with an adapted version of the light tool could sensitize stakeholders to the interactional possibilities and play metaphors of each.
3. **Technology probes:** Demonstrations of live prototypes of parametric displays were well received by stakeholders. Hutchinson et al. (2003) describe technology probes as a co-designing method employing simple technologies to meet goals of “understanding the needs and desires of users in a real-world setting...[and] inspiring users and researchers to think about new technologies” (Hutchinson et al., 2003, p. 1). Creation of a parametric display, embedded in the current preschool entrance could allow for testing over time. This may prove wrong as a design assumption, however: it may be revealing if children participate in choosing inputs over the duration of the test, e.g., children might enjoy experimenting with moving cameras or placing various sensors into the environment to see the visual results.

4. **Accessibility:**
   a. Due to time constraints, this research failed to consider the needs of those differently abled.
   b. Both interface and materiality should be considered to address the need for multi-modality in accessible designs as outlined by The National Center on Universal Design for Learning (Rose & Gravel, 2014).

6.3 **Evaluation of method**

Perhaps the most lasting positive impact this research can have comes through the cross-sensitizing process of co-design (e.g. see section 4.1.3, 4.3.2, 4.3.3.1). Stakeholders can carry on designing the preschool as experts in their fields more sensitized to how interactive technologies and experiences are linked to their practices. With respect to the use of co-design methods (see section 3.2) it is difficult to imagine any other way that so much cross-sensitization could have been imbued into the process. This method proved effective and should be continued.

The use of what Horst and Matthews describe as a live prototype was successful in informing the design process. Having access to a live demonstration tool that was easy for stakeholders to use significantly increased the expressiveness of their enactments and co-envisionment in the workshops. This research was done to explore parameters of digital interactivity in an ambient display, and so a live digital prototype was an appropriate choice vs. using static analog materials. Furthermore, applying Bekker et al.’s (2014) lens of open-endedness as well as Gaver’s (2007) advice regarding not prescribing use in ludic designs inspired the design of this tool and increased flexibility in participant interpretation and engagement.

6.3.1 **Methodological room for improvement:**

1. Due to time and ethical constraints, little was done to become sensitized to the perspectives of the immigrant families in Örkelljunga. Creating detailed personas as a methodological tool could bring insight.

2. One improvement in workshops would be the inclusion of small figurines such as LEGO figures. These would have been useful in imagining the figurines as users, and enacting various play or social scenarios.
7. CONCLUSION

This thesis contributed to the regional Health School project, specifically informing the community-building efforts of a preschool in Örkelljunga as they seek ways to improve communication among immigrant families and teachers. Working directly with stakeholders including a preschool teacher, architects redesigning the school, and a health sciences researcher, this research investigated how a welcoming and playful atmosphere might act as a social intervention in a shared community space (see section 2 and 4). Light installations were researched as a strategy for creating this atmosphere, explored through five research sub-questions intended to ground results in the needs of the community (see section 5.3). These sub-questions investigated how multicultural makeup influences design choices; how play behaviour stimulates social connections; how accessible design could serve diverse abilities, learning styles and cultures; and how lighting design and parametric design principles impact the social atmosphere over time.

The scope of this research was not to develop installation concepts, but rather to inform and sensitize the stakeholders to the possibilities and social consideration shaping the design space. Design milestones were set around two participatory design workshops (see section 4.1.4, and 4.3) using live prototypes to explore play behaviour as well as spatial and material factors, enriched by literature review, field observations and interviews. Concluding the design research process, a set of design principles were distilled for stakeholders who will continue this research beyond the scope of this thesis (see section 5). These design principles address the themes of the research sub-questions on the design space, and can be used to guide the stakeholders as they move into a conceptual development phase at a later time.

Beyond these design principles, three installation areas were identified as having potential to influence the social dynamic of the preschool:

1. an ambient light display could set a socially conducive atmosphere welcoming for immigrant families;
2. a play installation has the potential to stimulate social connections and aid in childrens’ development;
3. and a television screen has potential to serve cross-cultural sensitization purposes.

Additional interaction design research is needed to explore whether findings 1 and 2 above can be combined. Recommendations have been provided to stakeholders related to the research still needed into how play behaviour, architectural spaces, materiality, interface, as well as lighting design impact the design of said installation. Moving ahead, stakeholders will continue to develop the architectural plans for the preschool, equipped with design principles and sensitized to social and technical considerations in the design space of an interactive light installation for Örkelljunga preschool.
Methodologically this research has found Horst and Matthews’s (2016) concept of live prototypes to be a successful element in participatory design.

In conclusion this research has contributed valuable and actionable insights to the community stakeholders leading the Health School project, and it is hoped that it will have a positive and lasting impact in the Örkelljunga preschool community.

7.1 Looking ahead

While this research ends here, the project is set to continue as the preschool planning stages progress, and so some steps will be taken to help those stakeholders involved:

1. The Health School community project has noted that findings from the research into the Örkelljunga preschool will be applied to other school constructions across Sweden. This research can be distributed freely to be used as a reference by those involved in designing other preschools.

2. This researcher has volunteered time to consult the project remotely (from Canada). Research assistance, copies of code, wiring instructions and technical support for the light tool may be provided.

3. Stakeholders will be introduced to other interaction design students from Malmo University who will remain local and may be interested in assisting stakeholders in the conceptualization and design phase.

4. The stakeholders will be introduced to professional interactive lighting designers specializing in playful ambient displays should they be able to pursue conceptualization and design.

8. ACKNOWLEDGEMENTS

Firstly, this research is indebted to Anne-Marie Hansen, a design mentor and creative force of nature. This author gratefully acknowledges so many others including fearless leader and co-conspirator Jenny Vikman; the tireless and inspirational Anci Brickling; architectural visionaries Annika Markstedt and Ann-Sofi Krook; David Cuartielles (who is far cooler and more brilliant than I will ever tell him lest it go to his head); master designer and builder: Mattias Nordberg; and to Anne-Marie Hansen, Per Linde and Per-Anders Hillgren for setting me on a life-long path of co-design.
9. REFERENCES


Appendix A Health School in Örkelljunga background

Health school in Örkelljunga background

(Author: – URSULA BENGTSSON, CEO MultiHelix,
HEALTH SCHOOL PROJECT LEAD)

Work has been initiated to be part of the construction of a new health school profile in Örkelljunga. Örkelljunga municipality is in the planning stage for constructing, in the first stage, a pre-school and later planning for 1-6 school that could be a model for how knowledge / research can be utilized in society. A kind of "living lab” in schools provides an opportunity to develop new ways to meet the challenges that the future society is facing.

The idea is to build in sensors, measurement technology, eHealth in everything. The foundation is to work with a socially deprived area (diversity perspective) having a prevention focus (especially mental health) for our future generations. The work will be carried out in collaboration with, among others;

- Public health perspective by Region Skåne
- interdisciplinary research through the academy and
- a broad involvement of the business community of Skåne.

Some, but far from all, of the opportunities that could be relevant for the school are:

1) A school where all children, even those with different degrees of disability, can feel like part of normal everyday life together with staff and family. Where no special adaptations that distinguish children are needed but rather a working environment for everyone from the start.
LTH is working with 'Universal Design' involving, among others,
http://www.design.lth.se/the_long_view/
http://www.certec.lth.se/ud/

2) Some of the major challenges ahead are the growing proportion of mental illness among young people as well as child obesity and diabetes. A bet on the prevention of the disease can be made through the influence of the children's dining experiences, no to smoking,
alcohol and other drugs, exercise in daily life which should be as natural as learning to read and write.

