SPACE RE-DEFINED

A paradigm driven by dynamic light and computation

Laurence Bourghol

Master Thesis Lighting Design
Aalborg University

Aalborg University Copenhagen
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Semester coordinator : Giorgios Triantafyllidis
Secretary : Lisbeth Nykjær

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Frederikskaj 12,

DK-2450 Copenhagen SV

Semester Coordinator:

Secretary:

Supervisor(s):

Mette Hvass

Ellen Kathrin Hansen,

Abstract:

Lighting has always been deeply involved in our perception and feeling of space. Recently, the last technological evolution in this field has open to new possibilities without equivalent with the other forms of lighting technology. The digital state of light is transforming our urban environment into an ever changing and dynamic space, affecting our spatial perception of it. Our assumption, ways of thinking and methodology about space are challenged by the digital realm, defining a new spatial paradigm. The digital technology promises to enhance the space through informational data-landscape, while dynamic light, as one of the manifestations of this new paradigm, has the potential to bridge the physical and the digital into a re-defined space, hybrid child of these two realities. This thesis proposes to explore the new triangulation of architecture, dynamic light and computation, where lies a new way of thinking light as dynamic tool, able to convey a additional meaning to the space through reactive, responsive and interactive environment.

To investigate in this direction, we have first mapped the problem area, clarify an initial research statement, set the path for an interdisciplinary exploration at the edge of architecture, lighting and computation. A first technological background draws the technological advancement in lighting and computation applied to architecture, through its best manifestation in what is commonly called 'Media Architecture'. The third part will look at technology under humanistic perspective, looking at philosophy, architectural and social theories. The notion of spatiality will be reviewed under the three main axes of space as form, space as sensation and space as experience, to develop on theoretical concepts that could support the design of dynamic light paired with computation in an architectural context. Finally, the fourth part proposes an analysis of twelve existing cases of dynamic light used in architecture, through the lenses of the precedent technological and theoretical backgrounds. Each of these parts focuses on a particular way of looking at the contemporary question of dynamic light and the computational possibilities converging into our built environment, with the aim to open on new axes for future design cases.

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INTRODUCTION

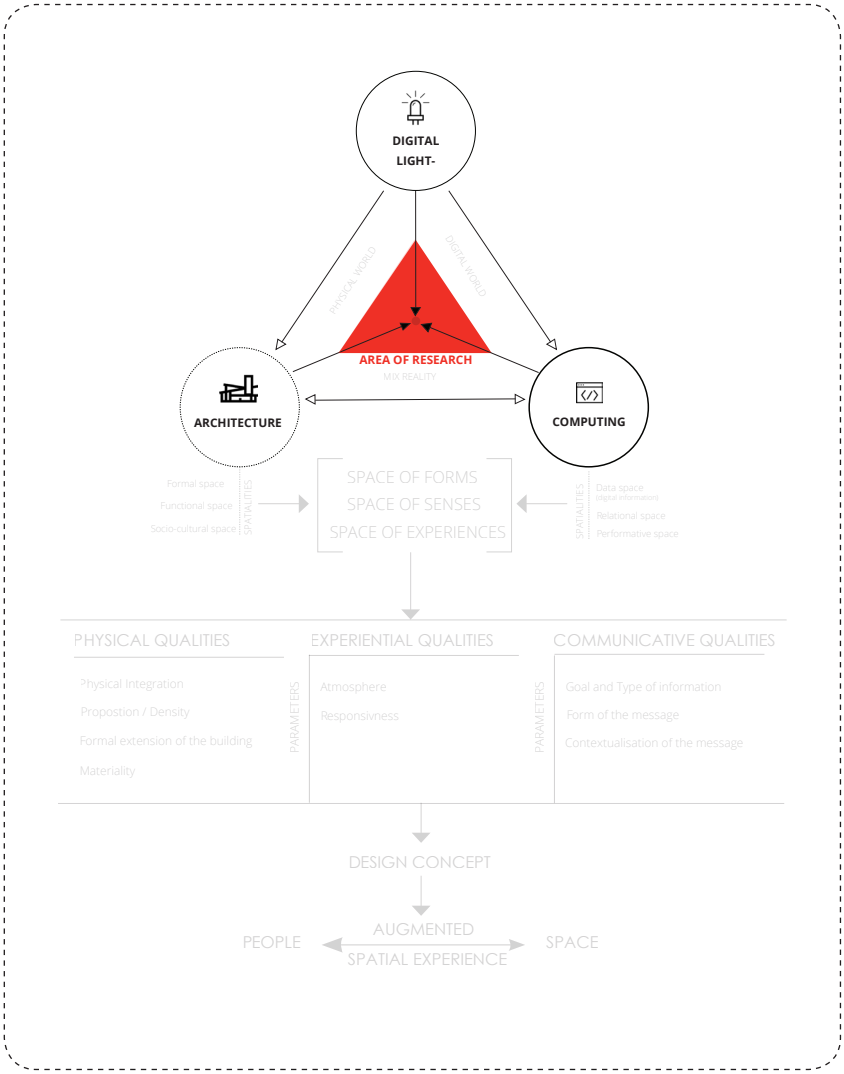
Lighting has always been deeply involved in our perception and feeling of space. Recently, the last technological evolution in this field has open to new possibilities without equivalent with the other forms of lighting technology. The digital state of light, pervading our cities is transforming our urban environment into an ever changing and dynamic space, affecting our spatial perception of it. Our assumption, ways of thinking and methodology about space are challenged by the digital realm, defining a new spatial paradigm. The digital technology promises to enhance the space through informational data-landscape, while dynamic light, as one of the manifestations of this new paradigm, has the potential to bridge the physical and the digital into a re-defined space, hybrid child of these two realities. We argue that in the new triangulation of architecture, dynamic light and computation, lies a new way of thinking light as dynamic tool, able to convey a new way to connect with our spatial condition.

To investigate in this direction, I will first map the problem area and my approach, to clarify an initial research statement as the starting point of this work. It will be the occasion to explain my initial intuition that triggered my interest on this subject, as well as setting the path to the following exploration. The second part will draw the technological background on which my hypothesis relies. I will set the state of the digital light and its particularities, that distinguishes it from the other forms of light. This part will also cover the evolution of computation from the screen to the space and how its combination with light, under its dynamic form, finds its best manifestation under what is commonly called 'Media Architecture'. The third part will look at grounding these technological advancements into a humanistic approach, looking at philosophy, architectural and social theories. I will explore the notion of spatiality, under the three main axes of space as form, space as sensation and space as experience. It will be the occasion to develop on theoretical concepts that could support the design of dynamic light paired with computation in an architectural context. Finally, the fourth part proposes an analysis of twelve existing cases of dynamic light used in architecture, through the lenses of the precedent technological and theoretical backgrounds. I will review the current state of dynamic light through a qualitative analysis following a set of parameters coming from the precedent parts. It will be the

occasion to reflect on the current practice, dealing with dynamic light, and to investigate on the potential axes of development.

Each of these parts focuses on a particular way of looking at the contemporary question of dynamic light and the computational possibilities converging into our built environment. I hope to mapp better this field, which is still too often limited to its technical or entertainment part, as a way to open new axes for future design cases.

PART 1
Approach



MOTIVATION

As I look out of my window [...] the restitutive promise of high architecture suddenly looks fragils. Out there the conditions of time and space are evolving in ways so powerful and dynamic that we ignore them at our peril. This is not to argue for the celebration of the instant; nor is it to suggest resigned defeat in the face of the maelstrom; nor is it to succumb the myth of inevitable progress. Rather, it is a call for a critical understanding of the present in all its complexity, conducting what Marc Auge calls an anthropology of the here and now, so as to reveal the spatial and temporal inscriptions of the present-day social practices. The aim is not to reproduce these inscription in architecture, but to know them so as to know how to operate within them.'
(Jeremy Till, Architecture in Space and Time, 1996, p.5)

Coming from an industrial design background specialized in textile, I have been used to think in term of sensible experience through tangible products. When I discovered light as a design element in itself, I have been instantly fascinated by its immateriality, and yet its incomparable power on our emotional and perceptual condition. My education in lighting design at AAU has been a time to nurture and develop my interest for light as a spatial material. Furthermore, it has also been the occasion to encounter crossing fields related to lighting, challenging even further my conception of design, through what is commonly called the "Media" culture.

From my experience as a designer, I have seen my field of practice evolving from the age of products to the era of service design. Driven by the new technology, we are now entering the realm of "experience" and interactivity, widely supported by the computational possibilities pervading every aspect of our lives. The change that the lighting industry is facing today with its digitalisation, is in this sense, emblematic of this societal change, and raises many questions. Relatively new as a professional practice, lighting design gained its independence as a field of expertise working at the intersection of space, human perception and technology. The current digital shift is challenging and redefining each of these three points, while the hybridization of light with computation and network technology is enlarging the scope of lighting and initiates a new type of relationship with our built environment .

The main motivation of the present thesis is driven by this observation and the questions raised by this transformation. I believe that light is and will stay an essential element involved in the definition of spatiality as a sensible experience. However, I have the intuition that the scope of lighting is widening a step beyond under the influence of computational possibilities. The digitalisation of light opens to new potential collaboration with other design fields like HCI (Human Computer Interaction) and is challenging, or at least raises the debate on the current role of light, when a part of architecture is moving towards responsive or participatory spatialities.

I would like to take the occasion of this thesis to reflect on the contemporary state of our spatiality under digital influence and how light as a design practice can possibly merge and adapt to this new parameter. It will lead to question and explore the combination of architectural lighting, used to deal with the concepts of spatiality, phenomenology and societal aspect of light, with the field Human Computer Interaction through the emerging field of spatial interactive design, more inclined to conceptualize experience through datas, relational and performative systems.

PROBLEM AREA

Lighting has always been intrinsically linked to the notion of space and time. Primarily pre-occupied by the notion of what could be described as the 'hard' part of spatiality (structure, envelop, geometry of forms, materials), a space is nonetheless also defined by what we would call a "soft" part, including atmosphere, flux (sound, light, humidity, thermodynamics, etc.), as well as social-cultural relations embedded within the environment. From visual comfort and functionality to the embodied perception of the space, light plays a major role in the traditional conception of our spatial experience.

This spatial reality is however evolving under the influence of network communication and computational technology. The digital shift is transforming our spatial realm, redefining our conception of architecture and urbanism. On the same time, the digitalisation of light allows to combine it with computational possibilities and network communication already in place in contemporanea big cities. This new combination is considerably widening the scope of light, from a medium to design formal space, to a media to design relational space.

This hybrid form of light, crossing the disciplines of the 'computational media' and 'architectural' cultures is however, still facing a conceptual gap. Whereas architectural lighting stands on the threshold of a dense architectural theories corpus developed for centuries, the cultural and theoretical discourses of lighting as a digital media have been mainly considered through technological consideration, often restricting light to a pixel performance. However, as computation is moving from the screen to the three-dimensionality of the city and its social relation in place, a new interest is raising among the community of HCI, that tends to close the gap between architecture and urbanism on one side, and media-HCI (Human Computer Interaction) on the other side. With the increasing presence in our cities, of what is gathered under the umbrella term 'Media Architecture', digital light is often approached as a graphic tool, close to the display culture and pixel world. The current technology allows lighting to become a dynamic and fully integrated element in our buildings, that can be connected and reacting to its environment and beyond, through a network of sensors and communication protocols. If the state of the current technology allows to design such settings, the aim is somehow still looking for a purpose beyond technology per se .

We argue, and this is the hypothesis of this work, that there is here a fertile ground of reflection and opportunities to bridge and combine these two cultures of light : on one hand, light as an architecture element, able to shape and create functional, as well as emotional connection to space; and on the other hand, light as digital media, revealing a new set of relational possibilities with our environment, able to create a cognitive connection in revealing intangible information about the space we inhabit.

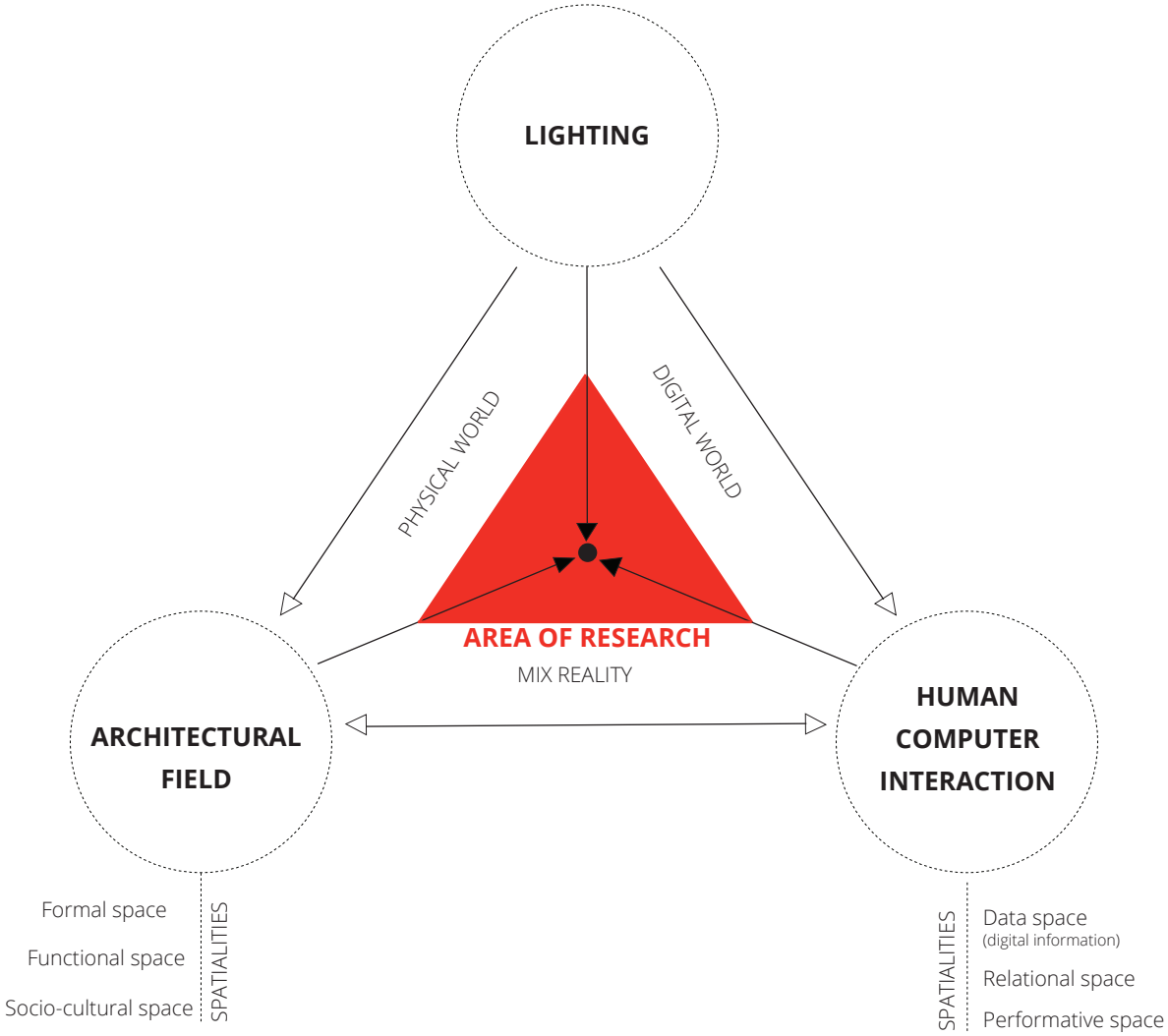


Figure 01 . Approach - Problem Area

APPROACH and METHODOLOGY

> *'The act of designing is ultimately about an integral whole wherein the object, event or state is defined with reference to a desired result. Design education aims to develop creativity, innovation, participation and critical perspective. On the other hand, it has a theoretical infrastructure supporting the teaching of various techniques and a multi/dimensional perspective of the problem. Against this background, interdisciplinary associations play an effective role in developing distinctive perspective. '*
> (Durmus, S., 2016, p.1)

Observing the spread of digital and dynamic lighting in many corners of the cities where I have been living so far (Paris, London and Copenhagen), as well as in the field of spatial art, I was starting to question the aim and purpose of such settings while wondering about their impact on our experience of space and time. This observation was the trigger point of my research journey. I formulated the initial research question based on this observation, as a broad, and accepted as such, approach. My interest was questioning the new combination of digital light with computational possibilities, an emerging field that did not look like having an established set of methodology or the straightforward approach of an established discipline. On the same time, I could observed more and more publication about what is gathered under the umbrella terme of 'Media Architecture', presenting many examples of spatial configuration, through architecture, urbanism or art installation. But somehow, I felt frustrating about the lack of critical thinking, or just design thinking about light as a material, beyond the 'pixel' performance of a direct LED light source.

I recognize that this area of research lies on the threshold of many other ones, and as such, the boundaries are not so clearly defined. Considering both, design and research, as processes of relation-seeking, I decided to explore territories around spatiality and digital technology, attempting to clarify how they could be combined in one whole in the context of light. I first drew on the current state of technologies in the fields of lighting and computation applied to spatial configuration. They both converge in what is commonly called "Media Architecture". Media architecture is a large topic in itself, and has been covered by many litterature. For this reason, it was

necessary to define and delimitate this topic, in regards to the medium of light that this thesis is investigating. From there, I felt that, if I wanted to grasp the relationship of the digital applied to light and our spatial condition beyond technology per se, I needed first to build up some literacy about what makes a place liveable. It implied an understanding of space beyond a formalist, restrictive and simplistic vision of the architecture function. For this purpose, I have been reviewed literature spanning across architectural theories, philosophy and sociology applied to space. Additionally, as my field of research was concerned by the impact of digital technology applied to light as a media, I needed to look for more insight about the connection between the digital technology and architectural spaces, beyond the technical concern per se. So the first step of my approach was to dive into different fields of knowledge, related to the way people connect to their built and technological environments. This first theoretical step allowed me to frame the subject, as well as to define the particular concepts, such as embodiment, atmosphere, ambient technology, augmented reality and performative space, that would be useful for answering the initial research question.

The introduction of computation in the field of architectural lighting challenges the existing conception of designing project. As my topic lies at the cross section of the different design disciplines of architectural lighting and Human Computer Interaction, (both disciplines being very young considering the architectural theoretical background they are both related too), I could not find any specific guidelines regarding their fusion on a design context. However, it became clear that even though lighting was already a context specific design approach, this feature becomes even more pronounced when dealing with the digital possibilities, as they are crucially tied to site specificities. I started to question the design phase I had initially planned to work on, as I did not have a specific case on which I could applied my new knowledge. I did not want to design on the void. If I wanted to find a creative solution for whatever project I would encounter on my way, I needed to develop a solid knowledge and a critical thinking about what has already been done in this field.

For this purpose, a selection of twelve study cases have been made, as a sample of representative works using dynamic light within different spatial contexts. I used criteria drawn from the technological and theoretical background, to analyse these real study cases according to

their physical, experiential and communicative features. Supported by the knowledge of the theoretical framework, the study cases was reviewed from a qualitative, critical and constructive design perspective, essential for the development of a creative approach in this field. The method consisted of gathering information about each projects and analyse them following the same criteria defined in part 4. In doing so, it became possible to compare and build up a clearer vision of the different categories and purposes using dynamic light in different spatial context.

When combining different disciplines, the limitations of the creative outcomes can arise if the possibilities are restricted to each specific field of expertise. From these study cases, it became clear that additional set of skills and knowledge are entering the lighting project's scope, and therefore, require a new and shared vocabulary to bridge the gap between the diversity of profils involved in this project's typology. The study cases illustrates different design approaches, with the aim to open an exchange of perspectives, methods, and professional practice. I hope each field could find inspiration and a common direction in this dialogue, as an alternative, creative and holistic way of thinking dynamic light in the context of computationally 'augmented' spatial experience.

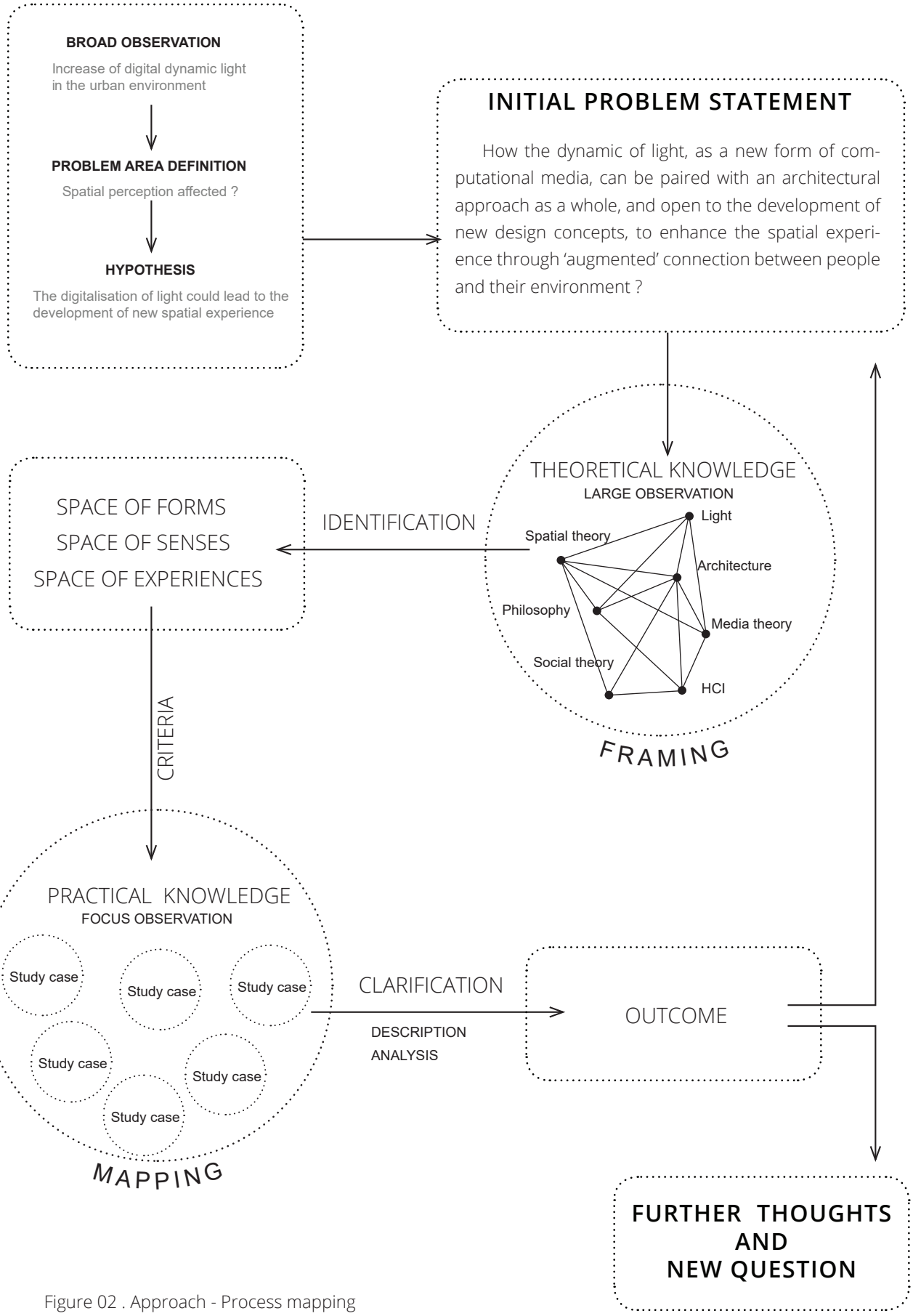


Figure 02 . Approach - Process mapping

VISION

Imagine if the both cultures of light as an architectural element and light as a digital media, could be fully combined as a single design element, to shape and trigger new spatial and relational experience with our urban environment ?