3) Socially vulnerable areas with great need for integration of newly arrived children and families can be supported by, among other things active associations including various types of recreational activities. Here, social climate of innovation and entrepreneurship have great significance http://socialinnovation.se/sv/nominera-en-social-innovation/

4) We see that the children, the whole family is affected to a healthier life. Children can become health educators for their families with the right support from the school.

5) The importance of the food we eat for the prevention of disease and healthy life is a major theme of Health School. The school needs a sustainable meal concepts both commodity / nutritionally and from a perspective of being together.

6) Through various efforts to "gamification" we can meet children's need for play but also affect behavior and learning. http://skolvarlden.se/artiklar/lat-dataspelen-forma-skolan.

7) There are almost unlimited opportunities to collaborate between different actors through what is called the Connected Health, m- and e-health. Through a smartphone or tablet with access to various functions and connections to the Internet of Things can only by our own imagination set limits. The school can from the start have built-in sensors and tools that are easily accessible and useful in teaching children where their own actions becomes information that may affect the teaching and development of the business. http://skl.se/halsasjukvard/ehalsa.1067.html and http://mhbc.se/mhealth/

8) Can SFI (Swedish for immigrants) implemented with innovation?

9) Culture and education - multicultural inclusive society - lifelong learning and maintaining curiosity. How do we get there?

10) How do we include parents and others in the local community?

11) More neighborhoods following the talks.
Appendix B Concepts generated in prestudy

See following pages.
Family Wall

**Description**
Family Wall is an installation that focuses around communication between teachers, parents, and children. Every child and their family’s photo is on display in the common area with two card slots adjacent to their photo for the community to see and recognize their peers. A parent can leave an emotion in the child’s slot at drop-off to let the teacher know what the child’s emotional status is. The teacher can change it during the day so that the parent can see it at pick-up if the child’s emotional status changed. A parent can leave their emotional status if they wish to reach out and let the teacher know that they would like to make room for a dialogue to occur.

**Modality**
- Visual - Images of family, collage, feelings card
- Verbal - Teacher/Parent dialogue
- Non-Verbal - Item Exchange
- Spatial - Interacting and observing in the space
- Tactile - cards, item exchange, storage unit
- Temporal - Change over day, Annual change

**Materiality**
Permanent wall/storage structure

**Types of Engagement**
- Singular & Multi-user
- Sharing, looking
- Very structured, only open-ended in personalization

**Difficulty**
Very low difficulty requiring only a small amount of time for basic interaction (putting in cards to show feeling)

**Expanded Ideas**
- Item Exchange
- Collage Probe/ Personalization
- Storage & Check-In
- Moving Photo Interaction (includes Harry Potter style moving pictures for each kid, when one kid checks in the others would all smile and when you check out they all wave (the kids would do whatever is in their own cultural norm … so every time you check in or out, you see their gestures again)
Co-building with Velcro

Description
Create a canvas made up of velcro strips, along with various geometric shapes including strips, rectangles, circles, triangles etc. Other objects and materials can be included, such as clay, cardboard, etc. The children can build upon the canvas in both 3D and 2D, alone or preferably together. A 3D construction can be a city, a park, or a fantasy landscape. 2D can include any form of abstract creation or real life objects, animals, people etc. This can be done free form or with minimal instructions from teacher if building after a template or drawing. Encourages play, co-creation, using creativity.

Materiality
- Velcro canvas, fabric, visual projections

Types of Engagement
- Open-ended or structured
- Singular or Multi-user
- Sharing/swapping building objects (negotiation)
- Negotiation of territory (building or drawing space)
- Collaborating with peers and/or teacher
- Alternating attention (focus on own creation, see what others are doing)
- Transform the space into “creation corner”

Difficulty
Low - Medium depending on format

Expanded Ideas
- Incorporating use of projector for co-drawing (see top illustration) or projection mapping.
- Creating an exhibition space - involve parents, siblings visitors. Central piece in “third space”
- Assign themes such as nutrition, my favorite animal, etc
Building Blocks

Description
Building with Blocks allows creativity and cooperation through action. Assembling blocks in different configurations, can create a sense of completion of a task, with the purpose of building anything from a projection wall or a chair, to a house, integrating play and planning abilities to the school’s activities. Building Blocks can also have an open ended play character, and present different shapes, scales, colors, textures. With applied electronics, this activity can have other types of engaging activities, such as combining red+yellow blocks with embedded lights, to produce orange, and gain knowledge on the categories of different colours. This concept is intended for interaction in the general meeting space, engaging the different groups of users (parents, children, teachers, community in general), although applications are varied.

Modality:
- Visual - Sides of blocks can vary in pattern design, in size, in color, shape.
- Verbal - Teacher/Kid dialogue and dialogue between kids
- Nonverbal - Using blocks and through gestures
- Spatial - Experimenting with perception of scale and configuration within space
- Tactile - Sides of blocks can have different textures

Materiality:
- Medium density foam/wood/plastic
- Painted/Tinted/engraved
- Glossy/Rough

Types of Engagement:
- Singular & Multi-user
- Constructing/Adding to/Changing/Deconstructing
- Imagination/Play

Difficulty:
Low -No rules and blocks should lightweight for easy handling.

Expanded Ideas:
- Could the blocks be opened to store things
- Personalization
- Could blocks light up? Glow in the dark?
- Could specific configurations result in vibration, lights, shapeshift, as goals to a game? By exploration or through instructions...
- Blocks can be connected with magnets/velcro/joints/
- Blocks can be ‘shapeable’?
2.4 Expressions Doll

Expressions Doll

Description
A child-sized “doll” similar to the dummy used for drawing but with the added feature of a face that can be manipulated into different expressions or body language, actions, movements. Can be used as a teaching tool and a boundary object to create a common understanding about emotions, conflict situations and body language between teacher and child.

Modality
- Visual - recognizing facial expressions, limb positions, body language
- Tactile - touching, moving the body parts, modifying expressions
- Embodied - inner reflection, mimic expressions, positions, expressions/demos from teacher
- Temporal - Used in different situations, example child feeling bad, energetic, conflict resolution, game

Materiality
- Modular face features
- Flexible limbs

Types of Engagement
- Single/Multi-user
- Open-ended
- Turn-taking, acknowledging actions, feelings of others
- Learning through mimicking
- Absorbing new information

Difficulty
Low - Medium
Difficulty increases with complexity of emotions

Expanded Ideas
- Incorporate feedback depending on input
- Other forms of interactions, stroking, grabbing, pinching pushing, hugging etc.
- Creation of games around the doll
Heartbeat Sensor

VIDEO OF PROTOTYPE demonstration at Health School community workshop March 16, 2017: https://dl.dropboxusercontent.com/u/17992361/HealthSchool_PULSE%20VIDEO_.mov

Description:
The pulse sensor concept is a simple prototype meant to demonstrate to the Health School project principals how biometric feedback can be integrated into play or learning experiences. The sensor reads pulse data and is connected to lights that blink as pulses are detected. While in general this type of sensor-driven experience can help children make the conceptual link between heart rate and exercise, while embedding the added benefit of making this playful and desirable. In testing, the interactive heartbeat experience was popular and successful at stimulating and encouraging children to try running on the spot to increase their heart rate and see the feedback.