INITIALE PROBLEME STATEMENT

How the dynamic of light, as a new form of computational media, can be paired with an architectural approach as a whole, and open to the development of new design concepts, to enhance the spatial experience through 'augmented' connection between people and their environment ?

PROCESS MAPPING

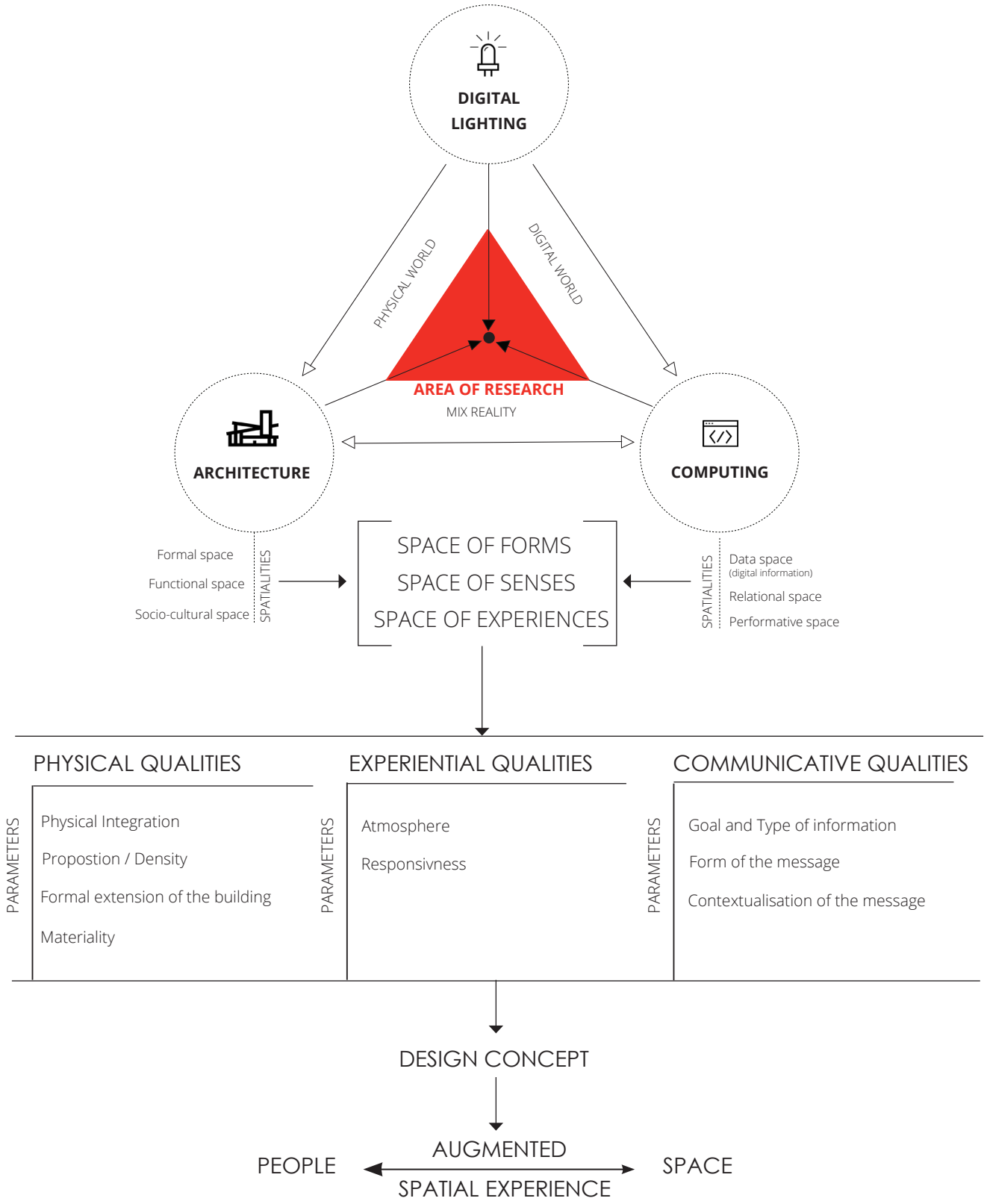
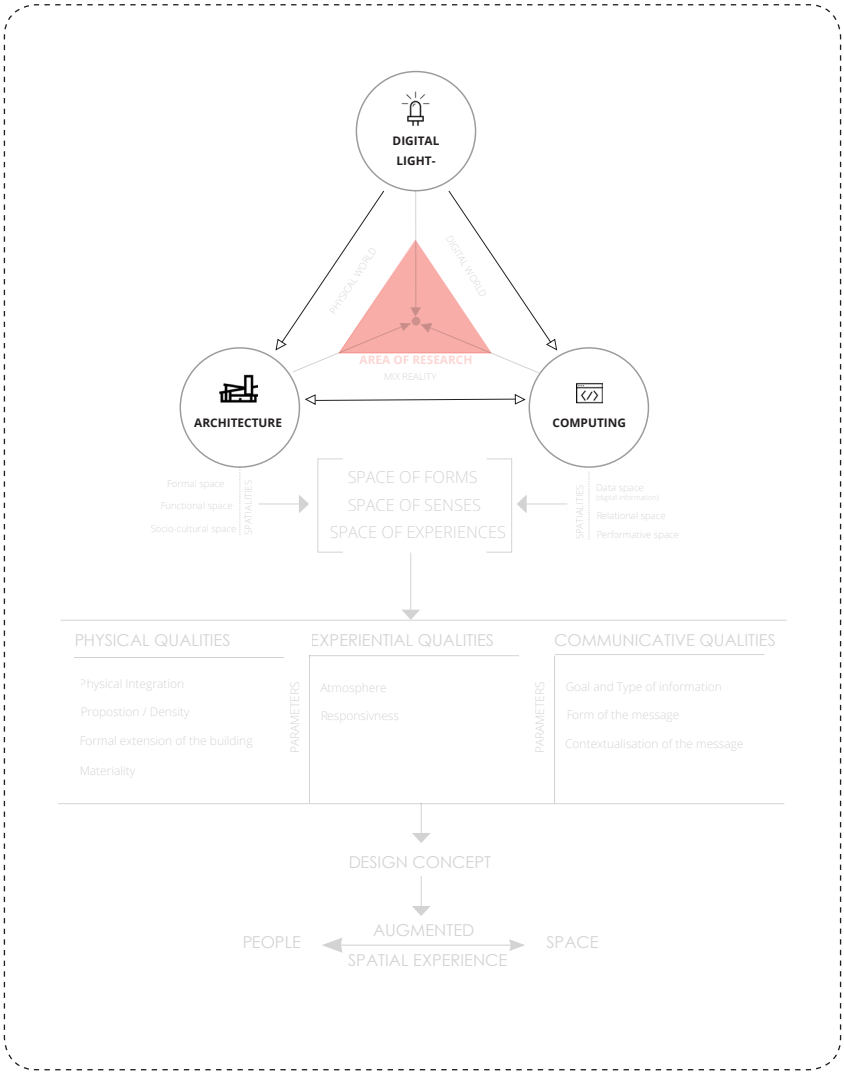


Figure 03 . Approach - Method mapping

PART 2

Technological background



PART 2 : TECHNOLOGICAL BACKGROUND

The aim of this part is to draw the technological background that has allowed the emergence of a new type of lighting system, often labelled as “intelligent”. By technical background, I mean an understanding of the technical aspect of the technology, as well as of its historical development as I think it is important to gain insight of the environment that triggered its emergence in order to comprehend what differentiates it from the other lighting technologies, and how it might change the way we think about illumination.

We will first review the emergence of the LED technology, to understand its origins. Following this historical insight, we will develop on its specificities, so we could draw on its inherent qualities, that distinguishes this lighting technology from the other ones. We will continue the technological background by a brief presentation of the evolution of computation, moving from the computer screen to the space of architecture. These technological advancements create the new triangulation of light, computation and architecture leading to consider a new type environment defined as ‘Ambient Intelligence’. We will describe this concept as well as its constitutives steps of sensing, processing, and actuating. Finally, as lighting and computation are converging in architecture under the form of what is commonly labeled as “Media Architecture”, we will review what are the form taken by light into this category.

By the end of this chapter, we will have identified what differences the LED technology from the other light technologies and how its inherent specificities, opening to its combination with computational possibilities, are leading to consider a new ways of thinking architectural illumination.

1 . SOLID STATE OF LIGHT

1.1 Brief History of Light emitted Diode (LED) technology

Currently, the lighting technologies can be divided in the four following groups : Incandescent, Fluorescent, High Intensity Discharge (HID), and Solid-State of light (SSL). This last one refers to devices that uses semi-conducting materials to convert electricity into light. This category includes organic light emitted diodes (OLEDs), light emitted polymer (OLEP) and inorganic light emitted diodes (LED). We will focus on LEDs technology that has become the dominant one in less than 20 years, and opened to new way of thinking illumination in architectural context.

Incandescent light Fluorescent light HID light LED light

Figure 04 . Current lighting technologies

LED technology is fundamentally different from the other traditional light sources and leads to a change within the lighting industry. The development of LED technology has not primarily been a straight forward trajectory driven by the lighting industry. It has first emerged from the exploration of new materials in electronics, linked to the properties of semiconductors components. As the development of LEDs is tightly bound to the composition of different phosphors, a large part of the technology development is coming from the chemistry sector, while the other part is due to the semiconductor industry, which are components found in all electronic circuits.

While light emitting diode technology can be traced back to the 1920's, LED technology made its entrance into commercial application in the 60's, with the first visible spectrum (red) LED developed in 1962 by the engineer Nick Holonyak.

The early version of LED's, in the 60's and 70's, were emitting a low-intensity red light that could be used for low efficiency and brightness electronic devices, but was not bright enough for illumination purpose. Monsanto Company was the first one to mass-produce LEDs and therefore started to developed divers commercial application. Companies like Hewlett Packard started to

introduce the LEDs into their electronics devices with numerical displays, like pocket calculators and swatches. Further technical improvement, mainly in brightness, efficiency and spectral distribution opened the technology to new applications including traffic light, larger indicator function and signage.

Parallel researches around green and blue LED completed the colour spectrum of the light and allowed the development of the first white LED light source in the early 90's. It quickly led to a technological breakthrough in the mid 90's with the introduction in 1996 of the first high-intensity white LED light by Nichia, (a company whose core business was phosphor for early TVs and fluorescent lighting). Made by coating with phosphor a high intensity blue-emission LEDs, this technical advancement marks the entrance of the LED technology into the lighting industry as a proper source of illumination.

If the first limitation of LED light sources was due to their limited flux output, efficacy and cost, the both parallel increasing markets of electronic displays and lighting devices have supported the fast improvement of the technology in such a way, that in less than ten years, LED technology has gradually penetrated every niche of the lighting industry, with competitive cost and significant increase of performances.

1. 2.The technological specificity of LEDs

Within the lighting industry, efficacy, defined as the amount of visible light (lumen) per unit power, has been the key performance leading the development and markets penetration of the LED technology. Traditional lighting technologies have a poor conversion efficiency from electric energy to visible light. In incandescent technology, most of the energy is converted into heat to makes a filament glowing and emitting light. In fluorescent technology, the current has to flow through a gas-filled tube to create ultra-violet (UV) wavelength which are then converted into visible light by phosphor coating lines into the tube. In these both technologies, most of the energy provided by electricity is lost into the change of material state, which is not the case of the "solid state of light" technology. Light emitted diodes (LEDs) are small electroluminescent devices that produces a range of different light spectrum depending on the characteristics of the semiconductor material used. A LED device includes a semiconductor material that forms a positive-neutral junction converting the flow of electrons into the emission of photons within a specific spectrum. Resumed in a basic way, LED light is emitted when current flows through a semiconductor.

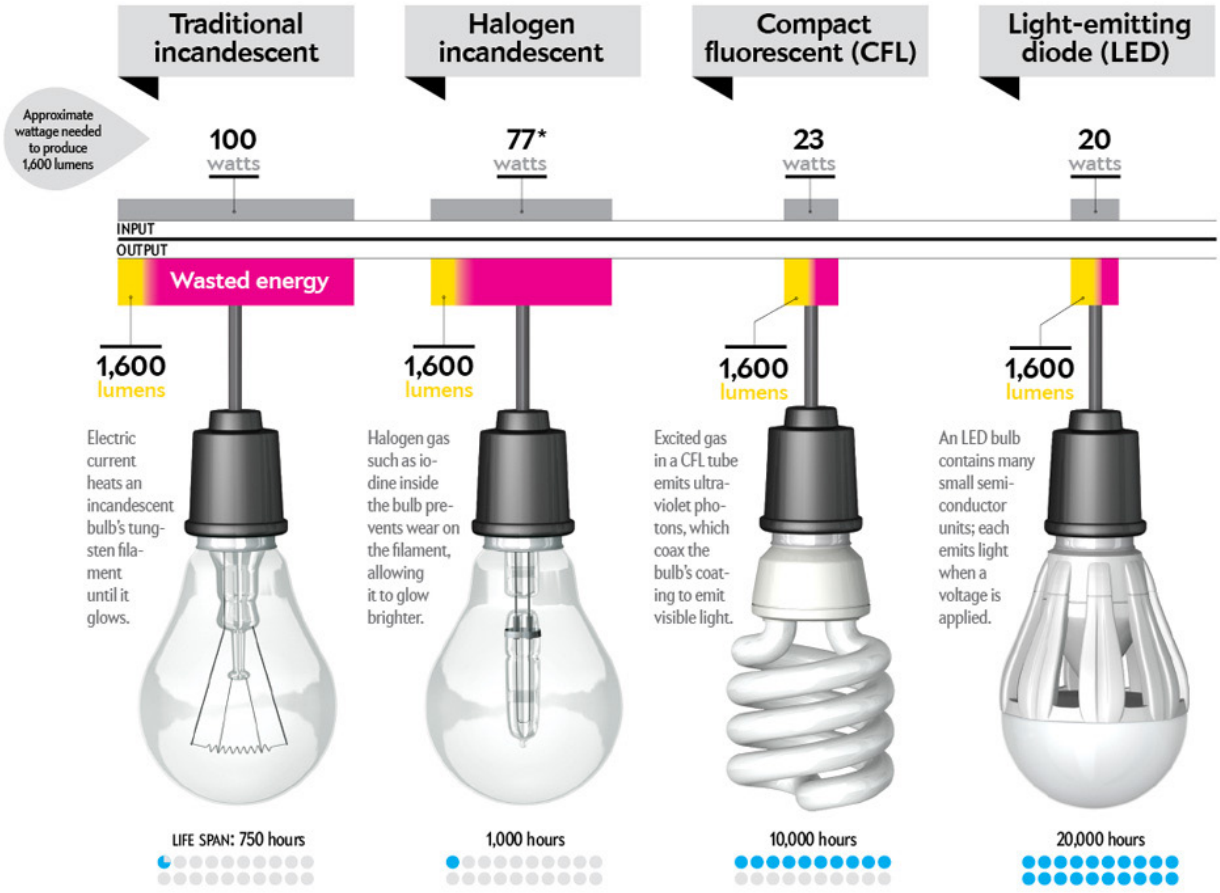


Figure 06 . Comparative illustration of different light technologies

The increasing demand for sustainability in architectural infrastructures, has made of the LED technology an attractive energy-saving replacement for traditional lighting including fluorescent and incandescent technologies. Although energy-saving is a significant parameter in any lighting proposal, the review of literatures concerning this technology is clearly dominated and driven by this cost efficiency approach.

LED technological marks however the introduction of a new mode of light emitting system, including additional possibilities without any equivalent within the other lighting technologies. As such, we argue for the necessity to understand its particularities and question how this new tool may redefine the way to think about light. Taking advantage of the inherent qualities of this technology, instead of replicating former light thinking patterns, may open to new creative application of lighting.

MINIATURISATION

One of the inherent feature of the LED is the miniaturisation of the light source that can be achieved. Rather than delivering illumination by projecting lighting on a surface, LED light source can be directly integrated into the architectural materials and forms. This feature is particularly interesting for facade lighting. In comparison to other traditional ways to lit up a facade, such as interior lighting taking advantage of transparent materials and flood lighting that underlines the volumes and decorations of a facade, LED technology allows the light to be fully part of the facade development. Its direct integration into the building skin allows a better control of the light distribution, while taking advantage of the building materials as a creative tool.

The ability to integrate LED anywhere within an architectural configuration, enable 'to experience light at the scale of the body' (Kennedy,2005, p.14) and 'opens up other uses for the light, particularly the delivery of information' (Addington and Shodeck, 2005, p.179). In that sense, LED technology, embedded into architecture, steps away from the "lamp culture".

> *" The real value proposition for LEDs lies in the change from the bulb culture to digital light [...] LEDs offer a new model for light - digital light - with a set of features that completely change the value proposition of light, the relationship between light and information, how consumer experience light, how they control it, how they can use it in their everyday lives."*
> *(Kennedy, 2005).*

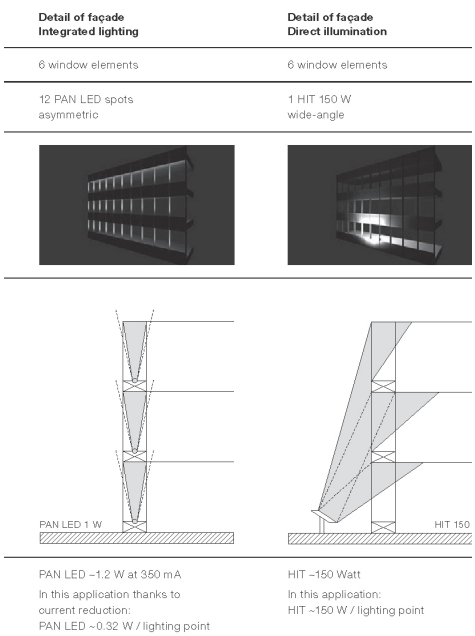


Figure 06. Two differents principles of facade illumination : Leds integration Vs Flood lighting

Figure 07 . Facade illumination from inside, CPH, 2017

PROGRAMMABILITY

The other benefit that distinguishes the LED technology from the other, lies in its easy programmability, instant switch capabilities and gradability. Unlike the other lighting technologies, LEDs can be dimmed and colour controlled instantly, without damaging the light device. The RGB light system is formed by mixing the light spectrums of three individuals red, green and blue diodes, that are then covered by a diffusing layer to homogenised the light emitted as one point source. When the RGB LEDs contain their own electronic controller, they can be individually addressable (programmable from a distance via wired or wireless communication network) and connected for data-in and data-out. This configuration enable a highly dynamic use of small light point sources, that can be instantly programmed, from a change of colour and brightness to a video animation, with a resolution depending of the density of their physical arrangement in the three dimensional space. This feature places the LED technology on the threshold between the lighting and display worlds. This particular position may explain the initiale suspicion at the beginning of the technology, among the lighting community. This technology transcends the barriers of differents technological worlds, and this is precisely what distinguishes LED light technology from the others.

> *" Clearly, if the efforts in place at the major manufacturers succeed in their goals of higher efficacy, higher flux and lower cost, then LED will be excellent replacement for both incandescent and fluorescents. But rather than trying to make this new technology behave the same way as the existing, can we not begin to explore how it might be different ? For example, how best might we take advantage of dynamic control as there is no other lighting technology that offers both dynamism and transiency ? The transiency is unparalleled - any color at any intensity at any time, at the size of a pixel to that of a large surface.*
> *This is an area in which architects and designers could play an important role in opening up new possibilities.'*
> *(Addington and Schodek, 2005, p.192)*

The programmability of light exists for more than twenty years and is particularly used in performance lighting. However, the capability of LED technology to respond instantly and its possible association with other networks of information, like internet, unveil unprecedented potentials and horizons for this light technology.

SMART LIGHTING

As we have stepped into the era of the Internet of Things (IoT), the concept of "smart space" has emerged, referring to human interaction with a technological-enhanced environment based on electronic devices, producing and consuming information. Among this category, divers appellation like "connected light", "smart lighting", "interactive lighting" have lastly appeared, expressing the emergence of a new field of experimentation and intervention for lighting. They all refer to the digital nature of the LED technology, that allows to bridge the lighting installation to a parallel network of information via computation. The lighting system becomes associated to information contained in the environment, as well as to the communication networks that relays these informations from one point to another. Within the field of "smart environment", lighting has a unique position since it is an omnipresent technology in the human environment. A smart lighting system has the intrinsic capability to detect, analyse and translate data into a light reaction, via the control of its parameters (mainly brightness and colours). While smart lighting technology still mainly focuses on energy efficiency or personalization of the light service, in street, office and domestic lighting markets, the technology puts forwards a new set of relation between light and its surrounding. This new configuration expands the scope of lighting through computation, towards responsive and communicative functions.