This concept as a prototype works as a proof of concept that can support conceptualizing of larger indoor and outdoor play experiences, e.g. one concept that evolved from this envisioned children “checking in” with an installation before they go out to play, and “checking in” again upon return to see how much active their hearts are; with added interface consideration being given to potentially tactile experiences such as hugging the installation to interface with the sensor, and getting pulse feedback in multi-modal capacities such as audio and haptic feedback of their pulses.

Develop an active and healthy lifestyle by cultivating good habits, and understanding basic health. Children learn about their senses and their sensory ability to explore the environment. Children learn about their bodies and develop an awareness of their five senses.

Modality:
- Auditory - pulse mapped to sound
- Non-Verbal
- Tactile- textures
- Visual -object, lights

Engagements:
- Movement and activity
- Processing of emotions through physical activity
- Bodily awareness
- The need to socialize
- Discovery, exploration, experimentation
- Handling and manipulation of objects
- Acknowledging peers’ actions

Materiality:
TBD
Visualisation of pulse

Types of Engagement:
- Singular & Multi-user
- Sharing, looking, take turns

Difficulty:
Low

Expanded Ideas:
- Feel heartbeat through object (ball) hug it...show different light colors according to pulse.
- Visual representation
- Large installation placed near entrance/exit of school so children can check their heartbeat when they leave and enter from the playground
- Check pulse placing hands on an object
Intermediary Space Interactive Light Installation

http://www.tangibleinteraction.com/artworks/sound-clouds

Description:
Field research has identified that Health School project stakeholders feel there is benefit in the concept of a ‘shared, multi-use community space’ at the centre of the school to bring together parents, children, teachers, families and the community. This shared space has been envisioned as an “ice breaker” to make immigrant parents and other community members feel welcomed into the space, and to set the atmosphere for social interaction, creativity and playfulness. Interactive light installations used in building lobbies, public settings and art exhibitions have a rich tradition of lending these types of qualities to spaces. While this idea in principal has potential, additional research is needed to be done to inform a concept so that it considers themes unique to this school – such inclusiveness and accessibility; physical / cognitive abilities for young ages; temporality (the space has different contexts at different times of day); children’s development as relates to tactility and non-verbal communication.

Modality:
- Visual - see lights / creates warm atmosphere
- Physical -
- Non-Verbal - communicates sense of emotion without words / signs
- Spatial - helps define the space
- Tactile - could be physically triggered or even tactile interfaces / interaction points , and also could be built into shapes that you could sit on, hide in, etc
- Temporal - it could set the mood in ways throughout the day appropriate to many contexts (warm / soothing in the morning, excited near end of day, can be controllable to set the stage for performances and exhibitions, can change with the seasons )
- Audio - could be sound reactive to respond to performances (like the Sound Clouds) , but since this will be in a space all the time this might be too intrusive

Materiality:
- Needs to be robust
- Needs to be appropriate to the location (not be wildly out of place or feel random conceptually)

Types of Engagement:
- Spectacle, setting the atmosphere
- Lots of ways to incorporate responding to groups and single users
- Ways to sense people in different spaces and try to bring them together
- Many sensors could be mapped to many contexts (i.e. it could also be linked to pulse idea )

Difficulty:
Low

Expanded Ideas:
Is it possible to incorporate ways you can “get better” at playing with it or controlling it? Installations like this don’t have to do everything, you can also have like a ‘smart board’ that can become part of the mix of the common room
Feelings Hat

VIDEO OF PROTOTYPE: first prototype: https://dl.dropboxusercontent.com/u/17992361/feelings%20hat.mp4

VIDEO OF CONCEPT: a co-design session with the preschool teacher https://www.dropbox.com/s/5bqwutru83nji86/Feelings%20Hat.mov?dl=0

Description:
Feelings Hat is an interactive teaching tool that a teacher can use to play with their students to recognize, respond to and enact emotions. Ideally, Feelings Hat is to be used as a pair for the participants to share how they feel with one another. This boundary object is in the shape of a crown with three light-up slots with various emoji faces depicting different emotions. These slots are attached by velcro so they are interchangeable and can be used modularly for different teaching opportunities. The lights on the crown are activated via an attached remote with corresponding images and lights. Feelings Hat has the opportunity to teach through showing, telling, and acting leading to lessons surrounding self-actualization, conflict resolution, and even storytelling through role play.

Modality:
- Physical / wearable
- Visual - uses interchangeable icons that link to feelings (might be pictures like the pics of emotion rabbits, but might be simpler, like smileys)
- Verbal - Teacher/Class dialogue
- Verbal and Physical - as part of exercise class does Telling / Enacting to respond to the acting game prompts from Ankis, and they all act along with the kid wearing the feeling hat

Materiality:
Kid-friendly - materials that kids can be very physical with and not damage.

Types of Engagement:
Social - teaching the basics of emotions through enacting common scenarios, the hats are just a teaching tool that Ankis would use to bring more attention to this, and to form a game around

Difficulty:
Low - the children just have to wear the hat and the teacher (or the student) can press the buttons on the remote

Expanded Ideas:
Ankis also developed a colored - card system with scenarios and emotions matched to different colours that she can use with kids to play as a game (with the Feeling hat, but this lets the hat be used for many contexts). The cards can have one side in color and the other white (for writing), and plastify them so that they last and one can write on the white side and erase it/rewrite as needed.

We also discussed some ideas around creating Hug Sensors and Push Sensors so she can lead a similar role-playing type exercise. She was very enthusiastic about us building these and she wants to keep them at the school.
Interactive Time Line

Description:
Time line is a daily display of Kids’ schedule located at the school’s entrance accessible to the school community. This tool helps Teacher and Parents visualize the children’s activities during the day. It can be interactive; through an app teachers can modify the schedule accordingly and keep parents informed about these changes. This open flow of information can lead to building trust between parents and teachers while promoting communication. Children can also interact with the tool so they can be aware of their daily activities in relation to time.

Modality:
- Visual - Can be a digital screen, color coded, with ‘universal’ figures displayed
- Verbal - Teacher/Parent dialogue
- Nonverbal - Pointing and gestures

Materiality:
- Plastic/digital screen/wood
- With lights
- Touch screen
- Magnetic Screen
- Types of Engagement:
  - Singular & Multi-user
  - Storytelling
  - Mobile application

Difficulty:
Low
Collage Technique

Description:
Collage is a technique that can be used at the micro and macro scale to engage children and their parents inspired by the IDEO Guide to Human Centered Design. Families can build collages together at home based around prompts such as, “What does health mean to you?” Not only does this make parents active in their children’s school activities, but also allows the child to share their family collage with their classmates. Furthermore, this lets kids go home and tell their families about how they are different or similar to their classmates, activating the children as agents of change. Collage can also be used in the classroom to create a shared environment of inclusiveness. Learn more about this technique in the IDEO Design Kit http://www.designkit.org/methods/25.