2. COMPUTATION FROM SCREEN TO SPACE

2.1 : New triangulation : Light - Computation - Architecture

COMPUTING OVERVIEW

Computers have pervaded our environment in only few decades. In the late 70's, the first microprocessors manufactured set a technology revolution symbolised by the emergence of the personal computer. The 1980's are marked by the computer at home, and a larger amount of information able to be processed. The futurist Paul Saffo calls this period the time of processing. The next decade of the 1990's has been all about the access of information and the decentralisation of computing network with the apparition of the World Wide Web. The 2000's saw the apparition of sensors attached to our computational abilities that have been transferred into compact and mobile devices such as smartphones. As the scale of the network of sensors continues to grow, we continue to collect more data about everything. This phenomenon called the Big Data, is currently raising question about how to convert them into something meaningful, that we might use to build knowledge about our environment. Paul Saffo argues that the next waves of technology advancement will be drive by interaction, as we interact more and more in real time with our devices, but also with the world around us through the network of sensors.

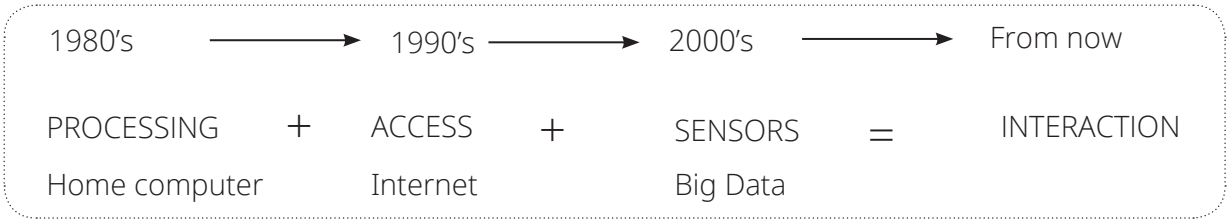


Figure 08 . Scheme illustrating the evolution of computing according to Paul Saffo

> *"In the 1980s, we created our process-based computer "intelligences". In the 1990s, we networked those intelligences together with laser-enabled bandwidth. Now, in this decade, we are hanging eyes, ears and sensory organs to our computers and our networks. We're asking them to observe the physical world on our behalf and to manipulate it. This decade will be marked by a sensors revolution - a big leap in automation that will have a far-reaching influence on business and society. Processing plus access plus sensors will set the stage for the next wave - interaction. By interaction, I don't mean Internet variety interaction among people. I mean the interaction of electronic devices with the physical world on our behalf.*
> *(Saffo, P., 2002, p.33)*

UBICOMP

In regards to architecture, our computational possibilities have migrated from the computer screen to the physical space of our daily environment through embedded smart technologies. LEDs lighting system, as part of the those ones, ties the light to the digital paradigm that has pervaded the architectural space. This shift was envisioned by Mark Weiser, in his article "The computer for the 21th century" published in 1991. He forecasted the computation freed from the desktop area and its seamlessly integration to the physical world with a significant impact on the way people experience space and time. He famously coined the term "ubicomp" to refers to the presence of invisible computers (ubiquitous computing), everytime, everywhere. This concept, foundation of computing research, relies on a networked of electronic devices providing a responsive and interactive background for interactions with digital information, while the user stays grounded in the physical space (Seitinger,2010,p68). It 'describes the phenomenon of interacting in context with artefacts and environments that are interwoven with processing and communication capabilities' (Schmidt,2002, p20). Also known as ambient intelligence, embedded environment or pervasive computing, this concept has become a reality today.

MOVE TO ENVIRONMENT

Ubicomp has expanded the context of human-computation-interaction (HCI) from the screen of individual computers to the physical space. Under the form of microprocessors and wireless communication, computing technology has proliferated in our the physical environment, and digital networks are no longer separate from architecture. As many litteratures pointed out (Harrison S. and Dourish P. (1996), Dourish, P. (2001), Ciolfi L.(2003), McCollough M. (2013), this shift requires a new way to comprehend the relationship between human and computational technology, as the interaction is taking place in the real environment and therefore is highly contextual. While the move of computation from the screen to the space is changing the role of computation, this shift also marks its convergence with the fields of architecture and urbanism, as well as its meeting point with architectural lighting. This new triangulation of HCI, Architecture and Lighting design opens to new perspectives towards the conception of adaptive, responsive and interactive environment.

> *The role of computation has changed, and information technology as become ambient social infrastructure. This allies it with architecture. No longer just made of objects, computing now consists of situations.*
> *(Mc Cullough, p.21)*

2.2 : Ambient intelligence

While HCI was primarily focused on interaction between human and computer, the move of computation to spatiale configuration has expanded the influence of digital technology within our physical environment, giving birth to new spatial concepts like ambient intelligence, responsive and interactive environments. While they differ by the type of user engagement they imply, they all refers to a physical space enhanced with the use of context-awareness technology and media. The digitalisation of light allows to connect the LEDs to these computational technologies already embedded into the urban environment, while this combination could take full advantage of the programmability and miniaturisation of this light technology.

If “Ambient intelligence” refers to the fact of sending information to a device in order to make it reacts, in the context of dynamic lighting, it must however be distinguished from a fixed and pre-set programmation, than a dramatist would call “mise-en-scene”. In this last case, the information is sent, like a script or scenario, and pre-defined the behaviour of the light for each instant. Programmation in lighting exists since at least twenty years. It is largely used in the fields

of theater and performance, but also in architectural lighting through DALI and DMX protocols. However, as McCullough points out, such settings "was simple enough before telecommunication" (McCullough, 2013, p.95). The new technological background and the rise of digital media changed the way to think about dynamic light. The new realm of omniscient and self-contained information into the physical environment, drive the light towards the horizons of ambient intelligence and responsive environments.

> *"Ambient intelligence proposes new way to interact between people and technology, where this last one is adapted to individuals and their context, showing a vision where people are surrounded by intelligent interfaces merges in daily life objects."*
> *(Tapia D., Paz Y., Bajo J., 2007, p.2)*

The term ambient intelligence has been caught in the first decade of the millenium, and combines context-awareness technology, ubiquitous computing and interaction. It can be described as an adaptive system linked to a context-aware technology, that allows this system to obtain information about the environment and have the ability to adapt itself to this context. Depending of the level of connection between the user and the system, it is either qualified as reactive, responsive or interactive. In all these cases, an ambient intelligent system is the product of several technologies chained together, following this three main steps : sensing, processing and actuation.

"Ambient" in the context of information technology refers to the background information contained in the environment, or context. A context is a set of information used to define a situation or circumstance, considered as relevant for the system to trigger computing tasks. It is linked to the notion of Ubicomp that provides access to information content through the environment, while making this access invisible to the user (Lino J.A., Salem B., Rauterberg M., 2010, p.1). The process of context awareness consists of clarifying (description and classification) the information contained in an environment, and collecting them in real-time using a set of technologies such as sensors, wireless network or wireless control devices.

SENSING

Contextual awareness starts from the ability of the system to recognize who or what it shall respond to. Sensing refers to the mechanisms in place to acquire the context information. It can refers to electronic or mechanical components (sensors), widely used in robotics, automation and process control. A sensor respond to a change in state that can be an event, a gradual attainment of a threshold, or the establishment of a pattern. It measures parameters in the phys-

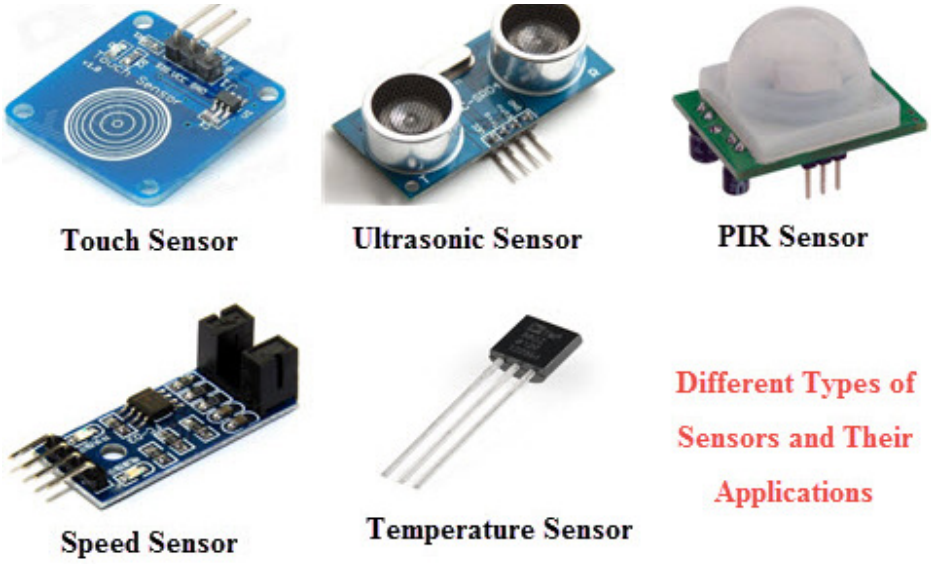


Figure 09 . Examples of electronic sensors

ical environment and provide information on electronic level, as analog output or digital signals. The range of sensors available is wide, but to give a broad idea of their diversity, we can mention, among others, sensors detecting motion, light level, radiation, temperatures, weight, magnetic field, audio. Sensing can also refer to logical sensors that provide information about the context without being physically measured, like time or digital datas available (Schmidt, p.79). As this process implies the collect of information from the environment to trigger a response from the system (actuation), it is often compared to the human perceptual process, with the presumption that the meaning of an environment can be sensed and measured as a quantitative metric.

> *" [...] the same way we use five senses to perceive and understand the contexts in which we live, spaces need to have the means to acquire information in order to locate users, understand what they are doing and provide a response. Metaphorically, sensors could be considered as the system's senses, whereas actuators are the system's means of expression".*
> *(Lino J.A., Salem B., Rauterberg M., 2010, p.1). p.5)*

In a context of data-fetichism and "smart city" as the dominant model of urbanism, ambient intelligence and responsive technologies are often presented as the paradigm of efficiency for infrastructure management. However, in her article "Methodolatry and the Art of Measure" (2013) the professor Shannon Mattern reminds that "There is no such thing as "raw" data; all data are formed through the means by which they are derived and presented." Datas gathering from the environment is therefore a first abstraction, or "minimal perception system", and shall be considered as such in an ambient intelligent environment.

> *" Having the right sensing infrastructure is just a prerequisite, to make use of it, perception and the ability to match the stimuli acquired with patterns that indicate actions is also an essential part. Senses, as we know them from biological systems, incorporate all these steps, whereas sensors in a technical context only provide very basic information. [...] in real settings, the central issue is to create a minimal sensing and perception system that can provide the information required."*
> *(Schmidt, p.84)*

This reminder is supported by researches in information sciences, from where the model of information hierarchy below is drawn. This one clearly illustrates that data are just the first step of a process, to build meaning and understanding of a situation. This model proposes a hierarchy where data are stimuli; information are data endowed with meaning and purpose; knowledge is a mix of framed experiences and contextual information; while wisdom is the ability to increase effectiveness through personal judgement.

Figure 10. Information hierarchy (Data/Information/Knowledge/Wisdom pyramid)

The current technologies available for “sensing” (we question here if “measured” could be better appropriate) allow the collect of information (data) within an unprecedented proportion about our environment. They also allow to collect information out of reach for the human perceptual system. But as the DIKW pyramid suggests, the question is what do we do with all these data, how to curate, organize and access them in a meaningful way ? These questions led us to consider the next step of a responsive system: the data processing.

PROCESSING

When data have been collected, they have to be filtered, reduced and abstracted in order to become manageable. This task is done by a microprocessor that executes a program. A program is a structured architecture of instruction sequences, that performs a specific task when executed. Computation is essentially a process made of data operations, that transforms inputs into outputs. It exists many divers programming language, but they all have the same purpose : manipulating information. Without entering too deeply into computer science, what is important to grasp here, is that programming is a language, and as such, a process of abstraction addressing information through a communication protocol based on rules. The structure of the program will affect how the information is abstracted, and therefore will influence the form of the final output. In a ambient intelligent system, the program can mainly takes two forms :

1 / Fixed computation : which means that the conditions (rules) of the system actuation are hardcoded; this configuration is suitable when the context and parameters that should be recognized are independent of the system.

2 / Adaptive and Generative computation: which means that the system is “open” or flexible and start tweaking itself in incorporating learning capabilities (adaptive) or new parameters (generative) that allow its structure to adapt progressively to an over changing context. (we won’t enter here in Artificial Intelligence, but as we will see later this distinction between these two forms of computation has its relevance in the design of responsive systems)

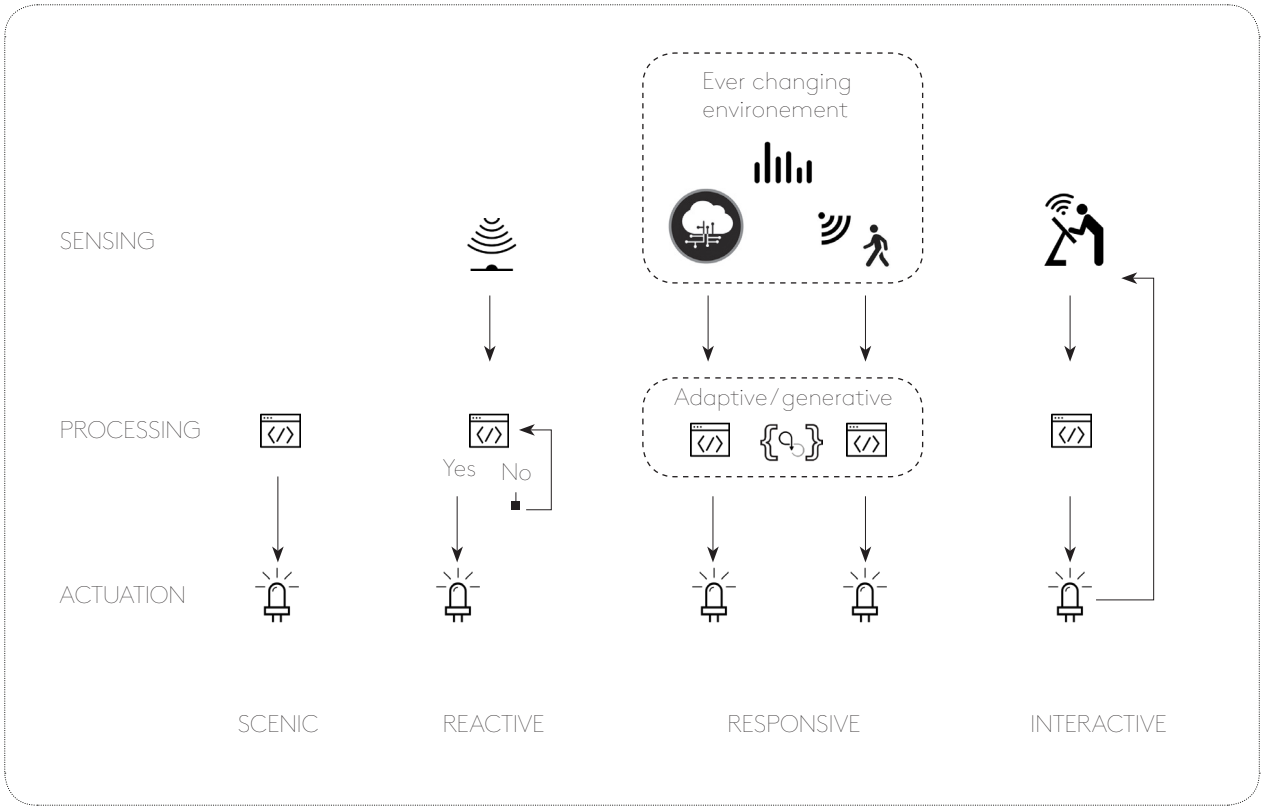


Figure 11. Illustration showing the different configuration of dynamic lighting

ACTUATION

When the data have been processed, the system actuates itself. Depending on the level of engagement and awareness of the users, the system is either reactive, responsive or interactive.

A reactive system corresponds to a first level of actuation. Reactive systems follow a reasoning and planning pattern, based on past experiences (scenari), that allows the system to react automatically to the same type of information. As the detection of information follows simple and identified conditions, like presence detection, this configuration is mainly used for automation devices. They are impersonal and does not require site specificity for adapting.

A responsive system actuates itself in permanence and adapt its condition in real time to an ever-changing set of informations, coming from its context. The output is tuned with the environment and form a contextualised response. Engaged in a site-specific actuation, the system deliver informations coming from the context as a way to engage beyond aesthetic pleasure or metaphoric consideration.

An interactive system requires an explicit engagement from the user, and therefore tailored a feedback conversation with this one. It requires the users to become actif and take initiative. Based on participation, interactive systems often aim to integrate the users into collective participation when used in urban environment.

In the context of lighting, the instant dimming possibility of LEDs has open the industry to this type of context-aware automation, particularly welcomed for the gestion of city infrastructures. The regulation of public lighting, with the raising concern of light pollution and energy saving is taking advantage of this configuration. Instead of being based on a centralised clock, the management of light levels for street lighting can now be managed locally in real time with the integration of motion detection or natural light level measurement. Street Lighting become "adaptable" delivering the light when needed. From the perspective of the technological background just reviewed, the street "smart or intelligent" lighting, is however no more than a reactive system. The current fields taking full advantage of dynamic light coupled with computational possibilities, lie at the moment in the fields of Media Architecture and Media Art.

3. LIGHTING MEDIA ARCHITECTURE

3.1 : Media architecture - A brief definition

The terminology 'Media Architecture' usually covers various forms of dynamic and/or interactive technologies integrated within architecture and the built environment, in order to passively or actively broadcast information to their surrounding. (Wouters, 2016:2) . In terms of technology, it includes electronic displays, dynamic lighting, mechanical or electrical elements, embedded into architecture. Considering the purpose of this research, we will focus on dynamic light. The term 'Media Space' covers differents type of dynamic settings, usually divided in the three main categories:

URBAN SCREEN :

Public display, usually attached to the building facade without having been integrated as an element of architecture. Often seen as the digital version of billboards, they tend to be localised in areas of human convergence, like public transport or shopping malls, and usually deliver local information or advertisement. (Wouter, 2016:2 et Tscherteu, 2010:12)

MEDIA FACADE

Media facades integrates into their design, electronic technology able to create dynamic effects, like digital light sources and network infrastructures. As they bring together electronics and architecture as a whole, they create an hybrid form of architectural surface, able to perform beyond the possibilities of urban screens. The surface of architecture become permanently changeable and the way to communicate can exceed symbolic communication. (Tscherteu, 2010:13). Integration as a whole is one of the main characteristic of the Media Facade, that clearly distinguish it from the urban screen.

MEDIA ARCHITECTURE:

Whereas Media facade refers exclusively to the skin of the building, the new born terminology of 'Media architecture' considers the whole space of buildings and urban settings as an integrated solution bringing together electronic and architecture into an holistic process of spatial configuration. As it enlarges the scope of architecture to the urban context, this form is highly relevant for the cityscape.

3.2 : Dynamic light in Media architecture

In the context of Media architecture, the dynamic nature of digital light can take three forms that condition the type of relation with the environment:

PRE-RECORDED CONTENT , where dynamic effects are pre-programmed like in a show. Even though it conveys a sense of time to architecture, the level of direct connection with the surrounding is nonexistent, if the 'plot' of the story has not been designed in relation to the context of the building. This approach is closed to scenography, as the narrative plot unfolds always in the same way, regardless of the context.

LIVE CONTENT : dynamic effects are generated in real-time by a program that translates the data captured from the environment. This type of settings can be found in what has been labelled as 'Augmented Reality' and 'Ambiance communication' (concepts that we will cover later on this thesis). The effects are dependent of the context as they are a 'visible' manifestation of intangible phenomenon in place on the environment. The level of awareness required ranges from unconscious peripheral to conscious and focus, depending on the design goal.

INTERACTIVE CONTENT : dynamic effects that require the conscious participation of the user, triggering light effects in real-time. A dialogue loop is set up between the built environment that influences the users and the user's performance that influences the building.

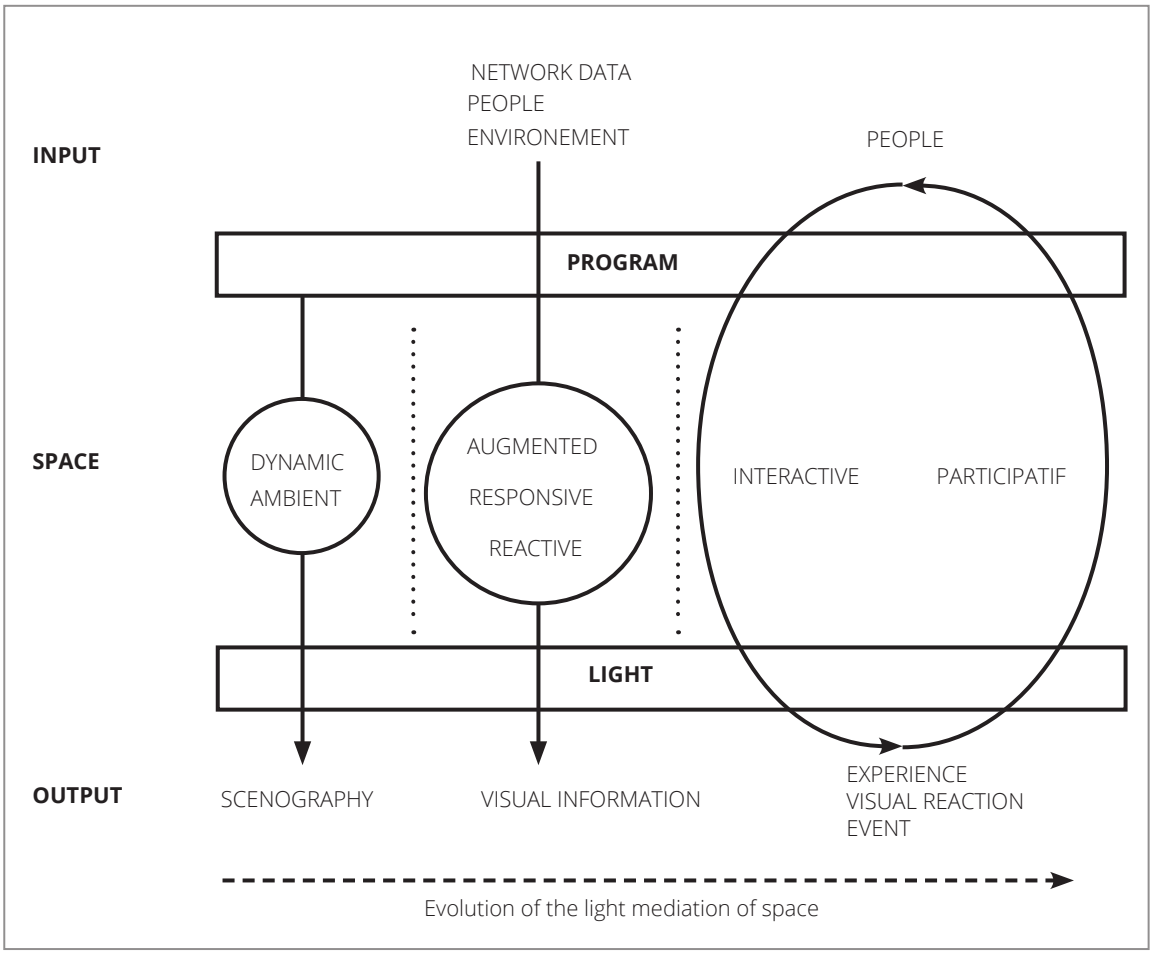


Figure 12. Illustration showing the different type of dynamic light mediation with space

Linked to the development of Media Architecture, the traditional mass-media have been supplanted by digital communication, based on an invisible network which connects every single points of the globe, anytime, all the time, and creates 'a society that demands new and different stimuli constantly' (Marques Pereira, 2011, p.2). This new media-environment is redefining architecture as well as our social structure. The contemporanea question about Media Architecture relates more to the impact of such spaces on human experience, rather than on technology per se.

> *"As open systems become more prevalent in computing, and as the processes they model include more social complexities of everyday life, the challenge of designing them becomes much more like architecture. Architecture intentionally configures space by means of schematic proposals. It models form and identity more often than behaviour or performance, and addresses all of these without the luxury of predictability. As a set of intentions about arranging space, architecture intrinsically applies a theory. As a philosophical means of ordering many aspects of experiences, a particular way with space reflects a particular culture. [...] Now the configuration of pervasive computing requires similar levels of theory, models and intentionality."*
> *(McCullough, 2004 p.115)*

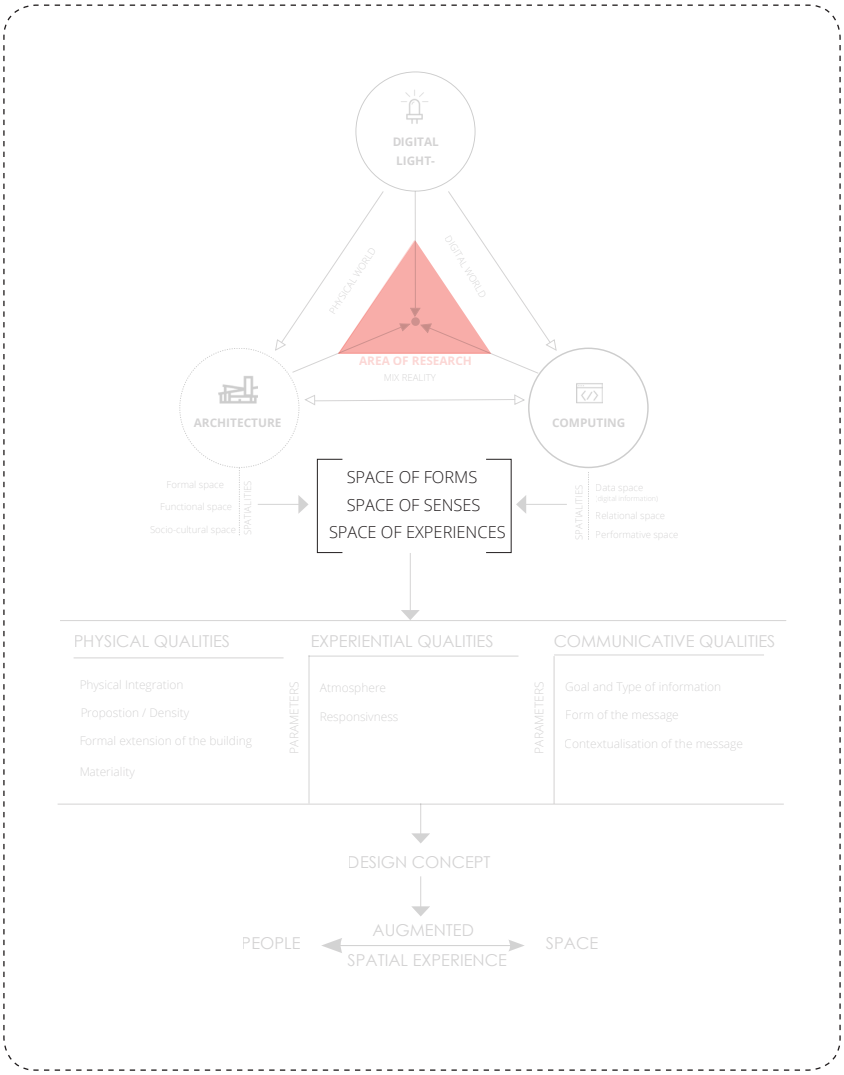
TRANSITION

If they have their own domain of specificities and concerned, lighting and computational technologies have some common particularities. Both omnipresent in the human environment, they however stay intangible technologies while crucialy defining the spatial condition of human beings living in big cities. They are nowadays both converging in space, where they entwined together with the common aim to enhance and define “augmented” experiences.

Lighting became a design field on its own, when it has been recognized beyond the lux levels, standards and technical performances. If a certain part of the field is still practiced in this purely quantitative way, there has been a raise of interest on the subject that has largely contributed to expand the scope of light beyond numbers and technicity. While interest in a human centered approach has gained in popularity, lighting has gradually been recognized as a qualitative, formal and perceptual tool in architecture and urban discours for the last fifty years. In parallel, the domain of computation has been developed in such a way, than ubicomp became reality, and computation entered the sphere of spatial concerns. With its recent digitalisation, light inherits of a new range of possibilities from computation, centered on reactivity, connectivity and communication as a new way to engage and experience the world. Becoming dynamic, responsive or interactive, light becomes integrated in a context-awareness system. The apparition of ambient intelligence marks the resurgence of the intangible in spatial discourse, looking at the concepts of ambience, embodiment and social interaction, to ground itself in space. How this new hybridization of light and computation entwined in our environment, is affecting our relation to space? As these both cultures of light and computation are converging in space, they need to be bridged together, so they can form a coherent whole.

To address this matter, we need to contextualised these emerging technologies, and find their places in the concept of spatiality. We will review differents aspect and theories, participating of the definition of spatial experience, from architecture, philosophy, and social sciences. The aim is to foresee technology beyond technic, so they can find meaning in a human centered design process.

PART 3
Theoretical background



PART 3 : THEORETICAL BACKGROUND

'Space is first conceived of as a property of the mind and then realised as physical matter. In the move from metaphysical concept to the physical reality, the word 'space' has to cover a whole variety of conditions [...]'
Jeremy Till, Architecture in Space, Time, 1996

As we have seen in the precedent chapter, the current advancement in digital and computational technology is changing light, in term of technical possibilities and arrangements.. At the merging point with architecture, this new hybridization of light is reshaping the way it relates to the buit environment. How this change might impact people's perception of their surroundings is still a pending question.

Lying between human perception and the environment, light ties together the concepts of space and time. Among fields concerned with spatiality, architecture, urbanism and art, have become used to integrate light in their practice, as a spatial and narrative element. Computational technology, however, has entered the field of spatiality more recently. In 2003, the professor Luigina Ciolfi was pointing out that the design and methods born from HCI and Interactive design, developed for different type of interaction paradigms and systems, were not carrying an inappropriate legacy (Ciolfi L, 2003,p.1). On the same period, the professor Malcolm Mcculloch was calling for an 'architecturally situated technology design', stating that digital technology could no longer be considered separately from architecture.

" Digital networks are no longer separate from architecture. [...] pervasive computing has to be inscribed into social and environmental complexity of the existing physical environment. [...] Unless this new field will belong solely to technocrats, or tyrants, it demands a richer cultural foundations. "
(McCullough M.,2004, p.XIV)

Considering the technological change in lighting, we will argue in the same way. Digital lighting has gained in popularity creating an urban environment transformed by dynamic light effects. As a spatial element, this pervasive technology is becoming an integral part of our physical environment, impacting the human experience of the space. In order to use technology beyond technic,

we call for a ground in humanistic perspectives, and consider it is important to gain insight on the human-space relationship.

> *" We do not need more technology, nor do we need more light. What we do need is an understanding of how to apply the technology already at our disposal, which can only come from an understanding of how we see, what we look at, what we perceive and why. "*
> *(Lam, W. 1977, p12).*

As stressed here by the lighting Designer William Lam, what we need is to understand technology from a human contextualisation. In order to use technology beyond technic per se, and to integrate it mindfully in a design practice, we need to ground technology in humanistic perspectives.

This chapter will explore different understanding of spatiality and how they can relate, nurture and ground a creative process for bridging together light and computation technologies into a spatial context. In the exploration of philosophy, architectural and social theories, we are looking at some conceptual markers describing the human-environment relation, and how they might be applied to think about the change of our spatial condition under the digitalisation of light. We will first look at the conceptualisation of space as a formal expression of the visual system through perspective. Then we will cover the notion of space as a field of sensations, from which the concepts of embodiment, atmosphere and ambient technologies find legacy. Finally, we will explore how the current digital Media culture is redefining the space as an experiential environment. By the end of this chapter, we will have gain insight on different layers and parameters to be considered when designing with light at the edge of the architecture and digital media fields.

1 . SPACE AS FORM

1.1 PERSPECTIVE AND THE HEGEMONY OF VISION

The experience of space is a blend of complex relational structures, coordinating the stimuli we perceived through our senses with the conceptualisation we have made of it in our mind. From the moment humans have been describing space by means of symbols, cartography, schemes and plans, their spatial perception has been shaped by the way they have been conceptualised space. In the Western world, the conception of space, based on geometry, has influenced not only architectural forms, but also its representations, and therefore the western vision and understanding of the world. In his essay, *the Projective Cast (1995)*, the historian and theoretician Robin Evans, demonstrates the close relationship between the production of architecture and its representation through the tools that architects have been used to communicate their concepts. He points out that geometry is a constitutive part of Western architecture, and distinguishes two types of geometries : the metrical, or haptic (the geometry of touch) and the projective or optique (the geometry of light and vision).

Geometry, which means in greek "the measurement of earth or land", was the first science to make the transition from the empiric and sensorial experience of the space, to a relational deduction as a purely mathematical branch of knowledge built upon axiomatic foundation (Wackermann, 2011, p.25) . The first form of geometry applied to space was found in ancient Egypt, as a method of orientation and appropriation of the environment in measuring and dividing the physical space of the lands with the help of a rope (metrical system). This first act of spatialisation through practical experience marks the beginning of an intellectualisation of space, that will lead to its theoretical abstraction, with the mathematical rules set by Euclid of Alexandria (c.365-300 BC). The Euclidean system describes the relation between different geometric elements as an abstract technique of measuring the physical environment. Since Euclid, geometry has been involved in the study of vision, giving birth to 'geometrical optic' as a common theoretical ground found in different domains as the art of pictorial representation (perspective), the construction of optical instrument and the functioning of the eye (Wackermann, 2011, p.26). Geometry has set the foundation of the understanding of vision in the western world, through which space has been mainly theorised since the mid-fifteenth century with the writings on perspective by Leon Battista Alberti. The Renaissance and the invention of perspective marks the primacy of vision on

the other senses, at the core of the spatial conceptualisation in the Western world. The american architect Peter Eisenmann, resumes :

> *[...] since the importation and absorption of perspective by architectural space in the 15th century, architecture has been dominated by the mechanism of vision. Thus architects assumes sight to be preeminent and also in some way natural to its own processes, not a thing to be questioned. [...]*
> *(Eisenmann, 1992, p.1)*

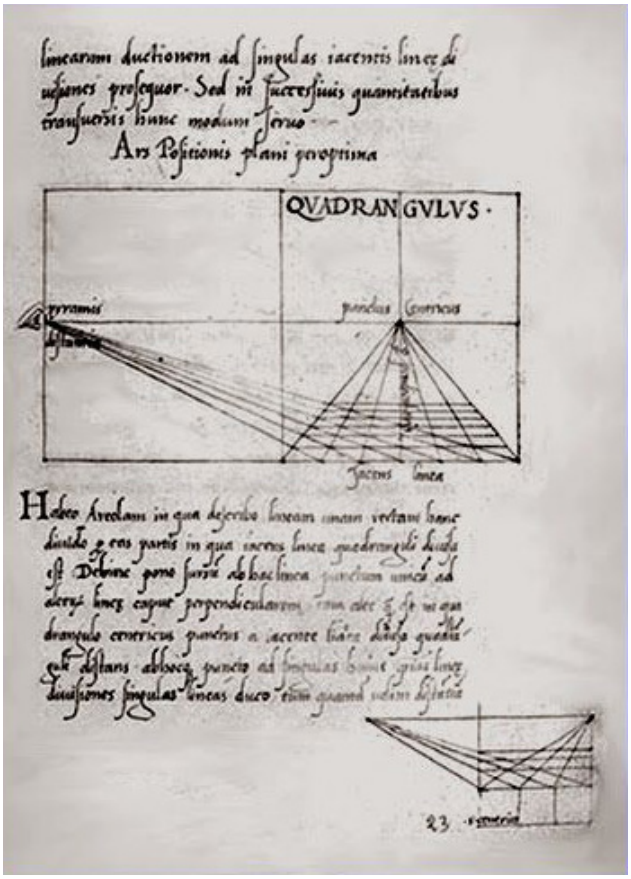


Figure 13. Leon Battista Alberti, De Pittura e elementa picture
1518 - Manoscritto cartaceo; Lucca, Biblioteca Governativa

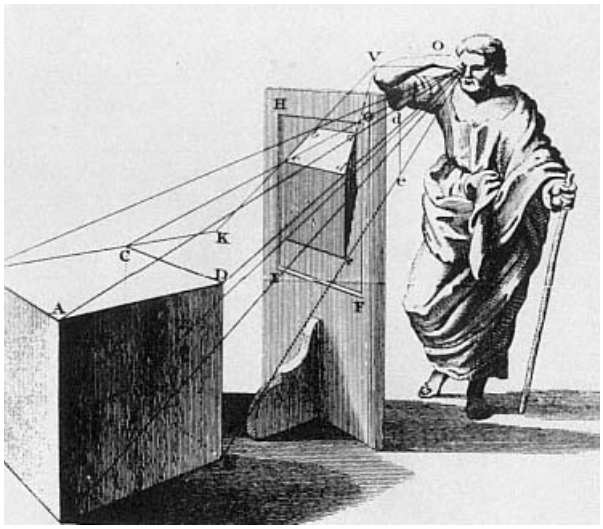


Figure 14.A demonstration of perspective principle
From Brook Taylor, New Principles of Linear Perspective (1811).

In his critical essay *The Eyes of the Skin, architecture and the senses* (2005), the architect Juhani Pallasmaa analyses the influence of the visual domination in Western culture. He demonstrates how the vision has pervaded the way to perceive, think and design our environment and therefore became the dominant way of knowledge to reality.

> *'The invention of perspectival representation made the eye the center point of perceptual world as well as of the concept of the self. Perspectival representation itself, turned into a symbolic form, one which not only describes but also condition perception'*
> *(Pallasmaa, 1996, p.16)*

The american geographer Yi-Fu Tuan goes even further on this direction, demonstrating how the perspectivist organisation of space not only shapes our perception of space, but also our conception of time.

> *'Seeing landscape in perspective presupposes a major reordering of time as well as of space. From the Renaissance onward, time in Europe was steadily losing its repetitious and cyclical character and becoming more and more directional. The image of time as swinging pendulum or as circular orbit ceded to the image of time as arrow. Space and time have gained subjectivity by being oriented to man. '*
> *(Tuan, 1977, p.123)*

1.2 PERSPECTIVE DISSOLUTION : THE RISE OF LIGHT AS FORMGIVER

The perspective, and its corollary vision, had a huge impact on the Western relationship of human with space. Placing for the first time, human at the center of the world, space was organised around a unic and human scaled focal point. This spatial conception has dominated architecture for several centuries, before being completely disrupted by the "technological sublime" (E.Nye, D. ,1994) of the XIXth century. The emergence of the industrial age, based on the new technologies and materials, with the apparition of electricity, steel and glass construction, marked an unprecedented change on the production of architectural and urban spaces.

Electrical lighting played an important role in the definition of this new spatiality. As Scott McQuire points out in the remarkable book *The Media City* (2008), the 19th century architecture defined a light-based city space, 'marking a critical threshold in the psychogeography of modern urban space' (McQuire, 2008, p.113). Electric light has defined a new relation between material and immaterial space, through a new sense of instant and 'action-at-distance' control of electrical switches, promising the 'mastery over time and space' (ibid, p.116). His analysis demonstrates that the impact of electric lighting exceeded its functional role, supporting the new urban and industrial society, while transforming the space of social life in the city:

> *' the ability to convert night into day at the flick of a switch offered the most striking proof of the superiority of the modern present over the past, the most compelling evidence of the ability of technological progress to subdue even the basic diurnal rhythm of nature'*
> *(McQuire, 2008, p.115)*

The development of glass as a facade material on one hand, and the apparition of electrical light on the other hand, have set up a new way to experience the space of the city. The culture of transparency became the symbol of modern life. The windows, until then corollary of the perspective view, extended their size to fit the scale of the walls. In defining a 'two-way' model of visuality, they transformed the relationship between the inside and outside spaces; while keeping the outside out, they, at the same time, brought the outside world in (Friedberg, 2006, p.127).

The modern expression of architecture, characterised by a large use of glass and steel, dissolved architecture in a floating structure, transforming the space in a play of light, while freeing itself from the perspectivist understanding of space.

This new aerial aesthetic of space marked an increasing interest for light as an architectural element. Pioneer in this approach, Richard Kelly (1910-1977) was one of the first to understand that modern architecture required a new way of thinking light. He figured out that new lighting fixtures only, would not be the solution to fit modern architecture, and started to elaborate his own personal approach, distinguishing him from the world of lighting engineers and theatrical lighting designers. Initially trained in theatrical production, he however felt that to legitimate his ideas among the architecture community, he had to become one himself. He enrolled and graduated from Yale in 1944 with a BA in architecture , and became the first architectural lighting designer practicing independently from lighting manufacturers and electrical engineers contractors. Setting the base of what would become recognized as an independent practice, Richard Kelly developed the first holistic understanding of light applied to architecture. His approach often resumed by the interplay of three illumination principles, focal glow (highlights), ambient luminescence (indirect light) and play of brilliance (sharp details), initiated a new way to think light, based on a qualitative approach beyond the functional and the decorative uses of light. Developing his philosophy, he distinguishes six light qualities to be considered when designing : intensity, brightness, diffusion, direction and motion. Focusing on perception, he introduced the concept of composition with the different qualities of light and effects, using contrasts to shape the visual dynamic of space.

> *In the use of any and all knowledge of light, its qualities, its tradition in cultural influence, etc, in combining the three major element of visual sensation to make beauty, remember that "variety is the spice of light", and thus must be used cautiously by an understanding hand to be visually significant.*
> *To play with light is to play with magic - it demands a trained eye to recognize real and relative values, experience and knowledge of the cultural and psychological effect of light in people, experience and knowledge of physical technique.*
> *(Richard Kelly, Light as an integral part of architecture, 1952)*

In using light as spatial reference, he introduced the central notions of perception, psychology and culture in the definition of space. This unique approach on his time, distinguished him from electrical engineering, mainly considering light as a uniform quantity of luminance to provide in a space. Richard Kelly has set the ground for humanist and qualitative vision of light, that still finds resonance today. Architectural lighting design focuses on the articulation of space with light as a medium dotted of physical, psychological and cultural qualities. Twenty years later Kelly, William Lam, was starting is seminal book *Perception and Light as formgivers for architecture* (1977) with these words :

> *"Light has always been recognized as one of the most powerful formgiver available for the designer, and great architects have always understood its importance as the principal medium which puts man in touch with its environment."*
> *(Lam, W., 1977, p.10)*

From this perspective, light can be understood as a "relational" medium. William Lam stressed out that the overall quality of a space is the result of the relationship of the light with the other elements of the visual field (Lam, W. 1977, p11). Advocate of a "perception-based" practice, he put forward the "process of visual perception and the nature of human needs for visual information" at the core of the design practice. According to this stance, the power of light lies in the connection between space and people by the way of human perception. Further on, the lighting designer Herve Descottes (2011) describes the light as a set of visual and experiential factors that are not easily measurable. Illuminance, luminance, colour and colour temperatures, height, density, direction and distribution of the light are some of the parameters that the lighting designer handles to make the space "visually significant", to use Kelly's own words.