Materiality:
• Paper
• Glue
• Scissors

Types of Engagement:
• Singular & Multi-user
• Sharing, looking, cutting, pasting
• Very open-ended

Difficulty:
Low - supervision may be needed with use of scissors

Expanded Idea:
• Digital Collaborative Collage: A scanning station where anyone can create digital representations of objects that are displayed in a screen thus co-creating a shared digital collage.
• Family Wall: Collages can be displayed with Family Wall as personalization
## Appendix C Insights from Co-Design Session at Preschool

<table>
<thead>
<tr>
<th>OBSERVATION</th>
<th>INSIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Children become engrossed in changing the colours, size and movement for long periods of time.</td>
<td>OPEN-ENDEDNESS STIMULATES IMAGINATION AND PLAY</td>
</tr>
<tr>
<td>2. Children imagined many things the lights could represent in the absence of figural forms or patterns.</td>
<td>Colour, size and movement is enough to stimulate diverse imaginative play scenarios amongst children. While not conclusive as evidence, it is possible that figural forms or assigning meaning to colours might hinder diversity of play and stimulation of imagination. Constraining content to only colour, size and movement lets the children assign their own meanings and game rules dynamically, and in ongoing dialogue with each other.</td>
</tr>
<tr>
<td>3. Simple prompts were enough to stimulate collaboration amongst the children to be creative with the lights.</td>
<td>NEUTRALITY IN FORM MIGHT INCREASE CROSS-CULTURAL ACCESSIBILITY</td>
</tr>
<tr>
<td>4. This light tool stimulated imagination and playfulness in children regardless of gender or culture, though in different ways for each child.</td>
<td>While testing was limited, it is reasonable to assume constraining content to be neutral in form supports multiculturalism in that children from different backgrounds are free to interpret colour and movement however they see fit.</td>
</tr>
<tr>
<td>5. Children placed significance in the places the strips of lights joined, in one case calling reaching it a goal they should try to achieve, another driving vehicles ‘over’ the corner.</td>
<td>LAYOUT OF THE LIGHT STRIPS IMPACTS WHAT CHILDREN IMAGINE</td>
</tr>
<tr>
<td>6. They assigned significance to the point where the light bends.</td>
<td>Since the children assigned meanings to the intersection, it is reasonable to assume these can enrich play. It would be interesting to test this again with children being able to move the points of light around however they wish. If creating lights like this in the floor or wall, a ‘terrain’ or variance in the lights allows for richer play experiences.</td>
</tr>
<tr>
<td>7. At one point, the children decide it is a fun game to make blue and purple kiss in the MIDDLE POINT (they movable intersection was interesting to them, and backed up Thomas’s comments about not breaking continuity of the line / causality</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>8.</td>
<td>When one of the childrens’ lights either shrunk below a visible size, or was obscured by the other player, or moved too quickly around the triangle shape, they were not able to determine where it had gone.</td>
</tr>
<tr>
<td></td>
<td>CONTIGUOUS PATHS AND CLEAR SIGHT-LINES ARE IMPORTANT FOR THIS AGE RANGE</td>
</tr>
<tr>
<td></td>
<td>Seeing the children play and observing their comprehension abilities, the earlier theory posed by a colleague that causality in the line turned out to be the most likely. It would not work to have these separated as the little children need to follow the lights moving in continuous path. Otherwise this breaks causality for the children.</td>
</tr>
<tr>
<td>9.</td>
<td>The small controls do not suit children’s small fingers or dexterity levels (two children complained the controls were difficult to use).</td>
</tr>
<tr>
<td></td>
<td>INTERFACE: MATERIALITY AND THE SPACE ITSELF WILL BE KEY FACTORS.</td>
</tr>
<tr>
<td></td>
<td>More exploration around materiality as it relates to interface is needed.</td>
</tr>
<tr>
<td></td>
<td>Ideal interfaces may not become clear until there is a sense of how the final space being designed for the new school can allow for physical movements and group dynamics; e.g. it is not yet clear if there will be room for children to run or play.</td>
</tr>
<tr>
<td>10.</td>
<td>The interface is confusing them... they think that the sliders make them move because it moves the pixels in an expanding way, so when they try to chase the other children’s light, they just use the slider, which takes over entire light.</td>
</tr>
<tr>
<td></td>
<td>INTERFACE CHOICES CAN BE GROUNDED IN PEDAGOGICAL GOALS.</td>
</tr>
<tr>
<td></td>
<td>Interfaces need to consider not only the hands-on interactional aesthetics of manipulating the lights (e.g. ease or fluidity of controls), but also how they can be grounded in learning goals for the children. E.g. Ann-Christine’s idea that letting children find colours in the environment can stimulate discovery can act as grounding for an interface that uses colour sensing to manipulate the lights instead of a controller. This interface choice may support two pedagogical goals: 1) encouraging children to move around physically in discovering colours within their environment, and 2) it links to pedagogy around learning and discussing colours themselves.</td>
</tr>
<tr>
<td>11.</td>
<td>Ann-Christine suggested using a wall as interface, using soft or tactile materials in large colourful shapes that children naturally gravitate to (e.g. stars and heart shapes).</td>
</tr>
<tr>
<td>12.</td>
<td>Ann-Christine notes how nice it would be if the children could discover colours in the environment and use them to change the lights.</td>
</tr>
<tr>
<td>13.</td>
<td>Ann-Christine notes that it would be even more useful if there were a pencil prop that the children could use to draw on the screen.</td>
</tr>
<tr>
<td>14.</td>
<td>For safety reasons the children needed to stay seated, but the excitement from the children around movement of the lights would easily stimulate chasing and running to follow them.</td>
</tr>
<tr>
<td>15.</td>
<td>During both sessions, many forms of play were evident and overlapped (e.g. verbalizing imaginary scenarios; linking to rough and tumble play; and collaborative play with the controllers sometimes turning into physical wrestling to gain control).</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>PLAY BEHAVIOURS SHIFT RAPIDLY, AND MULTIPLE SHOULD BE SUPPORTED.</td>
<td></td>
</tr>
<tr>
<td>The final design need not accommodate any one specific form of play because the play behaviours tend to overlap. Here the open-endedness allows for the experience to shift interpretations and styles along with the children’s play.</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>The brightness of the lights bothered two of the participants, one an adult and the other a child. To both of them, the colour red felt especially uncomfortable.</td>
</tr>
<tr>
<td>BRIGHTNESS BECOMES AN ACCESSIBILITY (AND MATERIAL) ISSUE</td>
<td></td>
</tr>
<tr>
<td>Brightness will need to be reduced to prevent overstimulation. Brightness can also be mediated by materials, i.e. various materials bring differing levels of diffusion.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix D Site observation: morning and afternoon drop-off and pickup

<table>
<thead>
<tr>
<th>OBSERVATION</th>
<th>INSIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drop off and pickup are the busiest times for this space.</td>
<td>THE INSTALLATION WILL NEED TO CHANGE AT DIFFERENT TIMES OF DAY</td>
</tr>
<tr>
<td></td>
<td>Any interactive installation needs to be sensitive to not interfering</td>
</tr>
<tr>
<td></td>
<td>with or distracting families and staff. Ongoing discussion with the</td>
</tr>
<tr>
<td></td>
<td>staff throughout the design process is needed to get their sense of</td>
</tr>
<tr>
<td></td>
<td>how the different times of day should be supported.</td>
</tr>
<tr>
<td>Teachers must escort students to and from the welcome area to the class</td>
<td>STIMULATING PLAY DURING PICKUP AND DROP-OFF TIMES COULD BE HELPFUL IN</td>
</tr>
<tr>
<td>area, as well as keeping an eye on those already in the classrooms, leaving</td>
<td>BUILDING BETTER SOCIAL CONNECTIONS</td>
</tr>
<tr>
<td>little time for parent / teacher interaction in the welcome area.</td>
<td>The proposed common space could allow for the children who have already</td>
</tr>
<tr>
<td></td>
<td>arrived to be gathered together in this same space while also waiting</td>
</tr>
<tr>
<td></td>
<td>for final arrivals. If teachers could supervise those children who have</td>
</tr>
<tr>
<td></td>
<td>already arrived without having to leave to greet new arrivals it would</td>
</tr>
<tr>
<td></td>
<td>allow more social interaction time. Having a playful activity to engage</td>
</tr>
<tr>
<td></td>
<td>the children during this time would help keep them occupied and</td>
</tr>
<tr>
<td></td>
<td>stimulated, freeing teachers to spend more time engaging with parents.</td>
</tr>
<tr>
<td></td>
<td>This would also encourage parents to play together with their children,</td>
</tr>
<tr>
<td></td>
<td>and perhaps get families playing together who would not normally have</td>
</tr>
<tr>
<td></td>
<td>this opportunity to engage each other.</td>
</tr>
<tr>
<td>There are several nationalities of immigrant families.</td>
<td>SCREEN-BASED CONTENT COULD BE INTRODUCED TO ADDRESS CROSS-CULTURAL</td>
</tr>
<tr>
<td></td>
<td>SENSITIZATION</td>
</tr>
<tr>
<td></td>
<td>There might be need for standard television screens in this space.</td>
</tr>
<tr>
<td></td>
<td>Linking to theory about need for cultural sensitivity in schools with</td>
</tr>
<tr>
<td></td>
<td>immigrants (Adair, 2015; Gonzalez et al, 2014). It would be helpful for</td>
</tr>
<tr>
<td></td>
<td>both parents and teachers if the common area could support playing</td>
</tr>
<tr>
<td></td>
<td>videos that explained the rules and pedagogy, filmed in several</td>
</tr>
<tr>
<td></td>
<td>languages. These videos could be written and cast to use</td>
</tr>
</tbody>
</table>
immigrant families who have already been through the Swedish preschool experience. Immigrant families could then hear from people of their own background and language describing what makes for a positive school-going experience.

This screen could also be useful as a place where class photos, along with photos and cultural content from the immigrant and Swedish families can come together in collage, as advised by Gonzalez et al (2014). This parent’s struggle to communicate with the teacher echoes Adair’s findings regarding how language and cultural differences can prevent the parents from representing their children’s interests (Adair, 2015).
## Appendix E Site observation of the outdoor environment for parametric design openings

<table>
<thead>
<tr>
<th><strong>OBSERVATION</strong></th>
<th><strong>INSPIRATION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>The school is situated in an area filled with examples of natural landscapes (trees, hills, a small stream, small animals, grass, sand, rocks)</td>
<td>Natural sciences are a part of the pedagogy. Bringing natural outdoor elements ‘inside’ through subtly influencing the light installation is:</td>
</tr>
<tr>
<td></td>
<td>1. connected to themes of environment and natural science</td>
</tr>
<tr>
<td></td>
<td>2. Harmoniously connects indoors and outdoors</td>
</tr>
<tr>
<td></td>
<td>3. natural elements are dynamic; weather, trees, flowers growing, etc change over time. This can bring an ever-green freshness to any content in the installation.</td>
</tr>
<tr>
<td>Clouds moving, and trees swaying in the wind are serenely pleasing to watch, and they change constantly as the clouds pass and wind speed changes.</td>
<td>A camera could track clouds passing and then ‘clouds’ could drift across the display</td>
</tr>
<tr>
<td></td>
<td>Wind speed and direction can be animated in the lights and could be grounded in natural science.</td>
</tr>
<tr>
<td></td>
<td>A simple abstract tree shape could be animated in real-time to mimic how a video feed of the real trees are moving in the wind.</td>
</tr>
<tr>
<td>There are many birds and insects.</td>
<td>Web cameras could be installed near high traffic areas for birds or insects (e.g. birdhouse); this activity could be reflected in the display as animations, or perhaps even a live video feed would be interesting and instructive for the children when activity deemed interesting is detected.</td>
</tr>
<tr>
<td>Children are highly active on the playground; and biometric data could be used as an input</td>
<td>As children use the slide or equipment there could be sliding movements on the display. Visualization of biometric data was tested with children during the prestudy, and was successful in encouraging children to increase their heart-rates; perhaps there are design openings here to create some kind of indoor game that children can link to their outdoor activity.</td>
</tr>
<tr>
<td>Changing of the seasons</td>
<td>An ongoing theme of the installation can be linked to lessons in the school around the seasons changing. A simple abstract tree shape rendered into an ambient light display could reflect the seasons that a tree goes through, e.g. colour changes and leaves growing or falling.</td>
</tr>
<tr>
<td>National Holidays</td>
<td>Perhaps over the course of the year, national holidays from other cultures represented in the student body could be celebrated and discussed. The ambient light display could display colours of the flag or culturally appropriate icons on these days, which could be a teaching tool for teachers to discuss the cultures of the various immigrant children.</td>
</tr>
<tr>
<td>Temperature changes</td>
<td>There is the possibility to link the temperature to the light display in a way that experientially complements variations. E.g. perhaps during freezing winter temperatures, there might be warming colours inside like oranges, or the lush greens of summer trees.</td>
</tr>
</tbody>
</table>
Appendix F Interview with teacher about preschool pedagogy

April 20, 2017

- The below are interview notes. All quotes are attributed to Ann-Christine Brickling (a.k.a. Anci).

- **Researcher: How do you use colour?**
  
  **Ann-Christine:** “For the 3-4 yr olds, they are playing with colour. They are using the hills outside for rolling and climbing, they’re using the big trees in their lessons, the chestnuts for counting and building in the sand with chestnuts. Using stones “how do you feel when you hold the warm stone, choosing your own stone” …the lesson is everyone is valuable…we look different but everyone is valuable”

- **Researcher: What are some of the core themes in your lessons?**
  
  **Ann-Christine:** “The lessons are about friendship and taking care of each other even though they might not have things so well…PLANTING SEEDS OF FRIENDSHIP. Friendship is combatting the “self” of “i want this…” vs. we can help each other. The lights can be very good at discussing emotions…we have lessons about emotions and feelings…these are good for the children because we show them in reality with stones, and animals how important it is to take care of each other and we are the same inside even though we look different…we are ALL valuable and we tell them they need to play and behave nicely…we are working a lot with this…trying to teach the children to be nice to each other and we get so much back when we do this… this makes them understand they are the same and they are equally valuable, they each have SO MUCH TO GIVE.”