From an architectural point of view, light understood as a spatial element based on perception, has opened the door to a more holistic way of thinking space. Out of the rational and analytic geometry coming from the legacy of a mechanical model of the visual process, the field of lighting design has gained recognition when introducing human factors in spatial conception. The perception-based approach of the pioneers of lighting design focused however mainly on the visual sense. The american architect Louis Kahn (1901-1974) has explicitly expressed the formal power of light as a visual structural element, playing with light and shadow :

> *'To me structure is the maker of the light. When I choose an order of structure which calls for column alongside column, it presents a rhythms of no light, light, no light, light. A vault, a dome, is also a choice of a character of light. To make a square room, is to give it the light which reveals the square in its infinite moods.'*
> *(1967, Kahn L., Space and the Inspiration, p.112)*

Here, Louis Kahn attributes to light a non-visible quality, which is to reveal the "mood" or the "atmosphere" of a space. Relevant from another major change in the understanding of spatial qualities beginning in1960's, the phenomenological and atmospheric vision of space has emerged as a new way to comprehend architecture through the experience of the senses. Light as a perception-based medium can finds legitimely its place in the "space as sensation".

2 . SPACE AS SENSATION

2.1 - PHENOMENOLOGY AND EMBODIMENT

Influenced by the return of a sensory understanding of the human being, the nature of human relationship with their environment has been extended beyond the concept of physical space, under the influence of phenomenology, **'**so that it encompasses not only its structural, geometrical essence, but also the dimension of its experience by one or more human actors.**'** (Ciolfi, 2004, p.38)

The phenomenology emerged in the 30's-40's, from a long philosophical tradition debating about Form vs Matter. As its origin, the german philosopher Edmund Husserl (1859-1938) introduced the notion of experience between the subject and object, trying to sensationalize the system of perception and therefore the knowledge of the world. In his 1930's context of socio-political crisis and the threat of totalitarianism, Husserl advocated for the necessity of subjectivity and called for subordinating the scientific rationalism to the more nuanced realm of subjective perception.

Phenomenology had a great influence in architectural theory, within the post World War II period. It has been of the most significant counter reflexion to the emergence of a mechanized and functionalist modernity. From the 40's to 50's, spatial theories proposing an experiential view of architecture flourished, emphasizing the importance of 'place', as opposed to the homogeneous Euclidean space, through the concept of *genius loci.* Architectural discourse have drawn from phenomenology a way to link closer the architectural space (object) to the experience of the people (subject). From a phenomenological point of view, the meaning of a space lies in the experience of it, focusing on the sensorial perception as a function of the built environment. It highlights the engagement with the space through the world of perception, emphasizing the level of the body-experience, prior to the analysis of the space.

> *'All consciousness is perceptual… the perceived world is always presupposed foundation of all rationality, all value and all existence. '*
> *(Merleau Ponty, 1945, p.13)*

Merleau-Ponty has emphasized the role of the body and kinesthetics in the spatial perception of architecture. He argued that the world of perception cannot be easily grasp intellectually, because it lies beneath the conscious cerebral awareness. According to him, all interaction

with the built environment happened at the body level, prior to any analysis of architecture. He theorised the concept of embodiment, as a pre-cognitive intelligence of the body, by which the awareness of world first occurs. Merleau-Ponty approach challenged the field of perception. He claimed that the perceptual field, is not engaged through the sum of isolated sensory stimuli, but is rather a dynamic process, a 'shifting fabric of sensory and bodily awareness' that continuously happens (Seamon, 2012, p.2-3). He stands on the fact that the world of senses cannot be understood separately, as they constantly and mutually intermingle to work as a whole. For him, this 'synaesthetic perception' resonates within the body as a whole experience and conveys an immediate meaning on an unconscious level of awareness.

> *"My perception is not a sum of visual, tactile, and audible givens: I perceive in a total way with my whole being: I grasp a unique structure of the thing, a unique way of being, which speaks to all my senses at once "*
> *(Maurice Merleau Ponty, 1964, p.48)*

Largely influenced by phenomenology, the work on the humanistic geographer Yi-Fu Tuan support an experiential and holistic approach to the way people connect and make sense to their environment. In line with Merleau-Ponty theory, he analysis and demonstrates how each senses are constantly working together to provide spatial information :

> *" [...] most people function with five senses, and these constantly reinforced each other to provide the intricately ordered and emotion charged world in which we live."*
> *(Yi Fu Tuan, 1977, p.11)*

Further on, Tuan demonstrates that the spatial experience is an active process created by the interwoven spheres of the emotions and thoughts. He therefore states that both are working together and shall not be considered separately. The meaning of a place comes from a cognitive process, informed by the senses, but analysed at an intellectual level influenced by culture.

> *"Seeing, it has long been recognized, is not the simple recording of light stimuli; it is a selective and creative process in which environmental stimuli are organized into flowing structures that provide signs meaningful to the purposive organism. "*
> *(Yi Fu Tuan, 1977, p.10)*

For an architectural concern, this perspective is important because it means that the process of perception entwined the subject to the environment in a perpetual feedback loop through body awareness that happens at an unconscious level. This interpretation suggests to overcome the conventional and presumed dualism between subject/object as well as body/mind. It implies to consider the relationship with the environment as an active and constant process of experiences through the mutual resonnances of all senses, or "embodiment". This vision of environmental perception has lead to rethink architecture through the larger spectrum of cognitive process and had a critical influence of spatial theories throughout the XXth century. Space was not anymore seen as a passive and homogenous container, but rather as a blend of complex relational structures, mixing together the stimuli perceived through senses to spatial conceptualisation inherited from social and cultural background.

The contrary is often assumed but the dematerialisation of architecture and the raise of digital media technology have brought back the theme of embodiment. The theorist Gernot Bohme argues that "the rediscovery of the human body occured in parallel with the twentieth-century development of modern technology". For him 'Human have their bodies returned to them precisely by technology development." (Bohme, 2016, p.82).

> *"[...] the renew actuality of human bodiliness in architecture is not surprising. Only temporarily and under particular temporal constellations can architects focus on the side of the object, believing that the goal of their construction is properly buildings. Classical modernity was such a period, and particularly the tradition inaugurated by the Bauhaus. Rationality, construction technology and functionality determined building in what appeared to be, from socialist, national-socialist and capitalist perspective alike, a mass society. The creation of spaces for bodily presence was not regarded as an essential aspect nor human disposition as an important topic."*
> *(Bohme, 2016, p.82)*

According to Gernot Bohme, the concept of embodiment has emerged from a conceptual shift happening in architecture since modernism, moving from the design of architectural object to the design of space (Bohme G., 2016, p.83).

> *" In the field of architecture and design the turn is from the form or shape of things to their contribution of tuning the space of our bodily presence"*
> *(Bohme, G., 2016, p.5)*

He sees in the detachment of architectural forms from horizontality and verticality, combined with the dissolution of the distinction between the inside and the outside, due to the use of new material (glass, steel, ..), the conditions from which architecture, liberated from the design of the thing was able to focus on the design of space :

> *"In summary, traditional architecture has conceived of space from the perspective of geometry and considered the people in it as bodies. In contrast, what matters today is to strengthen the position of the experiencing subject and to foreground what it means to the bodily present in spaces. This aspect will take architecture to a new level of design potential."*
> *(Bohme, G. 2016, p.95)*

More recently, the theme of embodiment has re-emerged in the field of digital media technologies. The last development in computing technology is following what architecture has achieved fifty years earlier, but may be in an even more drastic way. The disappearance of the computer, seamlessly integrated in the physical environment, has put forward the themes of the body and cognitive processes in discourses about tangible interaction. The field of HCI borrows explicitly the concept of embodiment from phenomenology, as a foundation to set interactive system into its new spatial context. The renowned computer scientist, Paul Dourish, explicitly addresses phenomenology as a framework for HCI :

> *"A variety of recent developments have begun to take on embodiment as a fundamental feature of interaction, rather than as a side-effect of interactive system development. In beginning to accept embodiment as a central feature of how we think about interaction, HCI has not been ploughing new ground. Embodiment, in a variety of forms, has been a critical component of phenomenological thoughts throughout the twentieth century. It is to this philosophical approach that we will turn to look for guidance in formulating new foundation for interaction and interactive systems. "*
> *(Dourish, P.,1999,p.1)*

Paul Dourish describes embodiment as " the property of our engagement with the world that allows us to make it meaningful" (Dourish, 2004, p.126), and shows how the phenomenological perspective can shed light on interactive systems, engaging the understanding of human cognition rather than disembodied rationality. Drawing on Dourish's theories, Alissa N. Antle proposes a definition of embodiment in the field of computer interaction as follow:

> *"Embodiment means how the nature of a living entity's cognition is shaped by the form of its physical manifestation in the world. An embodied perspective on human cognition foregrounds the role of the body, physical activity, and lived experience in cognition. Put simply, embodied cognition emphasizes how the particulars of human bodies acting in complex physical, social, and cultural environments determine perceptual and cognitive structures, processes and operations. In contrast to traditional views in cognition, an embodied approach suggests that human should be considered first and foremost as active agents rather than as disembodied symbol processors. "*
> *(Antle, A.N., 2009, p.27)*

In his book about the "Digital Ground" (2004), Malcolm McCullough explicitly calls on the concept of embodiment, as an understanding of the cognitive background for interactive design. Embodiment, grounded in phenomenology, refers to an active and permanent process of cognition taking place in the background of our consciousness while making sense to our environment. As one of the aim of an interactive system is to be seamlessly integrated in the physical environment, the concept of embodiment seams to be appropriate to consider HCI through the constant relational feed-back between people and their environment, that the concept of embodiment implies.

> *"Place begins with embodiment. Body is place, and shapes your perceptions. Embodiment is not just a state of being, but an emergent quality of interaction. "*
> *(McCullough, 2004, p.27)*

The concept of embodiment, as a pre-cognitive intelligence of the body, interpreting its interaction with the built environment by which the awareness of world first occurs, lead us to consider its corollary spatial expression through the concept of atmosphere.

2.2 - ATMOSPHERE

Drawing on phenomenology, the finnish architect Juhani Pallasmaa defines the quality of a place as an immediate synthese of sensations :

> *"The character of a space or place is not merely a visual quality, as is usually assumed. The judgement of environmental character is a complex fusion of countless factors that are immediately and synthetically grasped as an overall atmosphere, feeling, mood or ambience."*
> *(J.Pallasmaa, 2014, p.19)*

Close to the synaesthetic perception of Merleau-Ponty, Pallasama introduces here the concept of atmosphere as a criticism and alternative to the domination of sight in Architecture. In his seminal book, *The Eyes of the skin* (1996), he firmly advocates for an "Architecture of the Senses", arguing that the hegemony of vision since the Renaissance to the current mass-media culture, has lead to a loss of plasticity and sensuousness in the human-environment relationship. Pallasmaa's approach, largely inspired by phenomenology, emphasizes experience, as a two-way exchange between the human body and the space :

> *"As we enter a space, the space enters us, and the experience is essentially an exchange and fusion of the object and the subject."*
> *(Pallasmaa, 2014, p.20)*

For the architectural theorist Mark Wigley, the experience of architecture is what can be called Atmosphere (Wigley, 1998). Wigley claims that while the atmosphere is not easily perceived or defined, it is closely attached to the building itself (Karandinou, 2016, p.18). Arguing in the same way, the german philosopher and scientist Gernot Bohme, defines atmospheres as 'spheres of presence' (2017, Bohme, p.24), which is the manner in which we experience the space. According to him, atmosphere does not exists in itself as an object, but is rather situated at the connection point between the subject and the space.

> *'Atmosphere is the shared reality of the perceiver and the perceived. It is the reality of the perceived as the sphere of its presence and the reality of the perceiver insofar as he or she, in sensing the atmosphere, is bodily present in a particular way."*
> *(Gernot Bohme, 2016, p.24)*

All literatures on Atmosphere seem agree on the that point : if the notion of Atmosphere might be a difficult and elusive concept to define, it is however the result of a perceptible co-presence of a feeling body and its environment. For the architectural theorist Mark Wigley, atmosphere relates to the elusive aspect of a space that is experienced by the users (1998). Gernot Bohme advances that atmosphere "*are always something spatial and emotional* (Bohme, 2016, p.2), while Pallasmaa relates the concept to the *'Genius loci', the spirit of place, a similarly ephemeral, unfocused, and non material experiential character [...] which gives its unique perceptual and memorable character and identity.' (* Pallasmaa, 1994, p.20).

Considering architecture and atmosphere, it becomes clear that the properties aiming to define an atmosphere, do so by shaping one's perception of the space. Therefore creating an atmosphere lies in the emotional response achieved through one's body engagement with the space, as well as the context in which they are placed. We can find many more details related to atmosphere and architecture in Pallasmaa's writings. As essentials elements of the creation of an atmosphere the following can be retained: embodiment (that we have seen formerly), continuum temporality, peripheral attention, and non directional.

> *" These observations on the existential significance of unfocused peripheral vision suggest that one of the reasons why the architectural and urban settings of our time often project a weak sense of spatiality, interiority, and place, in comparison with the stronger emotional engagement of historical and natural settings, could be in their poverty in providing stimuli for peripheral perception. [...] Peripheral vision integrates us with space, while focused vision makes us mere ocular observers".*
> *Pallasmaa, 2010*

2.3 - AMBIENT TECHNOLOGY : THE CALM AND THE SUBLIME

As both lighting and computing are pervasives, shapeless and "non visible" technologies, they surround us in an intangible way, creating an environment, potentially source of atmospheric quality. We have identify two manners in which technology can relates to the concept of atmosphere : the calm and the sublime.

CALM TECHNOLOGY

While Pallasmaa observations about "vagueness" focus on architectural settings, they also find relevance in the context of ubiquitous digital technology. Research in HCI have demonstrated the importance of peripheral attention in people's interaction with technology. The concept of "calm technology" was first coined by Mark Weiser and John Seely Brown in 1995. It refers to information technology when the interaction with the users is designed to happen at the periphery rather than at the constant center of his attention. In the context of ubiquitous computing, in which technology has become pervasive, this approach has gained in popularity. Weiser and Seely Brown use "*periphery to name what we are attuned to without attending to explicitly"* (Weiser and Seely Brown, 1995, p.4). According to them, the peripheral attention is an enabler of calm through the increased of awareness.

> *"Technology encalm as they empower our periphery. [...] a technology may enhance our peripheral recha by bringing more details into the periphery. [...] When our periphery is functioning well we are tuned into what is happening around us, and so also to what is going to happen, and what has just happen." (Weiser and Seely Brown, p.4).*

In the 1990's, the term "ambient intelligence" was invented to describe an electronic environment embedding a non-textual type of information. In his book Ambient commons (2013), Malcolm McCullough traces back the legacy of "ambient intelligence" to the notions of milieu, ambiance, embodiment, and architectural atmospheres. Computation and architecture are nowadays sharing a common ground towards the effortless attention. The MIT AmbientRoom in 1997 illustrates some research done in the field of ambient media environment. The room equipped with electronic artefacts, was enabling the user to be aware of informations at his peripheral attention, using ambient media in the augmented space. Sound, lighting, air flow and projection on the wall were used as a source of ambient information, monitoring the information at a low level of consciousness, while allowing the performance of other tasks. In this experiment, dynamic lighting was used to give a sense of time or to inform on the activity and flow of people on the entrance of the building.


Figures 11 and 12 - MIT Ambient Room, Tangible Media Group - 1997

The literature available on ambient intelligence is growing in the field of HCI, while it is quasi inexistant in the field of lighting. The lighting industry stays for the moment attached to the notion of atmosphere still deeply rooted in the architectural tradition. However, a conference given by the lighting designer Tapio Rosenius in 2016 demonstrates that there is a potential to cross the very closes notions of Atmosphere and Ambiance. In his intervention, the lighting designer defines connected light as an “ambient communicator” “ allowing information to be received effortlessly, without user interface, creating an “ambiente space”. The lighting industry is still mainly attached to a more traditional way to design light as an illuminante medium for architecture. However, the raise of media architecture and the current technological possibilities might open to consider lighting as an ‘ambient intelligent’ component of a space. This suppose to revise the conception on the diffusion of information with light, in another direction than the display mode. As Pallasmaa and the researches in HCI about calm technology demonstrate, the peripheral awareness might be an more appropriate way to diffuse information when designing with light. In this context the reference to the theory of atmosphere, embodiment and peripheral awareness might set the ground for a purpose use of the technology, out of the limitation of purely commercial application.

TECHNOLOGICAL SUBLIME

Among different types of atmospheres, the sublime refers to an emotional state, shifting from an aesthetic concept of Romanticism linked to nature, to its re-emergence in the context of a technical frenesia through the XXe century. In both contexts, the concept of sublime relates to a state of emotion in front of the vastness or an intangible and powerful manifestation that transcend the physical and inspire a universal awe, a "moment of intensity", regardless of the observer background (Nye, 2004, p.2).

The notion of sublime first re-appeared as the expression of sensibility in a context of fast industrialisation of the society. One of the most influential work of this period, Edmund Burke's essay's *'On Philosophical Enquiry into the origin of our ideas of the sublime and Beautiful' (*1756), marks the awakening return of emotions, as a response to the mechanization of the environment. Adapting Burke's theory, Kant stated in *The Critique of Judgement (*1781), that the sublime is not an attribute of an object, but rather the result of a dialogue between the individual and the object. As the concept of atmosphere, it is a relational phenomenon. With this definition, Kant asserts that the space plays a smaller part in the sublime, and the 'observer becomes central in defining the emotion as the mind projects its interior state onto the world." (Nye, D., 1994, p.8). Kant emphasized the mind and the inner emotion, taking the definition of the sublime as a mental disposition that makes one feel small when looking at the vastness of space.(Bertin S., 2015, p4).

The author David E.Nye borrows the notion of sublime to describe the fast and daunting scale of technology progress, transforming American cities at an unprecedented pace during the industrial revolution of the XXth century. In his book, *American Sublime* (1994), he uses the concept of "technological sublime" as an "integral part of contemporary consciousness", and suggests that the experience of the sublime is an emotional configuration that emerges from new social and technological conditions. According to him, the technological sublime refers to the powerful experiences in industrial society, of particular technologies, able to foster a sense of community :

> *"One of the most powerful human emotion, when experienced by a large groups, the sublime can weld society together. In moments of sublimity, human beings temporarily disregard divisions among elements of the community'*
> *(Nye, D., 1994, p.12)*

Accordingly to his statement, Nye suggests to extend the notion of sublime from the inside view of an observer to a shared experience, as an element of social cohesion that unified the american multicultural society. Among the technologies cited, David Nye gives a particular attention to electrical lighting as a great manifestation of the technological sublime. He demonstrates how the illumination of the urban environment transforming the city landscape, embodied the cultural values of the American society. Following D.Nye argumentation, Scott McQuire also underlines the affinity of electric lighting with the idea of sublime, as for him, electricity offered a 'new sense of control over the environment' revealing a new relation between material and immaterial space generated by electrical lighting (p.116).

Since then, electrical lighting has become part of our daily life, and if it was once looked at with wonder, it became today an ordinary feature in most of the environment settings. However, we argue that the raise of digital technology and its corollary architectural form, commonly refers to as Media architecture, could find some relevance in looking at the notion of sublime, as an element of social cohesion. Looking at the digital fields, academics scholars have been associating the aesthetic of data visualisation with the notion of sublime (McCosker and Wilken, 2014, Costa (1990), Sack W. (2001), Heinrich(2016)). The argument developed there is that digital technologies are by definition linked to the formless and unimaginable immensity of the big-data. By making visible this vastness in real time, via a system of operation (program) rather than a fixed formal expression, they argue that the sublime lies in the experience of changeability they deliver. In that sense, they align with the interpretation of the sublime by the french philosopher Francois Lyotard as everything that the imagination cannot sum up in a single impression (Lyotard, 1979). Digital light paired with computation can access and express in a dynamic way the vastenss of datas contained within our physical environment. Despite this technological paradigm that light is facing today, there is no trace of literature on the subject. Discours on Big Data and lighting are focusing on optimization and space improvement. We argue that the concept of sublime, applied to the hybridisation of digital light with computation, could trigger collective emotion in front a second wave of "technological sublime" that electrical lighting once provided to the cities.

3 . SPACE AS EXPERIENCE

3.1 - MEDIA AS ENVIRONMENT

> *[...] today it is important to recognise environment as something more than places untouched by technology. Understanding the built environment better has to be a step in understanding humanity's larger place in the world. Media situated in the built environment may help build that understanding. In comparison with any previous age, however, so many more facets of today's experience have been mediated so skilfully that they increasingly merge with perception of the world. [...] Is this rich chaos of experience a new subject for design ? [...] Does it become some new sort of cultural commons ?*
> *(McCullough (2006), Ambient Commons, loc 314)*

Since the mid 19th century, the convergence of technology and different type of media with the architecture and the urban space has become the frame for a new mode of social experience. Instead of considering technology and media separately from architecture and urban space, the spatial experience of the modern social life comes from the interrelation of architecture, urbanism, social practice and media technology embedded in space.

In his seminal book about the *Media City*, Scott McQuire draws the origin of the 'mediated production of the urban space' to the mid 19th century, with the beginning of photography, shifting to cinema and recently to electronic and digital media. These types of urban space mediations have been affecting in different manners the production of space, from the building scale to the city environment.

In the mid-1960s, the canadian scholar of technology, media and communication Marshall McLuhan introduces the concept of 'media-ecology', and argued that media shall be studied as an 'environment', which means understood as dynamic processes of relationships :

> *' It is perfectly clear to me that all media are environments. As environments, all media have all the effects that geographers and biologists have associated with environments in the past […] the medium is the message because our environment transform our perceptions governing the area of attention'*
> *(Mc Luhan, 1970, p.4)*

For McLuhan, media cannot not be reduced to a channel between the sender and the receiver. He explained that as each form of media involves different sphere of sensation, it creates different conceptualisation of 'space and time', with consequences on the way people grasp and experience their environment. McLuhan proposed to understand the relationship of space and time through technology, as this is the way people connect, engage, understand and get to know their milieu.