  “When we talk feelings… if a child has done something bad to another child, we don’t say (angrily) “WHAT HAVE YOU DONE”… we use a DISCUSSION with them about EMOTIONS and FEELINGS to make the children be REFLECTIVE and BE CRITICAL … so we say “what did you do just now”, how did that make you feel? So then we also hug the children and make them feel special — so we give the kids the right tools to take care of each other, to make them think critically about their actions”

  “We do a lot of ROLE PLAYING with this, and we include the kids as actors…we could use a larger wall of lights with the colours in this way, in the beginning we have a play with blue is sad, and we would enact how we feel down and sad, and we have the lesson through playing and acting, then we would say “this is how we can feel we do the good things” then we use the light and colour the same way we might use music that can be sad and gloomy can have dramatic effect. We could play games with the seasons, AUTUMN could have orange colours, Summer can be like flowers, winter we pretend we are skiing and acting out playing in the snow”

- “We teach colour and shapes together, where the children form shapes by lying on the ground arranging their bodies…these shapes could be the lights in the floor…maybe a playful floor where the teacher can draw on a screen and have the shapes come on the floor”
# Appendix G Insights from interview with teacher about preschool pedagogy

<table>
<thead>
<tr>
<th><strong>Observation</strong></th>
<th><strong>Insight</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing and friendship are key themes.</td>
<td>These themes could be incorporated into open-ended playful experiences by e.g.: mixing colours when different children's light blobs interact, or by making interface choices that require children to collaborate socially to bring their colours together.</td>
</tr>
<tr>
<td>Ann-Christine states they do a lot of role-playing and acting out plays as the basis for teaching various lessons. She feels that being able to control the lights as dramatic stage lighting would be helpful in these activities. Ann-Christine envisions that the lights could be helpful in games and lessons relating to the seasons (e.g. cycling through seasonal colours in a lesson, or pretending they are skiing or acting out playing in the snow). Ann-Christine feels the lights can be very good at discussing emotions and feelings, wherein the colours can be linked to feelings in a role-playing lesson about identifying ones' feelings and acting appropriately.</td>
<td>This installation needs to remain flexible and reprogrammable for the teachers to apply any lessons they might choose (e.g. emotions, sharing or other dramatic roleplaying). Incorporating an interface that only teachers can use would allow them to override any ambient interactivity in order to incorporate the wall flexibly into any lessons they see fit. The teachers already use ipads to manage the check-in, check-out and daily recap photos of the children, so creating a simple web-based interface that lets them select colours and animations could be useful for the teachers. Responsive animations for role playing such as “acting out playing in the snow” could be pre-programmed and selected, although this would require unique consideration of how human input is sensed.</td>
</tr>
<tr>
<td>The teachers employ colour extensively in their lessons. Sometimes they use natural materials like stones collected by each student outside to teach how we might all look different all different, but all the same inside and deserve the same respect.</td>
<td>Perhaps allowing them to create an array of colours and shapes on the light display could be used in a pedagogical way to represent many types of diversity.</td>
</tr>
<tr>
<td>Ann-Christine showed pictures of children learning about colour and shapes together by lying on the ground and forming large geometric shapes with their combined bodily arrangements.</td>
<td>This relates to a comment Ann-Christine made during the co-design session with the light tool, wherein she imagined that embedding lights into the floor and walls would stimulate discovery. Lights embedded into the floor could be used in lessons like this, e.g. creating different coloured shapes as outlines in the floor as fun templates that children can arrange their bodies around. The teacher could again use a simple web-based interface via ipads to draw or preselect shapes.</td>
</tr>
</tbody>
</table>
Appendix H Written responses from prompts sent to Ann–Christine on time of day and light.

N.b. Ann–Christine’s responses are captured verbatim. April 21, 2017.

**INSPRIATION**

**ARRIVAL TIME 7–8am**
- takes time for all children to arrive, kids play with each other.
- lot of immigrant parent / kids, don’t’ always have language – but not a lot of interaction between the parents and other children, they come in and out

**THE LIGHTS HELP PEOPLE BE SOCIAL, and TEACH LESSONS BY BEHAVING LIKE.....**

**EXAMPLE:** a wall of lights is displaying soft, warming colours – soft oranges, peach, cream, light yellows, light greens (etc). There are also children discovering and playing with small lines of lights that are being playful with them in the walls and floor, this makes them move around. This lets the children be playful and play with each other. The parents also help play with them, and maybe they are meeting other parents here too.

**ANN–CHRISTINE:** I think it is a good thing to meet a soft light in the morning because some parents need to calm down and have a good time with their children before going to work.

Sometimes some parents are coming quite stressed and they have had a terrible morning together with their children. Then it may be a good thing to speak to each other through soft colours.

I also think as you, that it could be a good platform(base) for parents to meet.

Maybe real soft music in the background. To achieve the best result for feelings there is a lot of special music, ex. Mozart, that makes us feel good. (it has been used for autistic children. There is scientific research about how it affects the limbic system(latín–limbus).

**DURING THE DAY, NOT A LOT OF ACTIVITY WITH CHILDREN, BUT THE ROOM IS STILL THERE:**

**AS INSPIRATION, THE WIND IS BLOWING OUTSIDE**

**EXAMPLE:** you can see the lights moving in the same way that the wind is blowing, this helps teach children about something nature related. This is also something nice for people to lift their spirits, and can be in welcoming colours that match the type of day outside.

Maybe there is an abstract ‘tree’ that lives in the wall of lights when it is calm in the room, and you can see the tree moving in the wind the same way the real trees are moving in wind.
<table>
<thead>
<tr>
<th><strong>ANN-CHRISTINE:</strong></th>
<th>Maybe the children can follow the seasons with the tree on the wall and it can end up with a great interaktiv learning situation.</th>
</tr>
</thead>
</table>
| **PICKUP TIME ... parents and siblings begin to arrive around 2–3pm** | **EXAMPLE:** sometimes parents come with siblings, and at this time the children are also excited and energetic, it is end of day and they are excited to play. There are play activities in the lights and room to encourage children and parents to play with each other and siblings.  
...is this a good idea? What should the lights be doing at this time? There can be multiple things, there is no shape or form yet!  
**ANN-CHRISTINE:** Soft light in combination with soft music, and possibilities for the parents to create something together with their kids. See what we write above. |
| **LESSONS DURING THE DAY** | **EXAMPLE:** the children are playing WITH each other and interacting physically and being co-operative. You would not see lights in the floor until it was time to begin, then they would be just barely visible through the floor, and you can make out lines and shapes, and the colour can change  
**ANN-CHRISTINE:** The children can use different things and make shadows, building things and explore things from nature if there is light in the floor.  
**EXAMPLE Continued...** we change the colours and do the small plays and role playing, this teaches children the lesson in an engaging and dramatic way. In the beginning feeling sad and grey (and the wall is blue and grey), and then we can use our ipad to select the next colours to be "warm and happy" when we learn a lesson about sharing and being kind to each other.  
This makes the children more aware of how being different is okay. On the wall is something where each child can select a shape and colour, and then all the shapes and colours start moving around, or mixing colours, or have smiles on them.  
**ANN-CHRISTINE:** Even here you can work with Music that amplifies the feelings and the mood.  
Then we are also helping the children without Swedish language and it doesn't matter which age you have. |

<table>
<thead>
<tr>
<th><strong>ANN-CHRISTINE:</strong></th>
<th>Maybe the children can follow the seasons with the tree on the wall and it can end up with a great interaktiv learning situation.</th>
</tr>
</thead>
</table>
| **PICKUP TIME ... parents and siblings begin to arrive around 2–3pm** | **EXAMPLE:** sometimes parents come with siblings, and at this time the children are also excited and energetic, it is end of day and they are excited to play. There are play activities in the lights and room to encourage children and parents to play with each other and siblings.  
...is this a good idea? What should the lights be doing at this time? There can be multiple things, there is no shape or form yet!  
**ANN-CHRISTINE:** Soft light in combination with soft music, and possibilities for the parents to create something together with their kids. See what we write above. |
| **LESSONS DURING THE DAY** | **EXAMPLE:** the children are playing WITH each other and interacting physically and being co-operative. You would not see lights in the floor until it was time to begin, then they would be just barely visible through the floor, and you can make out lines and shapes, and the colour can change  
**ANN-CHRISTINE:** The children can use different things and make shadows, building things and explore things from nature if there is light in the floor.  
**EXAMPLE Continued...** we change the colours and do the small plays and role playing, this teaches children the lesson in an engaging and dramatic way. In the beginning feeling sad and grey (and the wall is blue and grey), and then we can use our ipad to select the next colours to be "warm and happy" when we learn a lesson about sharing and being kind to each other.  
This makes the children more aware of how being different is okay. On the wall is something where each child can select a shape and colour, and then all the shapes and colours start moving around, or mixing colours, or have smiles on them.  
**ANN-CHRISTINE:** Even here you can work with Music that amplifies the feelings and the mood.  
Then we are also helping the children without Swedish language and it doesn't matter which age you have. |
Appendix I Email interview: Ann Poochareon, Aesthetec Studio

Website: http://aesthetec.net/
DATE: APRIL 11, 2017

Researcher: When designing play installations for preschoolers, the first words or thoughts that spring to mind are: ...