> *'All media work us completely. They are so pervasive in their personal, political, economic, aesthetic, psychological, moral, ethical and social consequences that they leave no part of us untouched, unaffected, unaltered. The medium is the message. '*
> *(M.McLuhan, 1964, p…)*

McLuhan mainly differentiates two types of spaces, based on the separation of the senses : the 'acoustic space' based on orality, and the 'visual space' of the literate, alphabet-based cultures. While the acoustic space is closed and omnidirectional, the visual space is a space of a linear spatial perception, a Cartesian space based on the order of perspective, stable orientation and mechanical vision (Busbea, L. 2015). McLuhan foresees in the electronic media age, the end of the linear visual space, and the return to a phenomenological embodied space, as the electronic environment would allow human to be back to a new immersive experience, thanks to a new form of sensory engagement. He envisioned a 'programmable' environment that would work as an 'extension of human's nervous system', proposing one of the first idea of network based communication and computation technologies to come on the next decades with the post-modern Media-Architecture.

From a methodological point of view, McLuhan explains that environments can only be observed indirectly, through the way they transform the 'old environment', as they are invisible dynamic process of relationships. Thus for him, architecture is a form of old environment, that the new media technology elevate to another state. In a letter written to the anthropologist Edward T.Hall, he formulated this new statut for architecture :

> *"When the environment itself is constituted by electric circuitry and information, architecture becomes the content of the new information environment. Architecture is the old technology which is automatically elevated into an art form.'*
> *(cited in Busbea, L. 2005)*

McLuhan's theory is relevant in this thesis for two main reasons. First, he introduced the idea of the media being an environment, and therefore a field of study beyond technicity. Replacing technology in a socio-cultural context, McLuhan demonstrated that the form of the media impacts our space, time and social structures. Secondly, McLuhan's legacy goes far beyond media culture, as he has anticipated a new type of space, an hybridity between the physicality of architecture and the immateriality of a 'programmable' environment as an extension of human being. In that sense, he envisioned the coming out of the cyberculture and cyberspace, that would influenced the avant-garde architecture in the 50's-60s and later in the 80's-90's, be at the origin of what is commonly called today 'Media-Architecture'.

3.2 - FROM CYBERSPACE TO HYBRID SPACE

Prefigured by a visionary like McLuhan, while computing was pervading the built environment, the vision of 'virtual space', started to get an impact on architecture through the concept of 'cyberspace', coined by the author William Gibson. In his novel Neuromaster (1984), he described how a virtual space could be experience as a form of architectural and urban space, and gave the definition of cyberspace as a 'graphical representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of mind, clusters and constellation of data' (Gibson, 1984, p.51).

For Gibson, the Cyberspace was a non-physical imaginary space that transcends materiality and space boundaries. As a new layer of spatiale experience, this new type of spatial reality would fusion the intangible and abstract agglomeration of information contained in communication network to the built environment. In her essay about the fictional world of William Gibson, Tatiana Rapatzikou (2014) nailed the key feature of this new type of space. She clearly refers to this aesthetic or new spatiality, as a 'palimpsest' that can be 'only visible in a state of constant flow'.

> *'[...] the effect that its structure creates is generated by its construction as a palimpsest. Within the carefully designed space there is no sense of wholeness in the way its elements are arranged. The manner according to which the layers of data are assembled and superimposed on upon the other shatters their rigidity and effaces their separateness. This produces a distorted version of their initial shape and form as one layer recedes towards the other, preventing readers from perceiving this electronic assemblage of information clearly, since it can only be visible in a state of flux.'*
> *(Rapatzikou, 2004, p.100)*

In the 80's-90's the proliferation of the cyber-rhetoric found resonance in the avant-garde vision of architecture. It gave birth to speculative architecture around the idea of mixing an immaterial world of digitised information and the built world. The idea of 'digital architecture' started to emerge. Discours about liquid space, dematerialised and fluidity in architecture flourished, while the computer (CAD system) began to be used as a tool of conception in architecture allowing the free-forms of postmodernist architecture. The architect Michael Benedikt, described in his essay *Cyberspace:first steps* (1991), the fusion of the human sensorial world to digitised information in a new 'virtual reality', whereas his homologue Marcus Novak, defined the 'liquid cyberspace' as 'liquid architecture that breathes, pulses, leaps as one from and lands as another' (Novak, (1991), p.272). Even though Novak and Benedikt visions were purely speculatives, as the technology back then was not yet allowing their realisation, they profoundly question the idea of architecture and its materiality as something fixed and tangible. They introduced the notion of architecture as an hybrid space, that changes and evolves over time, prefiguring what will become Media Architecture few years later.

3.3 - VIRTUAL WINDOWS

In the late 80's-early 90's, the migration of the computer screen into architecture, with the apparition and proliferation of wall-size screens, marked the emergence of a new dialectic of the space through the fusion of 'digital media' and architecture. This changes introduced the screen as an architectural element, a moving surface becoming the skin of the buildings. Several architectural theorists have nailed the consequences of this change in our spatial perception as a whole. McQuire suggests the comparison of these wall scale screens to 'electronic windows' , while Anne Friedberg argues that 'the screen has become an actual substitute for a window' (A. Friedberg, 2006, p.12). Already plagued by the transparency of glass in modern architecture, the function of the window as a 'fixed relation of a viewer to a framed view,' and its spatial corollary, the perspective, are definitively ending here. The screen as an architectural element introduces a new visual system, coming from the computer technology, and therefor transform our understanding of reality. As an additional layer between the subject and the gaze, it produces a new mediated and de-materialised representation of the space.

For the architect Robert Venturi (*Complexity and Contradiction in Architecture (*1966) and *Learning from Las Vegas (* 1972)), whose theories have set the foundation of the post-modern aesthetic, electronic displays are at the very center of architecture in the information age. According

to him, the modernist vision of architectural space, coming from the Industrial age, shall be replaced by architecture as an 'iconographic representation emitting electronic imagery from its surfaces day and night' (Venturi, 1972). This position, placing screens and their messages as an integral part of the building, is also defended by Ann Friedberg in her essay *The Virtual Window* (2006). She considers the surface of the screen as a space of tension between the material reality of the buildings and the dematerialised imagery space of the screen; she refers to the screens as a form of 'transitional surface as light became a building element in a newly immaterial architecture.' (Friedberg, 2006, p.21).

3.4 - THE QUESTION OF PERMANENCE IN ARCHITECTURE

This dematerialised 'imagery-based-architecture', is what the french philosopher Christine Buci-Glucksmann, in her essay the *Aesthetic of Ephemeral* (2003), calls the 'image-flux', or 'image of light'. She argues that this aesthetic is the expression of a new ephemeral temporality, linked to the digital culture of flux (Buci-Glucksmann, 2003, p.57). In this essay, she nails the following paradox : it is in architecture, the most perennial art form, that the transformation of the walls as fluctuante digital skin has been the most advanced so far (Buci-Glucksmann, 2003, p.76).

The Introduction of mutability, dynamism, and variability inherent to digital media, challenges the idea of architectural object as a final one. The digital raises the question of permanence and materiality in architectural forms. For the media theorist Lev Manovich, variability, and the constant change prefigured by cybernetic, are the characteristic of architecture in the Information Age. Referring to the Freshwater Pavilion by NOX/Lars Spuybroek (Neeltje Jans, The Netherlands, 1996) Manovich states :

> *'Its continuously changing surfaces illustrates the key effect of the computer revolution: the substitution of every constant by a variable. In other words, the space that symbolizes the Information Age is not the symmetrical and ornamental space of traditional architecture, the rectangular volumes of modernism, nor the broken and blown-up volumes of deconstruction. Rather, it is a space whose shapes are inherently mutable and whose soft contours act as a metaphor for the key quality of computer-driven representations and systems: variability.'*
> *(Lev manovich, 2002, p.234)*

This constant states of change introduces the idea of ephemerality in architecture. As Buci-Glucksmann re-contextualised, the research of ephemere started to become explicit in the

60's, with the birth of art forms such as installation, art in situ, Land art, etc. However, it is mainly from the historical shift of a culture of objects and permanence (coming from industrial revolution) to a culture of flux and instability (linked to the digital area), that a new type of relationship with time, and therefore space, has emerged. The digital culture, expressed through media-as architecture, is one of its most explicit expression. (Buci-Glucksmann, 2003:16). But, since ephemerality has long been associated with negative connotation or spleen melancholic ideas in the Western world, thinking ephemerality in architecture requires to reconsider the notion of time under new perspective. Buci-Glucksmann proposes a vision of the ephemeral as a positive value, that could be the fourth dimension of architecture (Buci-Glucksmann, 2003:16). She proposes to re-evaluate the notion of time as a qualitative value in spatial design, an affirmation of life, where catching the transitional would brings new meanings to the experience of the space, seen through energy flow rather than forms.

> *'Because when crossing time through screens and sanded glasses, it is about embodying space with light, in using the colour of a transparent intensity, of an energy and a flux. So there is a displacement of light and of ephemerality that unmaterialised everything, such that it delocalised space. What we see is less the form, than the energy, as in all the work of James Turrell.'*
> *(Buci-Glucksmann, C. (2003:63)*

With the inclusion of media into the buildings, architecture in its perennial nature is challenged. One of the question is how architecture, understood as a set of spatial relationship defining human action, adapts to this new and immaterial media-ecology. In her essay 'The site and the Landscape' (2002), buci-Glucksmann clearly expresses this radical transformation. She highlights the fact that architecture is shifting from the purely formal research of spatial configuration, to a 'more abstract system of datas that can only make sense by their relationship to people' (Buci-Glucksmann, 2002:157) . In that sense, she then refers to an architecture embracing ephemerality and network based system, that would rather be 'defined by a process rather than a final form.'

This statement leads us to consider one of the main challenge of Media-Space has an architectural form. In her book about the *Theories and Practices of the Ephemeral in architecture* (2013), Anastasia Karandinou nails the raising concern for immaterial elements in architectural discourse. According to her, it reflects the current societal shift influenced by the digital technology and its invisible integration into the contemporary state of architecture. However. while the digital technology are promising the possibility to enhance the space with an informational

'data-landscape', architects and designers are facing the fusion of the digital media with the physical architecture, and are still trying to figure out how to mediate between the immaterial and the material space.

For the media theorist Lev Manovich, the challenge and potential lies in the 'design of meaningful connection between the physical space, and the contextual data-scape, between what we sense and what we learn from the environment.' (Lev Manovich, 2002, p.233). He calls for the fusion as a whole entity, of the immaterial information to the physical space of architecture.

> *'While many architects and interior designers have actively embrace electronic media, they typically think of it in a limited way: as a screen, i.e, as something that is attached to the 'real' stuff of architecture - surfaces defining volumes.. [this] limits our visions of how architecture can use new media. [...] Going beyond the 'surface as electronic screen paradigm', architects now have the opportunity to think of the material architecture that most usually preoccupies them and the new immaterial architecture of information flows with the physical structure as a whole. [...] architects along with artists can take the next logical step to consider the 'invisible' space of electronic data flows as substance rather than just a void - something that needs a structure, a politics, and a poetics '*
> *(Lev Manovich, 2002, p.237)*

3.5 - AUGMENTED REALITY and PREFORMATIVE SPACE

The question of permanence in architecture, marks the breaking point, where converge different alternatives and potential for digital light and space. This new type of architecture, understood as a transitional form that conveys meaning, blurs the boundaries with scenography into the emerging forms of narratives, commonly labeled as 'Augmented', 'Performative' or 'Interactive' spaces'.

In his article *'The poetic of augmented space*' (2002), the media theorist Lev Manovich discusses how people experience spatial forms filled with dynamic multimedia information, focusing on the human experience and cultural shift rather than technology for itself. He questions if this new layer of information added to architecture is creating a new form of spatial experience as a whole. He differentiates this new architectural type from ornament, defining it as an 'augmented space, a new kind of physical space 'overlaid with dynamically changing information'(Lev Manovich, 2002, p.220).

> *'Augmented space is the physical space which is 'data dense', as every point now potentially contains various information which is being delivered to it from elsewhere. At the same time, video surveillance, monitoring and various sensors can also extract information from any point in the space, recording the face movements, gestures and other human activity, temperature, light level and so on. Thus we can say that various augmentation and monitoring technologies add new dimension to a 3-D physical space, making it multidimensional. As a result, the physical space now contains many more dimensions than before, and while from the phenomenological perspective of the human subject, the 'old' geometric dimension may still have the priority, from the perspective of technology and its social, political and economic uses, they are no longer more important than any other dimension'*
> *(Lev Manovich, 2002, p.223)*

In his article, Lev Manovich questions the phenomenological experience and cultural application of such 'augmented space'. He proposes an architectural problem approach, and argues that the issue of augmented space must be seen as conceptual rather than a technological.

> *'Augmented space provides a challenge and an opportunity for many architects to rethink their practice since architecture will have to take into account the fact that virtual layers of contextual information will overlay the built space. [...] the layering of dynamic and contextual data over physical space is a particular case of a general aesthetic paradigm : how to combine different layers together, [...] how to overlay physical space with layers of data '*
> *(Lev manovich, 2006, p.225)*

Lev manovich goes one step further in this direction, proposing the augmented space as a potential space for 'contestation or dialog', when coupled with computation, and therefore opening to performative and interactive performance of the space:

> *'Of course, if the messages communicated by traditional architecture were static and reflected the dominant ideology, today's electronic dynamic interactive displays make it possible for these messages to change continuously, making the information surface a potential space for contestation and dialog, which functions as the material manifestation of the often invisible public sphere.'*
> *(Lev manovich, 2006, p.232)*

Performativity is the corollary of data-driven technology. It allows dynamic and responsive answer, changing over time, and hence not easily representable. This attitude towards design reflects a 'paradigm shift' from the building space to embedding information technology into the physical world. In 1960, the architect Cedric Price asked : "*What if a building or space could be constantly generated or regenerated?*" (cited in Bullivant, 2005:5). The current technology allows such transitional space. This is not anymore a question of technical gap to overcome. The first experimentation in responsive architecture occured in the late 80's. The *Tower of Wind (*1986) from the architect Toyo Ito, illustrates the first realised case of a building able to change of appearance according to stimuli taken from the environment around. With the transformation of the building surface, the notion of form in architecture reaches its limits. The meaning changes along with the material expression. The performativity translates the formal and structural concern of architecture to what it actually does, how we can understand it and analyse the way it performs.

> *'Things are not made up of matter of form [...] but they are the result of exchanging forces. Forces that creates things or spaces may be the events that takes place in order for a building to be created, or events that occurs and form in this way the ambiances of built spaces.*
> *(Karandinou, 2013:29)*

On the last decades, the introduction of a further level of interactivity has opened new possibilities for buildings to 'perform' in a two way communication with the environment and people around, driving architecture towards interactive settings and the creation of event space. This shift is relevant of a new attitude concerning the definition of architecture. Designing space is not anymore only concerned by the design of physical settings, but is shifting towards the design of experiences with communicational potentials. This experiential shift expresses the societal change that Pine and Gilmore have nailed as the emerging "Experience economy" (1998). A change that Gernot Bohme also notices as one of the main feature marking the transformation of the capitalist economies since the 1950s with their ubiquitous aestheticization or the "staging of everything". According to him this "staging value" offers new perspectives in architecture as they enriched the built environment by an emotional and sensory-experiential layer. From his perspective he links the creation of atmosphere to the art of 'tuning space', which implies further consideration than visual perception:

" it becomes clear that what is at value is not really visual spectacles - as what perhaps believed by practitioners of the old scenography - but the creation of "tuned" spaces, that is to say, atmosphere. "
(Bohme, 2016, p.32)

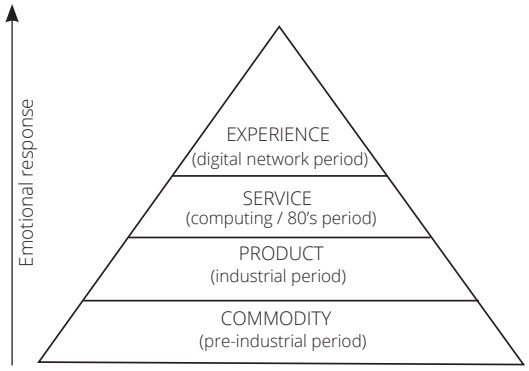


Figure 17 - Illustration of Pine and Gilmore theory

A vision that has also been advocated by the avant gardist architect Bernard Tschumi, since he states that there is no architecture without event. Taking distance from the functionalist ideas of modernity, Tschumi proposes a definition of architecture as a combination of space, action and movement. Influenced by the Deleuzian philosophy of events, Tschumi advocates that architecture shall reflect the current state of our society, based on the multiple, the fragmented and the spatialisation of events.

'The event is seen as a turning point - not a origin or an end - as opposed to such proposition as 'form follows function'. [...] Just as important is the spatialization that goes with the event. Such a concept is quite different from the project of the modern movement, which sought the affirmation of certainties in a unified utopia as opposed to our current questioning of multiple, fragmented, dislocated terrains.'
(B.Tschumi, 2000, p.175)

He states that architecture, wrapped on an expression of time, becomes an 'event', a platform for new experiment. Following on these thoughts, Tschumi places the 'design of conditions' or events, at the center of architecture, and as a way to get a positive impact on society.

> *'Architecture is not about the conditions of design, but about the design of conditions that will dislocate the most traditional and regressive aspects of our society and simultaneously re-organisize these elements in the most liberating way, where our experience becomes the experience of events organized and strategized through architecture. '*
> *(Tschumi, B., 2000, p.177)*

This position is also supported by the catalan architect and philosopher Ignasi de Sola-Morales, when this one states that architecture seen as the expression of permanence has become obsolete:

> *The place of present-day architecture cannot repeat the permanence produced by the force of the Vitruvian firmitas. The effects of duration, stability, and defiance of time's passing are now irrelevant. [...] Yet the loss of these illusion needs no necessarily result in nihilic architecture of negation. From a thousand different sites the production of place continue to be possible. Not as the revelation of something existing in permanence, but as the production of an event.'*
> *(Sola-Molares, 1997:104)*

The philosopher Jean-Francois Lyotard interprets this aesthetic of experience or event as the expression of Post-Modernity. According to him, the notion of sublime which belongs to it (refers to part 3) is opposed to the classical notion of beauty, based on order and truth. The goal of the aesthetic of experience is not based on moral judgment, but rather on an objective to catch the intensity of a moment.

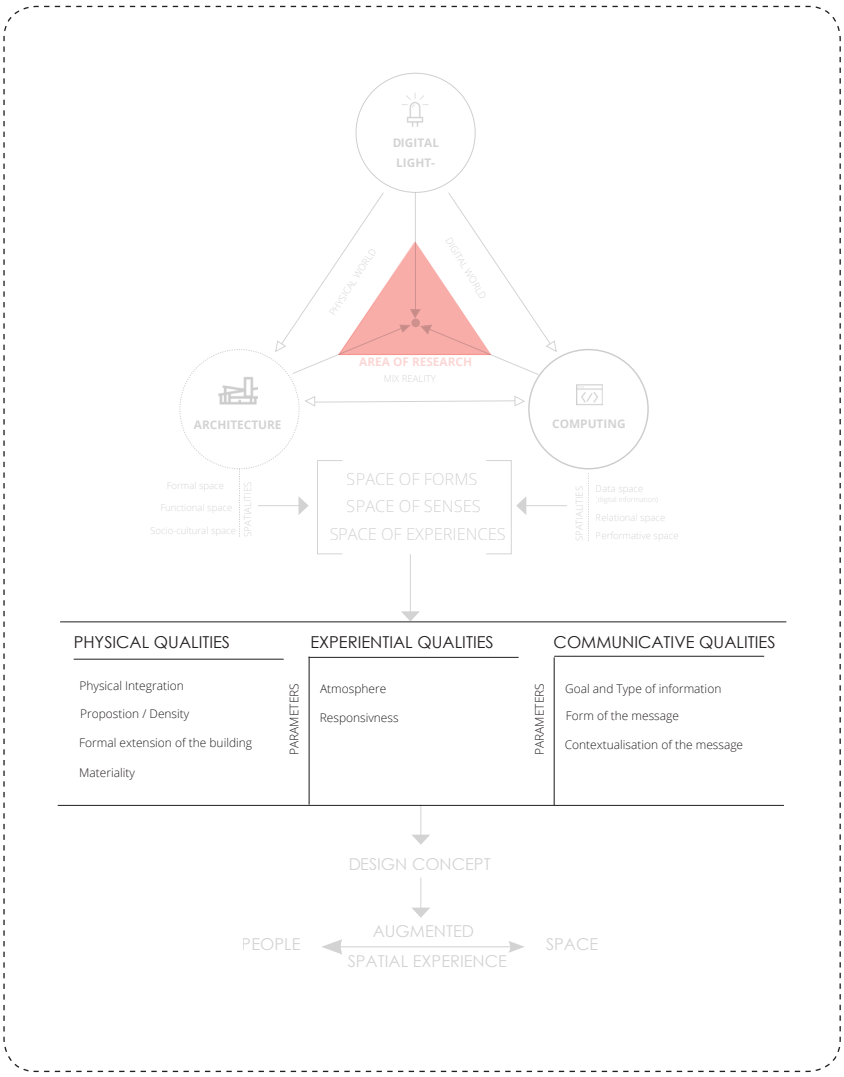
> *[...] The sublime constitutes an other form of aesthetic experience, that is once more, as pure event: something new that happens, even if only for an instant, fictively produces a parallel world.*
> *(de Sola-Molares, 1997:103)*

All these theorists demonstrate that the coming age of space as experience or event, is a corollary of our media-based epoch. And as Sola-Morales reminds, facing this condition is not about having a nihilist architectural position, but rather to engage in this path and find a way to integrate this change into a meaningful design process.