Researcher: I'm looking forward to chatting with you about interfaces, play patterns, behaviours of preschool aged children (3-5)...

Thinking about the abilities of preschool aged children, I know that kids’ develop fast between 3-5, and they even develop in the ways that they play. How do you tend to think about interfaces or engagement patterns for kids this young?

Ann: Interface should be pretty simple.. although nowadays the 3-5 group are very well versed with multi-touch devices and YouTube navigation. They also learn very fast. Toys are really engaging for kids, even if they’re not interactive they can use imagination. Screen-based interaction has to be very simple with big rewards. If they can’t figure something out they also get bored easily.

After spending so much time in kid spaces (drop in play, indoor playground, etc. etc.) I personally am not even convinced that kids this age need any fancy tech installation. Physical, tactile and focus on play is more important.

Also for physical interface - things should be their size. i.e. table at their height, kid sized chairs, step stools for things that are out of reach. They become a lot more engaged and clue in to things that are sized for them. They are surrounded by adult-sized things and can usually pick out the stuff that are meant for them only. For example, Oren absolutely has no patience for grocery stores, but if we find a grocery store that has a mini cart for kids to push around, he becomes this amazing helper and doesn’t even need bribes to get through the store. He’ll even try to load things onto the belt at check out. Sadly, our toronto grocers don’t do this b/c the mini carts keep getting stolen.
Researcher: Thinking about preschoolers, what kind of interactions come to mind for you as natural choices? *getting them to run and move, hands on interaction, etc*

Ann: Run and move is the best thing (b/c it expels energy and parents are happy afterwards), next to that is hand-on interaction… playing with balls or blocks, building things, etc. Also costume and pretend play is big.

Simple ideas like musical stairs (notes play when you run up or down the stairs), light up floor, etc. are my first thoughts..

Researcher: Aside from yourselves, do you have any favourite artists / studios who mix lighting with fun architectural installation; this could include walls, ceilings, seating, furniture, etc. I'm looking for best practices / inspiration…

Ann: For kids, Sago's mini door installation is my absolute favourite. I think you know what I’m talking about… We were in Thailand two years ago, and there was this really fancy indoor play spot that incorporated a lot of interactive tech w/ kids play - [http://www.bkkkids.com/blog/imaginia-playland-emporium/](http://www.bkkkids.com/blog/imaginia-playland-emporium/).
Researcher: In your experience both as an interaction design researcher and artist, what are some simple words or feelings that first spring to mind if I ask you "why do you choose light and colour as key elements in many of your works?" Maybe you see they have effects in people or are good at communicating certain things

ANTHONY: Our work is deliberately abstract, it can be mesmerising, entrancing, uplifting (after all, light is at the source of all life). We also use its ability to augment and transform spaces in a way that is effective, highly controllable and with no moving parts (so robust, relatively ecological etc). The space remains the space, but it becomes an ever-changing environment.

Our work is also concerned with engagement and immersion.

The social element is REALLY important in our work - in contrast to much VR-style work, our works are highly social - Submergence, for example, casts light on everyone’s faces, placing people in a SHARED yet slightly strange, and beguiling, environment.

We’ve had impromptu parties occur in our work, as well as long periods of sustained contemplation.

We had some visits by severely disabled kids - it went incredibly well, their carers were very impressed by the effect the work had on their charges.

The level of immersion can be easily controlled and altered using ambient light levels.

Researcher: As an interaction design researcher and as an artist, have you noticed that light installations can have positive social effects on the people or communities who experience them? If so, what would you describe these as?

ANTHONY: I did some research on behaviour with our work Submergence in the PhD - basically I noted two forms of behavioural response - contemplative (wow factor, oo ahh, lying on the ground, as you’d expect in an immersive piece) and social; which often seemed to occur spontaneously, mainly I guess as people there have a shared experience. Social media responses from our installs back this up (I ahve some great pix in particular from an install we did in Bristol a couple of years ago, but there’s plenty more out there.

Researcher: Ideally this installation stimulates social connections among immigrant and swedish families / children etc. Maybe this does this just by providing atmosphere, or
maybe it is formed in some way in the architecture to encourage people to come together. As an interaction design researcher, have you come across any sources how installations support social development, e.g. stimulating social connections among strangers, or something like this?

ANTHONY: not really that I can think of right now, but it definitely happens. The non-lingual attributes of this type of work create a shared experience that can be explored through any form of communication, so I’m sure it can help with any language barriers and other issues.

Researcher: This will be a permanent installation, and to offset it becoming predictable or boring, I’m considering parametric inputs (linked to nature in the playground, eg. wind / clouds / trees). I know that you have worked with and discussed parametric design in your research. I am searching for anything that might ground this choice; do you know of any source that makes a case for this?

ANTHONY: I haven’t been in academia for the last 18 months so my referencing ability is currently low! But from practical experience, we used (for example) wind information (speed and direction) in a piece called Aeolian Light. What that did was create a multimodal connection - you could feel the wind, and also see it as it blew digital artefacts through the installation. More here: http://www.squidsoup.org/aeolianlight/. Anything that grounds a work in the real world can only help people understand/feel it.
**Appendix K Interview: JP Dyson, Deborah McCoy, The Strong National Museum Of Play**

Website: http://www.museumofplay.org/
Date: MAY 10, 2017

*Researcher:* WARM UP: When designing play installations for preschoolers, the first words or thoughts that spring to your mind are (any word associations of first thoughts?): …

**DEBORAH:**
Preschoolers are much more capable than we may expect

**JP:**
Fun, repeatable, engaging

**Researcher:** What are safety precautions that you think about when designing or curating installations for preschoolers?

**JP:**
Some element of risk-taking is good for children. Unfortunately we sometimes have to be more careful than I’d wish, especially because we cannot count on paid staff being there at any given time. Thus nothing that would involve potential falls (e.g. monkey bars). We’ve had to remove a couple of slides and other interactives because of falls. My impression is that Europe they’re much more tolerant of risk than Americans are. If you haven’t seen Tim Gill’s No Fear: Growing Up in a Risk-Averse Society you might find that useful. [https://rethinkingchildhood.com/no-fear/](https://rethinkingchildhood.com/no-fear/)

**Researcher:** Re: safety precautions, are there any materials that might be best for the overall design or specifically for interfaces that either resonate with, or aid children in this stage of their development?