TRANSITION

This overview presenting different approaches of spatiality, mainly through philosophy and architectural theories, set some conceptual markers to ground the design of dynamic light and computation into the context of a human-environment relationship. It demonstrates that architecture, and therefore lighting design, has evolved from a visual and formal aspect to a more holistic approach encompassing the sensorial experiences of a space. Linked to the transformation of architecture during the Modern period, the emergence of lighting design as an independent discipline marks the beginning of a more holistic vision of architecture, concerned by the perceptual aspect of the spatial experience. Coming from this ground, architectural lighting is familiar with perception and spatial orchestration, and therefore at ease to deal with concepts like atmosphere and embodiment. However, its new dynamic potentiality, paired with computational possibilities is extending this approach to derived concepts like ambient technology. Ambient technology marks a point of convergence for lighting and computation, with the field of HCI looking at phenomenology as a ground for his spatiale applications. The concepts of calm technology and sublimity refers both, in different manners, to the realm of unconscious emotional awareness, with the aim to create a deep connection to the space. Lighting and computation are both pervading and transforming our daily environment into an ever changing space of events, bringing forward the idea of impermanence into architectural forms. Instead of adopting a nihilist approach, this shift reflects a profound societal change where architecture, lighting and computation could converge in a meaningful way. A new type of spatial experience is emerging, able to convey additional information or to foster participation, through augmented reality or performative space. In order to comprehend how these concepts could be applied on a practical base, I will review a selection of works using dynamic light through their physical, experiential and communicative qualities. This analyze will demonstrate how this new triangulation of architecture, lighting, and computation is currently applied and what are the potentials for the development of new design concepts.

PART 4
Study cases



PART 4 : STUDY CASES

You can't think about something you know nothing about. You have to be literate. [...]
(Richard Brandston, Learning to See, a Matter of light, 2008, p.10)

From the precedent chapters, we have seen that dynamic light is becoming an ubiquitous element in our built environment. As a result architecture and urban space are embedded with a new dynamic experiential dimension, that convey potential opportunities for the creation of a responsive and/or interactive environment. The technological background has set an understanding of the main techniques available, while the theoretical part has allowed to gain insight on the human experience of the space related to light and technology.

In this chapter we will look at existing cases of spatial installation using dynamic light in different type of environments. The field called "Media architecture" encompasses actually more than architecture itself and cross over different typologies of spatial settings in place in the urban environment. For this reason we will use the term "media environment" instead of " media architecture" as it seems more relevant to illustrate the diversity of installation using dynamic light.

About the selection of the work, while it is important to be aware of the limitation of this process, I argue that this sample of works is representative of the current trends, and will provide a comparative starting point to identify and understand some critical aspects when designing with dynamic light on an architectural scale, and therefore impacting people's life.

METHOD

As the field concerns a diversity of typologies, I will start by describing the study cases, as a first step towards literacy, which is what the lighting designer Richard Brandston advocates for, with the expression "learning to see" (2008). I will pursue with their analysis, according to their physical, experiential and communicative qualities. To do so, I will look at each case following the criteria list below, that has been drawn from the technical and theoretical background. Using the combined insights gained from the technical and theoretical precedent chapters, I will review each of this parameters. From the technical background, I will analyze how the LED technology has been used to integrate dynamic light seamlessly into architecture and how lighting technology is pairing with the built environment to create a visual coherent whole. I will then analyze the experiential criteria of each study cases following two directions. First the concepts of atmosphere, sublimity and calm technology, that the theoretical framework has identified as an enhanced spatial experience, will clarify the level of emotional awareness supported by each work. Then the level of responsiveness will be analysed according to the level of context-based technology that each installation presents. I will finally review the communicative purpose of each case, relating to the goal, forms and contextualization of the messages conveyed. I decided to include in this analyses an additional section concerning the design process, as it is important for the field of lighting design to understand the value of a cross-discipline approach using light. In this perspective, I will look at the background of the designers, and the level of computing integration in their project.

While I am aware than this method prioritizes qualitative aspects, I consider that such an approach is necessary, as the field is missing of critical understanding beyond its technical or marketing aspects. The limitations and bias of this study mainly lies on the lack of material available to gather a wider sample of opinions and investigate on how weakly or strongly people agree on the following criteria. Additionally, some aspects of a project may sometimes be better described, because of more information available. However, I consider that the type of documentation available, as well as the vocabulary used to communicate on the projects, are relevant of the project's approaches and can reveal new angles of analysis for the projects. As a premise on the topic, this analysis proposes to clarify and mapp the current practices and issues, while providing insight for future design cases.

CRITERIA ANALYSIS

1 . PHYSICAL CRITERIA

The architectural quality of a lighting media installation is captured by the way it is physically integrated into the physical environment. The means employed, as well as the temporality in which the lighting part enters in an architectural project, determines its alignment and coexistence with it. I have identified the following questions as critical to analyse this parameter :

1.A : PHYSICAL INTEGRATION

How it is physically integrated in the architectural form that is supporting it ?

1.B: PROPORTION AND DENSITY

Proportion and density (or "resolution") : how does the dimensionality of the installation echoes the architectural form ?

1.C : FORMAL EXTENSION OF THE BUILDING

Does its physical arrangement extend the form, rhythm of the architecture ?

1.D: MATERIALITY

How the installation use the materiality of architecture or additional ones as a mean of architectural expression ?

2 . EXPERIENTIAL CRITERIA

As we saw in the theoretical background, the human connection with a space is defined by a wide range of parameters including different levels of experiences form the sensorial to the experiential ones. From the theoretical background, I identified two main perspectives for the experiential quality of a space :

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

Does the lighting installation enriches the space in providing a remarkable mood or sense of sublimity ? What kind of awareness does it implies ? Does it foster a collective awareness of the space ?

2.B : RESPONSIVENESS

What is the level of responsivity related to the dynamic light ? Is it a real-time actuation, and what inputs are taking part of the system ? How the installation engaged with its surrounding and what is the temporality of the time based light reaction ?

3.COMMUNICATIVE CRITERIA

The content in media environment is a critical topic. It ranges from readable messages, abstract lighting pattern, and coloured light.

3.A : GOAL AND TYPE OF CONTENT

What type of information is delivered and for what purpose ?

3.B : FORM OF THE MESSAGE

As they refers to different level of cognitive attention, what is the way used to transmit the information : readable message, abstract pattern, coloured light ?

3.C : CONTEXTUALISATION OF THE MESSAGE

Does the message is contextualised and offer information about the physical environment around ?

4. DESIGN BACKGROUND

In regards to the topic of this thesis, I consider it is important to understand the design background of each project and how it does affect the integration of light and computation within the design process.

4.A : FIELD OF PRACTICE

What is the professional field of the designer, how does they position themself in the spectre of the lighting practice ?

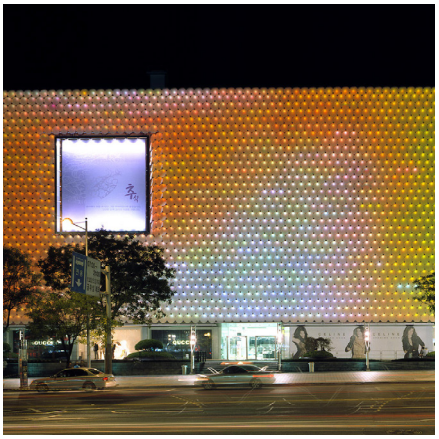
4.B : COMPUTING PART

Is computing a constituante part of their project ? Has the project necessitated the creation of a custom software ?

STUDY CASES

01

C4 PARQUE DE MIRAFLORES
Cordoba, Spain
Realities:United
2012



02

GALLERIA DEPARTMENT STORE
Seoul, Korea
UN Studio / Arup
2003/2004

03

Dia Light + Salling Light
Copenhagen, Aarhus, Aalborg, Denmark
Kollision
2013 + 20017

04

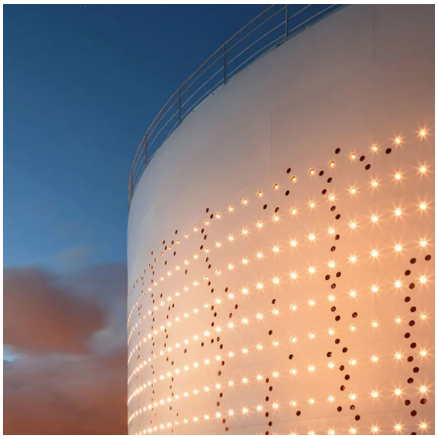
TOWER OF WIND
Yokohama, Japan
Toyo Ito
1986

05

DUNE
Roterdam, Netherlands
Studio Roosegaarde
2006-2012

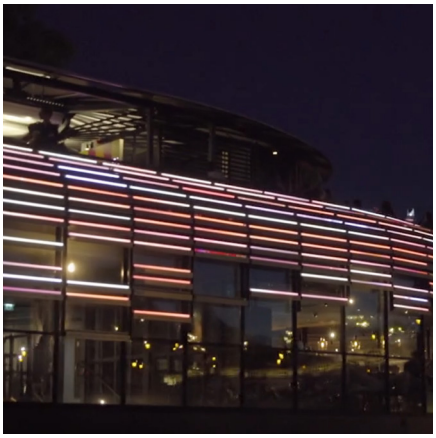
06

BAY LIGHTS
San Francisco, USA
Leo Villareal
2012



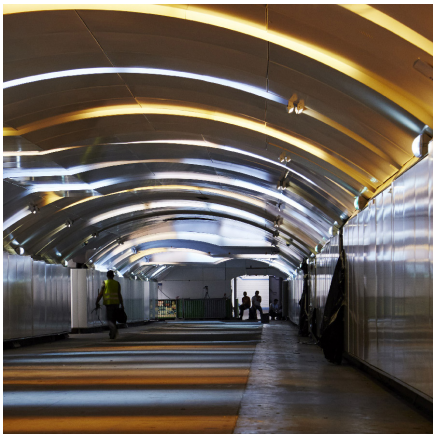
07

SILO
Helsinki, Finland
LDC
2012



08

ELYTRE
Paris
Yannick Jacquet / Anti VJ
2017



09

STATION LES HALLES
Paris
Agence ON
2017

10

INTERFERENCE
Kolding, Denamrak
Kollision
2014

11

RER E / BOMBARDIER Z5000
Paris
Yann Kersale
2018

12

AMYGDALA
Japan
Fuse
2016

01

Figure 18 - C4 Contemporary Art Center, Realities:United, 2012

C4 : Contemporary Art Center

Parque de Miraflores, Cordoba, Spain

Architect : Nieto Sobejano Architectos

Facade Lighting Realities:United

2012

Figure 19 - C4 Contemporary Art Center, Realities:United, 2012

DESCRIPTION

The C4, 'Centro de Creación Contemporánea de Córdoba', is a new building designed by the Spanish studio Nieto Sobejana, with the collaboration of the German atelier Realities: United for the elaboration of the façade. It is located next to the Guadalquivir River, on a peninsula opposite to the historic center, in the Miraflores park and in proximity to the emblematic Mosque of Cordoba. This project is part of a modernization of the city, with a special care given to the relationship between the historic center and the expanding urban area around. The C4 facade is orientated facing the Guadalquivir River, on which the city of Córdoba is expending to redefine its identity.

This new building is described as a contemporanea version of the traditional hispano-muslim architecture of the city. Its overall spatiality is created by a geometric grid made of polygons defining the inner spatial organisation of the building. Their analysis was the starting point of the facade project. This one has been conceived as an extension of the inner structure of the building. Following its geometric principle it asserts the identity and presence of this new cultural landmark along the Guadalquivir river.

In an interview for the Vitra Museum, the designers of Realities Unites explain their process :

> *"[the proposal of Nieto Sobejano] was to create this media facade in a perforated format as a concrete facade with round holes, behind which hang colourful luminescent tubes. When we were consulted, we realised that the idea of the light behind the facade wouldn't really work because it would create a type of shadow mask. For this reason, we brought the light forward to the front of the facade, were it could shine and depict the inner structure of the building typographically in pixels. The format of these hexagonal structures is based on the ground plan of the building, which the architectes developed from their enthusiasm for tessellation patterns. [...].*

Derived from the building's floor plan, a system of prefabricated 3D-panels has been specially designed and arranged to form the outside topology of the 100 meters long facade. 1 319 hexagonal panels of different scales are distributed all over the facade, to constitute an all-over 3D-pattern made of panels in fiberglass reinforced cement. Each panel serves as a reflector for an integrated artificial light source, with an individually controllable intensity, forming a huge and irregular low resolution, monochrome, 3D-display surface.The distribution of the different scale of the panels defines areas with different light densities. The center of the facade is covered with smaller panel, so the definition of this area is higher than on the outer edges covered with panels of a bigger scale. The designers explain that in the same manner than the eye's retina, this distribution defines different 'acuity' of visual perception.

> *"Since there wasn't a lot of money available, we had to make large pixels. However, since the building is 110 meters long and only eleven meters high, we were able to insert a lot of information lengthway but not much upwards - this meant very little could be presented. That's why we opted for area with varying pixel sizes and densities. The underlying idea was to create a facade which function similarly to the human eye. It is constructed so that the center of the "eye" has a relatively large number of receptors that supply information, while the outer sections have relatively few. It therefore not only reflects our eyes, but also the far end of our brains. A person thinks he or she sees a sharp image, but that's actually not the case; the head leads us to believe that, because it knows that must be the case. And that's the way this facade works too - if you take in the various areas with their different resolutions, the eye pulls the information together and recognizes what's happening on the facade. "*
> *(source : interview published on the Vitra Design Museum website)*

Figure 20 - C4 Contemporary Art Center, Realities:United, 2012

Figure 21 - C4 Contemporary Art Center, Realities:United, 2012

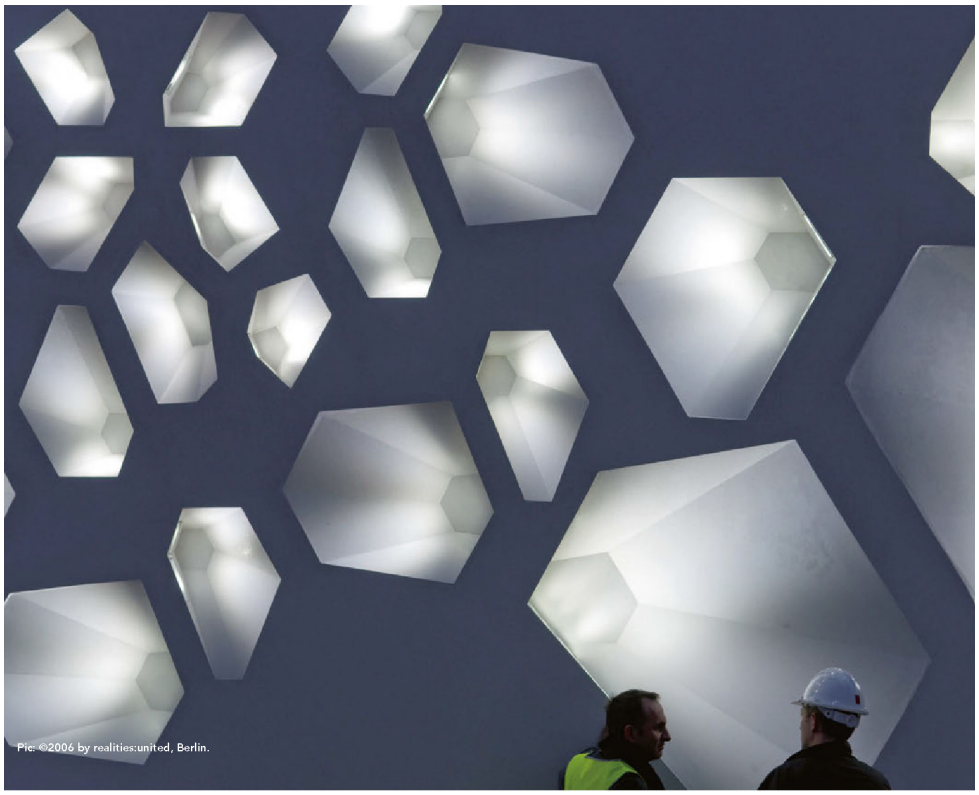


Figure 22 - C4 Contemporary Art Center, Realities:United, 2012

Figure 23 - C4 Contemporary Art Center, Realities:United, 2012

Figure 24 - C4 Contemporary Art Center, Realities:United, 2012

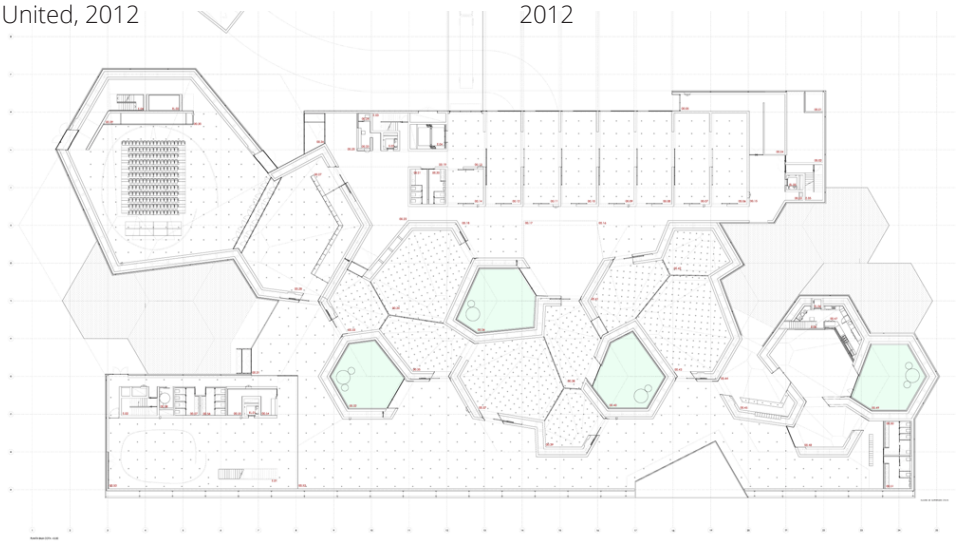


Figure 25 - C4 Contemporary Art Center, Realities:United, 2012

Figure 26 - C4 Contemporary Art Center, Realities:United, 2012

Figure 27 - C4 Contemporary Art Center, Realities:United, 2012

ANALYSIS

1 . PHYSICAL CRITERIA

1.A. PHYSICAL INTEGRATION

The facade has been conceived and built on the same phase than the new building. Its physical integration is directly derived from the floor plan of the architecture proposing a visual extension of the building from afar. One of the remarkable feature of this project that distinguishes it from other media facades, is its play with natural light. The lighting installation does not denature the building by daytime. The facade presents a three-dimensional surface, with no signs of being a media facade. This low-relief topology modulates the surface, by a playful composition of light and shadow that constantly changes with the movement of the sun, as the negative image of the night scheme. The daytime appearance provides a feeling of time and tactility, while the embedded lights into the volumetry of the facade will turn it at night, into a dynamic communication surface reflected by the river in its surrounding.

1.B. PROPORTION AND DENSITY

The lighting installation is distributed as an all-over pattern on the flat facade facing the river. The interesting point in this study case is its uneven distribution, using the economic constraint as an opportunity to play with the light points repartition on the facade. The special arrangement of the light creates different "resolutions" that clearly distinguishes it from a display. It demonstrates that the distribution of the lighting points can be creative and use as a design element in a project. The analogy with the eye's mechanism of vision cited by the designers stays unproved, but remains an interesting axe of research for nurturing design ideation.

> *" As far as our concepts are concerned, it would be wrong to think that we simply put screens onto buildings and thus transpose the television, film or computer screen format onto the building. Why would we do that ? [...] the facades actually morph into what is essentially a three-dimensional skin wrapped around the building, given the building as much in the day as it does at night. The same applies to the C4 facade for the Contemporary Art Center by Nieto Sobejano in Cordoba. That is precisely the pixel research I was talking about : we often work with rudimentary resolution and do not therefore pander to people's expectations about what a screen should be. It doesn't always have to be HD and full-color; what's much more important is that it is delivered to be specific to the location.*
>
> *(source : interview published on the Vitra Design Museum website)*

1.C . FORMAL EXTENSION OF THE BUILDING

In this case the facade aligns perfectly with the building, and even more, as it constitutes its external image in illustrating his internal structure, derived from the historical architectural context of the region.

1.D. MATERIALITY

The facade clearly uses the physicality of material as a part of the illumination principle. Each bowl plays as a reflector to distribute the light which is not seen as a point source, but as a delimited surface, of difference superficies, depending on the size of the bowl.

2 . EXPERIENTIAL CRITERIA

2.A. ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

The environment of the river participates by a play of reflection to the global image of the building. It obviously gives an appealing dimension to the river side. However, the lack of testimony about people's reaction does not allow to conclude on any specific type of atmosphere created.

2.B. RESPONSIVENESS

Since the content of the project depends on a collaborative works done by other artists, the facade has been designed as a flexible entity : run by a real time software that routes and converts any kind of digital images into the specific resolution and pixel arrangement of the facade, the low resolution and monochromatic light shall enabling the readability of the message while providing a tool for creative freedom.

3. COMMUNICATIVE CRITERIA

3.A. GOAL AND TYPE OF CONTENT

In term of communication, the objective of this facade was to provide a nocturnal identity of this new cultural landmark, and a mean of expression for artists supported by this new media art center in the city. Therefore, the goal was to remain flexible regarding the content.Because the specific arrangement of the light differs from the typical pixel grid of a display screen, a the custom made realtime software is necessary to preview the effect in the creative process. The designers of United:realities admit that it could be seen as a challenge for its appropriation by

other artists and could limit its appropriation and selection of content, which are then constraint to the C4 guidelines of usability.

> *'This is because of its special resolution and arrangement it becomes very difficult to imagine how certain content works on the facade'*
> *(source : interview published on the Vitra Design Museum website)*

From their experience on media facade, the designers however drew the conclusion that content should be specifically designed for the project and not let as an open-platform.

> *"Many of the facade we have created are more like platforms for which artists are to produce changing content.[...] This works well with some projects, but failed completely with others. That's why many projects now have specific artistic content clearly defined by us."*
> *(source : interview published on the Vitra Design Museum website)*

3.B : FORM OF THE MESSAGE

The different documentation found on the project showed different types of message, from abstract dynamic flow of white light to image based message. As the facade has been designed to be a flexible platform for content, this aspect stays questionable in regard to different future collaborations.

3.C : CONTEXTUALISATION OF THE MESSAGE

Same as per 3.b

4.DESIGN PROCESS

4.A FIELD OF PRACTICE

The designers describe their practice as the intersection of art, architecture incorporating new media and information technology. There is no specific mention of light as their principal medium.