**JP:**
Obviously avoid sharp edges, soften likely head bump surfaces. We use a lot of plastics (high-density polyethylene (HDPE) especially) and wood in construction, and upholster and pad things where appropriate. The substances need to be cleanable.

**Researcher:** Re: materiality, this will be a permanent installation and wear and tear could be an issue. The Strong welcomes hundreds of thousands of visitors per year; do you have any advice for a permanent preschool installation?

**JP:**
We generally avoid painted wood surfaces anywhere where there will be a lot of traffic, so use HDPE or non-painted wood surfaces.

**Researcher:** Specifically on "accessibility" for preschoolers, in a general sense, do you have any top three things to keep in mind?
JP:
I bet the Association of Children’s Museums (ACM) has some materials. In general, we want things to be achievable but challenging yet still safe. I think of some of the work of Vygotsky such as his concept of the zone of proximal development. Sorry that’s not very quotable! One thought is that I would be cautious about thinking of preschoolers as limited. It’s true they can’t do many things adults can do but they also then approach the world in ways that adults often miss. Alison Gopnik, whose work is very good, had a column to this effect recently in the Wall Street Journal: https://www.wsj.com/articles/when-children-beat-adults-at-seeing-the-world-1487266807. You might check out our American Journal of Play for specific examples as well. There are numerous books on childhood play as well by authors such as Fromberg & Bergen, Jim Johnson, my colleague Scott Eberle (Handbook of the Study of Play), and others.

Researcher: What type of interface or interaction limitations do you consider when making or curating exhibits for preschoolers, e.g. “we can’t use game controllers because they are too complex, but we can make large buttons, and use kinect sensors ...”.

DEBORAH:
This may seem obvious, but not to rely on words to give directions. Trust in children’s natural curiosity as a motivation to try things.

JP:
I like to keep in mind the idea of affordances (see the work of Doris Bergen on this in relation to technology). What sort of play does this technology afford or make possible? Generally toys and technologies that promote open-ended play work best. This is where repeatability is a good metric to use. Can this be used over and over again?

Researcher: Do preschool children ever struggle figuring out interfaces in your installations?

JP:
If instructions are involved or they need to read to understand what to do then yes.

Researcher: Thinking about the abilities of preschool aged children, kids’ develop fast between 3-5, and they even develop in the ways that they play (e.g. rough and tumble vs socio-dramatic). If you were designing an installation for preschoolers, what are some keywords or bullet points that would be ideal features of the installation? e.g. another respondent replied saying “it’s important to get them moving, and also stimulate role playing”...

JP:
Yes, role play and physical play are very important. In general, we find Howard Gardner’s Theory of Multiple Intelligences to be a useful framework for exhibit design, and then it’s a matter of figuring out what a developmentally appropriate level is for that interactive that calls on musical intelligence, bodily-kinesthetic intelligence, etc.

Researcher: The social issues at this school are related to a lot of immigrant families not being able to speak Swedish or English (causing tension and lack of communications between teachers, parents and kids), so my research premise is loosely: “how can an interactive light installation
help this community build social connections through playful atmospheres that are sensitive to the diversity of cultures". The open-endedness is inspired by play researcher Tilde Bekkers' "Lenses of play", specifically her lens of designing for open-ended play experiences. This tool avoids any figural forms that might not be interpreted as intended; I wanted to see if only using colour, size and motion would be enough to stimulate play without using figural forms which could be mis-interpreted by different cultures / genders / etc.

DEBORAH:
This makes sense to me. The schools of Reggio Emilia are now facing some of these same issues. I participated in a study tour of Reggio Emilia and visited the Loris Malaguzzi Center, which houses two urban ateliers, the Digital Atelier and the Atelier of Light. You can see a video about the center at https://www.youtube.com/watch?v=MnffkLbg1ns

What came to mind immediately was the theory of The Hundred Languages of Loris Malaguzzi, one of the founders of the preschools and infant toddler centers of Reggio Emilia, Italy. Malaguzzi used the idea of the hundreds languages as a metaphor for the great potential of children to express their thinking using many languages (visual arts, dramatic expression, construction, etc).

Researcher: Do you know of anything that might support me saying "keeping content non-figural supports cultural inclusivity / sensitivity by allowing children to interpret it however they see fit"?

DEBORAH:
The Theory of Multiple Intelligences may be helpful.
## Appendix L Insights from discussing parametric input with architects

<table>
<thead>
<tr>
<th>Discussion</th>
<th>Insight</th>
</tr>
</thead>
<tbody>
<tr>
<td>One participant noted these were like ‘windows’ into the sky and trees and nature.</td>
<td>Consensus formed that any theme for the ambient lights should be linked to nature in the school yard, which also ties to pedagogy.</td>
</tr>
<tr>
<td>“Windows into nature” has potential to inspire conceptualization. It was discussed how Livingston’s (2014) recommendation for using nonuniform perimeter lighting as being most transmissive of relaxation could support the concepts of ‘windows’ into the outside, placed throughout the space, where an ambient light in one area of the common area could focus on the sky, while others act as windows into the trees, water, earth, insects and creatures etc. Each of the ‘parametric windows’ could have special ‘super’ features that would override their parametric display only when children choose to use said super feature, e.g. if a child discovers a colour in the environment and holds it to the sensor, the display could temporarily pulse with that colour. This could bring a playful element into the displays that would recede back into parametric display when input or child proximity are no longer detected. In this scenario, the lights could still be movable and multi-use for other purposes, but when hung as parametric displays still maintain pedagogically grounded interactivity for children’s play.</td>
<td></td>
</tr>
<tr>
<td>It was suggested children inside would find it interesting to see when birds or other creatures pass. The ambient lights would only show an abstracted rendering of creatures, but this sparked a response that “this is good because children have so much fantasy and they can imagine many things… they will want to tell their parents about it at the end of the day which would stimulate more social connections”.</td>
<td>Linking to themes of nature, and allowing for potential to have the forms abstracted somewhat:</td>
</tr>
<tr>
<td>Stimulates childrens’ imaginations and potentially play. Also may address the issue of diverse cultural interpretations; nature themes are relatively neutral, and the abstracted forms are even more open to interpretation than simple video feeds would be.</td>
<td></td>
</tr>
<tr>
<td>Seeing themes of nature in the lights sparked an idea from a participant that ambient lights could be used as tracing tools or the basis for creative lessons to “make the pictures to come to life for the children”, e.g. if tree animations were displayed, children would place paper on the lights and do drawings and paintings of trees on top of the lights. This also implies that the lights would need to be movable to a horizontal position to enable this.</td>
<td>This theme of ‘multi-use’ rose consistently throughout discussions with the teacher as well as the architects, meaning an installation would have to be flexible to many physical placements as well as re-programmable to be of most benefit to the community.</td>
</tr>
</tbody>
</table>
One of the architects repeatedly suggested the lights should be movable vs. being one or more permanent displays, e.g. “it would be nice if you could put these in different places”. She explained that it is useful that the pieces of the live light tool can be moved, so it made sense to her that the lights should be movable as well. The others agreed with this.

It is possible that the movable multi-piece form of the light tool – intended as boundary object only – influenced participants’ mental images of what a finished use might include. This could be a reason for more caution in explaining the role of the light tool in further tests so as not to influence peoples’ preconceptions. While it was indeed by design that the pieces could be used in many ways, it may have also been inadvertently suggestive of user scenarios.