4.B COMPUTING PART

Due to the special distribution of the lights points, and the need for flexibility allowing future collaborations, a specific software has been developed to allow the visualisation of the light effects and support the a creative process.

02

Figure 28 - Galleria Department Store, Seoul, UNStudio 2003/2004

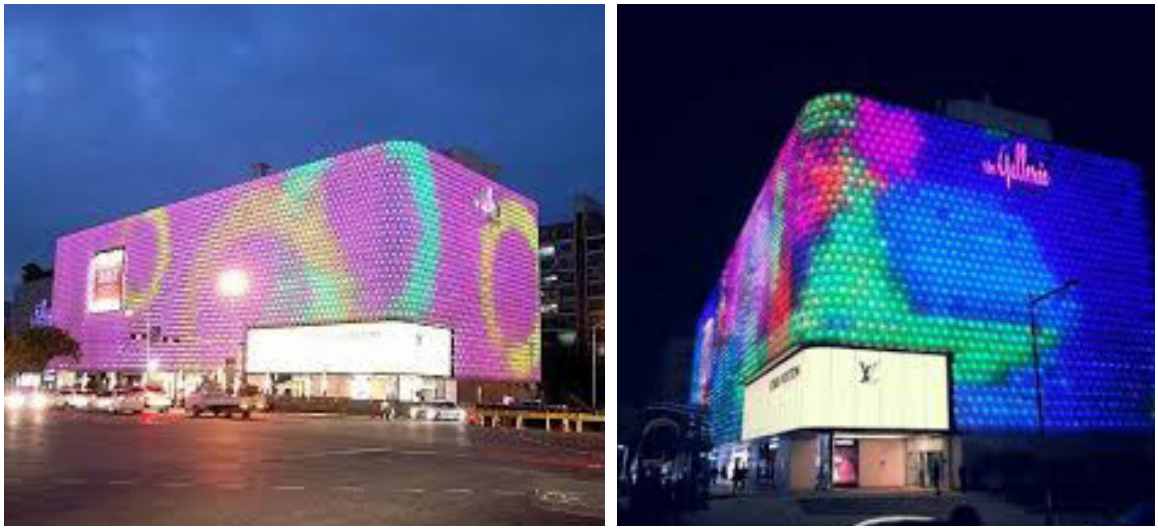
Galleria Departement Store

Seoul, Korea

2003/2004

UN Studio

Arup



Figures 29 & 30 - Galleria Department Store, Seoul, UNStudio 2003/2004

DESCRIPTION

This project is a renovation of the existing facade of the commercial gallery in Seoul. The design principle consists of wrapping the bare concrete of the original facade by 4330 discs of glass illuminated by RGB led. The discs of a glass are covered by a dichroic filter, revealing by day a soft mother-a-pearl iridescent skin, while at night, each disc is lit up by a RGB Led light point, individually controllable, to create fluid, dynamic and colourful effects. In this project, the content is treated like a dynamic graphic effect, playing with the materiality of the glass that conveys a feeling of preciosity, in relation to the luxury standard of the shopping mall.

On the UnStudio webpage, we can read about an another one their similar commercial project (Galleria CenterCity, Cheonan, Korea, 2008-2010):

> *' In the design we respond to the highly social function of Southeast Asian department Stores, in which people meet, gather, eat, drink, shop. The departement store is no longer solely a commercial space, but a social and cultural experience for the visitors. Visual and spatial connections are at the hearth of the design. Together we generate a lively, stimulating environment. '*

ANALYSIS

1 . PHYSICAL CRITERIA

1.A. PHYSICAL INTEGRATION

This project is a retrofit installation. Its integration in the former architecture works like an additional layer covering the integrality of the building. The combination of glass discs with light make the light source disappear on a halo of diffuse colour at night, while staying hidden by day. As it cannot be perceived as an add-on, its addition on the building looks like being an intrinsic part of the building.

1.B PROPORTION AND DENSITY

The installation is a cover-all setting of the building, regularly distributed following an even grid square. It covers entirely the architecture, acting like an integral skin.

1.C. FORMAL EXTENSION OF THE BUILDING

The building did not look like having a particular formal character to put forward. Therefore the light installation uses all its sides as flat surfaces to be embedded.

1.D. MATERIALITY

The lighting points are hidden behind the dichroic covered glass discs, and therefore cannot been perceived as pixels. This type of glass diffuses the light and creates a blurred rendering on the final output when seen from afar. The new skin conveys a sense of precious materiality to the building, while providing a dynamic coloured appearance at night. In this mean, it distanciates itself from the display screen.


Figures 31 & 32 - Galleria Department Store, Seoul, UNStudio 2003/2004

2 . EXPERIENTIAL CRITERIA

2.A. ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

The scale of such an over-all installation conveys without any doubt a feeling, a mood to the space, depending on the type of dynamic content delivered. However, as the goal stays mainly commercial, and therefore is to catch people's attention, the dynamism and colours are put forward to create a playful and vivid feeling to catch the eyes.

2.B. RESPONSIVENESS

This installation is not made for any responsiveness with the environment.

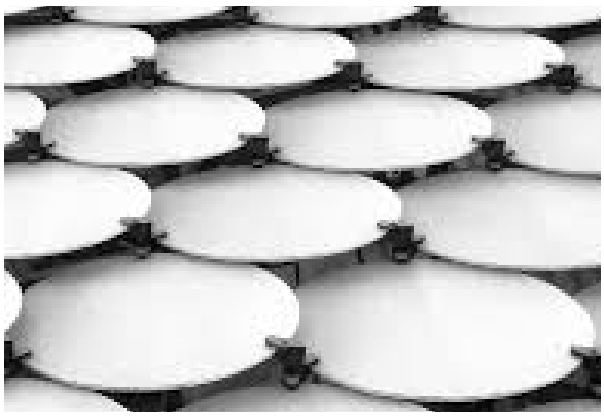
3. COMMUNICATIVE CRITERIA

3.A. GOAL AND TYPE OF CONTENT

The lighting installation responds to the need for a new identity of the building. While catching customers' attention is the main objective of the setting, the content shall be attractive without being too assertive. This setting relates to branding architecture.

3.B. FORM OF THE MESSAGE

The different documentations found on the project showed different types of message, from abstract dynamic flow of large colour gradient surfaces to blurred branding icons. Due to the lighting setting using diffused light, the message will never be perceived as a focus render. Therefore it distinguishes itslef from a display and could be associated to the concept of calm technology, depending of the dynamic rhythm applied.



Figures 33 & 34 - Galleria Department Store, Seoul, UNStudio 2003/2004

3.C. CONTEXTUALISATION OF THE MESSAGE

There is no contextualisation of the message except when associated to a brand selling its goods inside the shopping center.

4.DESIGN PROCESS

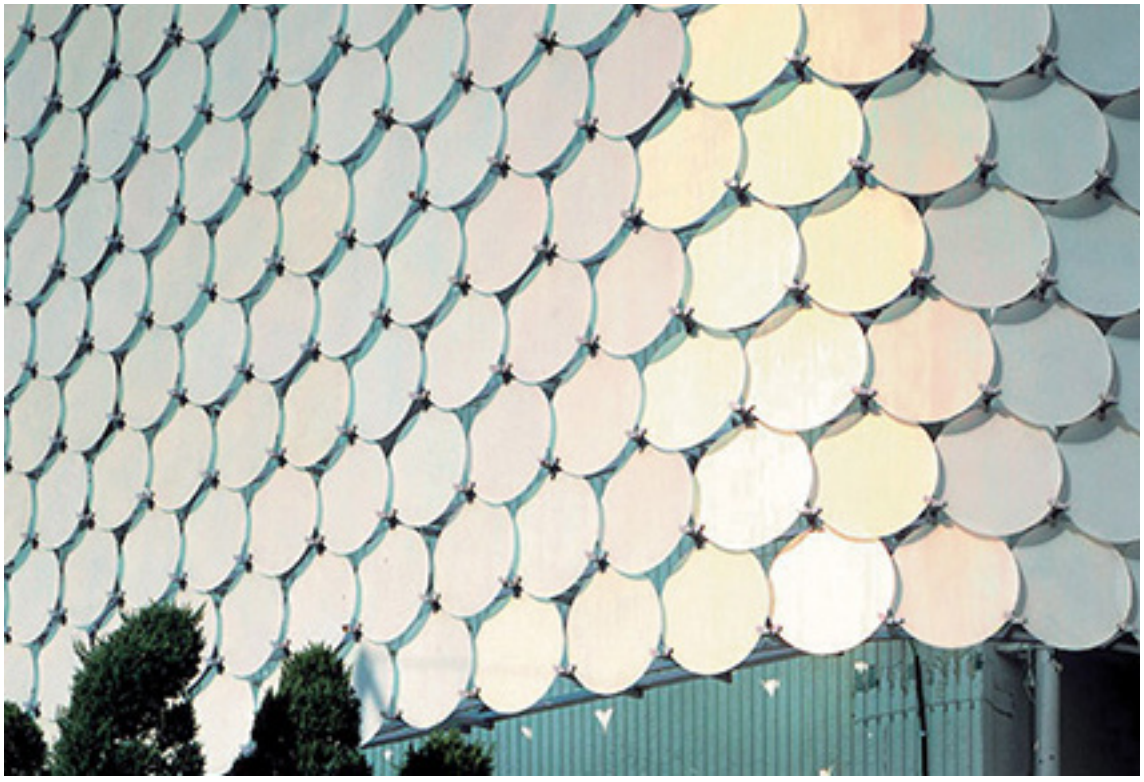
4.A FIELD OF PRACTICE

Collaboration between architects and lighting designer.

4.B COMPUTING PART

No specific software have been designed for this project.

Figures 35 - Galleria Department Store, Seoul, UNStudio 2003/2004



Figures 36 - Galleria Department Store, Seoul, UNStudio 2003/2004

03

Figures 37 - Dia Light, CPH, Kollision, 2013

Dia Light + Let's Play	Salling Light
Copenhagen,	Aarhus and Aalborg
Denmark	Denmark
Kollision	Kollision
2013	2017

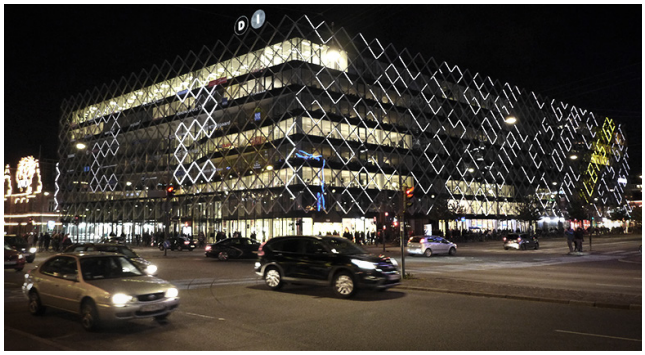
Figures 38 - Salling Light, Aarhus, Kollision, 2017

DESCRIPTION

We will study these both projects together as they have been made by the same design studio and share the same design principle. The both projects are taking place on the heart of a city center. The project DIA Lights in Copenhagen is installed on the facade of the Headquarter of the Confederation of Danish Industry (DI), while Salling lights is covering the facade of a departement sore on the main shopping street in Aarhus.

Both projects are revisiting existing buildings with strips of individually controllable RGB LED light, defining a loose and minimalist canvas on the building's facade. In the case of DI in Copenhagen, the lines are evenly distributed according to a grid defining a large diamonds patterns letting the former facade of the building visible. The facade of the Departement store Salling is mounted with vertical lines concentrated on a corner of the building, with a fading away density of their distribution along their sides. While the both study cases show a different light distribution, they are both relying on the same principle : the addition of a low resolution, discrete and non-obstructive layer of linear led, arranged following a loose distribution that does not obstruct the existing facade of the buildings.

Figures 39 - Salling Light, Aarhus, Kollision, 2017



Figures 40 - Dia Light, CPH, Kollision, 2013

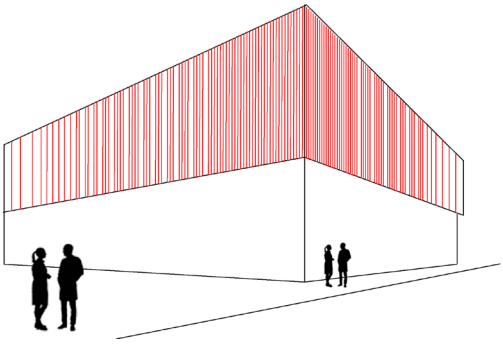


Figure 41. Salling project - Luminaire distribution

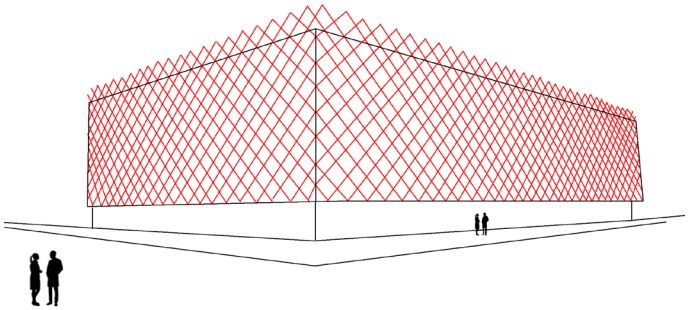


Figure 42. Dia Light project - Luminaire distribution

Both set up allow the light to be dynamic or transformed into a participative installation at an urban scale during special events. An interactive plug-in has been created for both projects, allowing the passer-by to interact with the facades, via a smart application. In Salling lights, people can 'paint' on real time the facade of the building by swiping their fingers on their mobile phone acting as an interface. The system allows several people to act simultaneously and transforms the aesthetic of the building into an abstract manifestation of light, as the result of their simultaneous actions. The large scale of the facade is visible from afar.Therefor, the participative feature relying on the public participation, is exhibited and can be experienced by many. The light setting of the DI facade has been similarly used temporarily, at the occasion of the Culture night in 2016. The lighting allowed a playful happening under the form of a game installation at the urban scale, called 'Let's play'. Via IPads embedded in boxes settings in front of the building, two persons could play a tennis game at the urban scale, with an homage aesthetic for the first 70's video games. This temporary intervention proposed a ludic way to make people participate in the installation, with the building becoming a gigantic low resolution display of the game. '

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTERGRATION

In both cases the integration of the light consists of an additional layer of linear LED, forming a non obtrusive skin in front of the current buildings' facades. The light is non integrated into the buildings' facade, but rather works as a second skin, almost invisible under daylight due to the small size of the LEDs.

1.B : PROPORTION AND DENSITY

In both cases, the installation cover the overall surface of the buildings, playing with either a large grid distribution or an evolution with the distribution density.

1.C : FORMAL EXTENSION OF THE BULDING

In the case of DI Lights, the light expresses the rectangular geometry of the building at the scale of the pattern while providing an aerial expression of the building's presence at the urban scale. In the case of Salling Lights, the light distribution uses the corner of the building, which is also its entrance, as the focal point of light, with a denser distribution of the linear LED at this point.

1.D: MATERIALITY

Neither of these two installation are playing with a material quality. Light is used as a direct point, in its raw expression of linear LED, and therefore stayed affiliated to the pixel aesthetic.

2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBBLIMITY and CALM TECHNOLOGY

In both cases, it seems difficult to rely on the concept of atmospheric quality. As we saw in the theoretical part, atmospheric quality are largely depending on an abstract and diffuse level of cognition. Even though the both projects can be the support of abstract patterns of light, their light expression stay close to the pixel aesthetic, closer to a display ou video game expression, than a calm technology.

2.B RESPONSIVNESS

Both projects however provide the possibility to engage a public in an active and participative way. Their real-time actuation allowsfor the direct feed-back with participants, while their scale provide an event to look at by a larger audience, creating a collective happening, a shared moment among the community of people present in the space.

3. COMMUNICATIVE CRITERIA

3.A : GOAL AND TYPE OF CONTENT

In both cases the goal is ultimately to give a presence by night to these buildings, in cities where the night-time represents a large part of people's life. In term of message conveyed, the communicative goal is not that clear when not applied to an interactive installation. In that case, the participative goal take over and the installations can be used as a playful platform, creating a space of participation at the urban scale.

3.B : FORM OF THE MESSAGE

The messages are taking several forms : from abstract patterns to textual and icon base communication. Its expression is however clearly attached to the pixel world, as the LEDs are used as direct point sources, closer to the display aesthetic than to an atmospheric lighting.

3.C : CONTEXTUALISATION OF THE MESSAGE

When the installations are not used in an interactive context, they does not connect to any contextualised information. However, in the context of interaction, they are the expression of a collective action transforming the space and activity around the buildings.

4.DESIGN PROCESS

4.A FIELD OF PRACTICE

In their website, the design studio defines the boundaries of its practice as "interactive communication, interactive design, dynamic media architecture, citizen participation in architectural project and urban development." There is no mention of light as a specific medium.

4.B COMPUTING PART

Both cases relate to the development of software plugin and application for smart mobile devices. As participation is at the core of both project, the problematic of interface is clearly an important feature here.

Figure 43 - Dia Light, CPH, Kollision, 2013

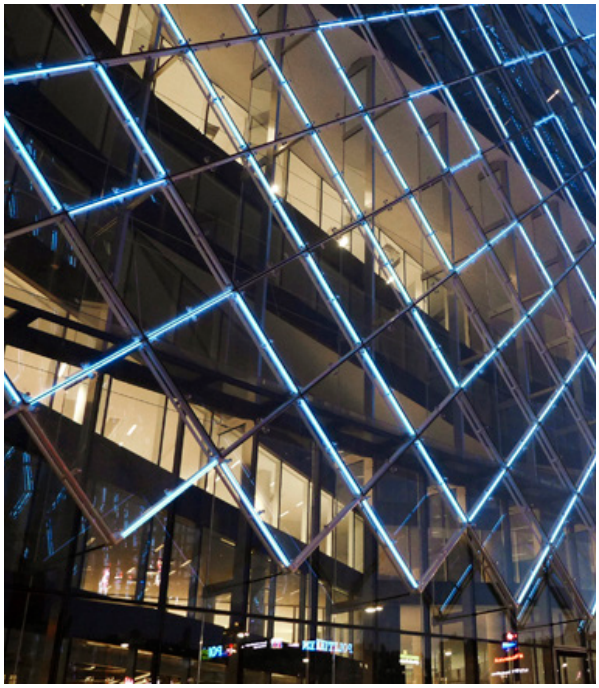


Figure 44 - Dia Light, CPH, Kollision, 2013

Figure 45 - Dia Light, CPH, Kollision, 2013

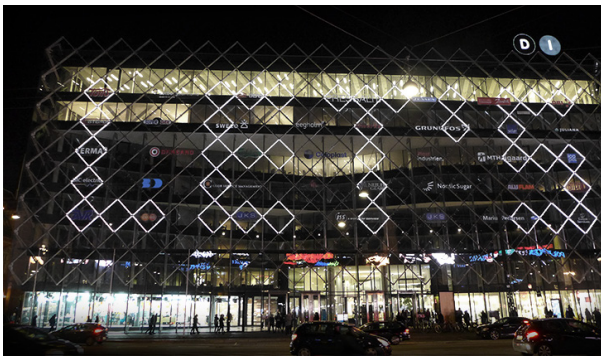


Figure 46 - Dia Light, CPH, Kollision, 2013

Figure 47 - Salling Light, Aarhus, Kollision, 2017

Figure 48 - Salling Light, Aarhus, Kollision, 2017

04

Figure 49 - Tower of wind, Yokohama, 1986

TOWER OF WIND

Yokohama, Japan

Toyo Ito

1986

Figure 50 - Tower of wind, Yokohama, 1986

DESCRIPTION

The project was a transformation of an existing concrete 21 mt high tower, built in the 60's as a water reservoir for the air conditioning system in the mall beneath it. The decision to redesign it marked the 30th anniversary of the opening of Yokohama's nearby Nishi-guchi station. This renovation was a non-invasive design concept, as no change was made on the structure itself. The concrete surface of the tower was covered by a series of reflective plates and was then wrapped by an oval cylinder of perforated aluminium. A combination of different types of lights were positioned in the space between the reflective panels and the aluminium layer : 1280 mini lamps, 12 neon lamps ring and 30 floodlights at the bottom.

By daytime, the sun is reflected on the cylinder surface and makes appear the tower as a monolithic and opaque volume. At night, the limit of this volume were disappearing within a play of transparencies created by the lights. The fluctuation of the wind speed and ambient noises were registered by a computer. Their translation into a visual experience via the control of the light intensity and colour, transformed the architecture from an opac monolithic shape to an almost disappearing, 'blurring architecture'.

This project demonstrates the ability of light to transform an anonymous construction into a strong landmark. But further on, it marks the first attempt to signify the context of the building by converting the environment into an information that architecture can contain and express, as an alive relationship with the city life. This project was a pioneer in the use of computation as a way to introduce a constant dialogue between architecture and its environment. It is also a rarely attained achievement regarding the use of light; at this epoch, the LED technology was not yet advanced enough to use them in such a project. However, Ito demonstrates here that the understanding of light as a spatial material goes beyond thinking the light as a alignment of points, in reference to the pixel units of the displays. This way of using the materiality of light

coupled to computation into performative architecture, is nowaday barely reached by the most sophisticated media facade, as they too often concentrate mainly on LED light as a direct point source, discarding as such, the spatial qualities of light beyond the digital technology.

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

The light sources have been physically integrated in the project in such a manner that they were invisible by daytime. Their integration did not disturb the look of the building, even though this project was a refurbish one, and therefore worked by an additional layer of artefacts to the architecture.

1.B : PROPORTION AND DENSITY

The light in this project is used in a play of reflection and transparency. For this purpose the setting was wrapping the entire volume of the building, in order to use its mass as a support for the play of light. It might be relevant to note here, that the function of the building was not directly linked to a daily people's activity around. Therefore this type of architecture does not have to deal with windows, and relates to space as a spatial landmark, close to a sculptural effect at urban scale.

1.C : FORMAL EXTENSION OF THE BUILDING

The formal expression of the building is very close to a monumental column. The light installation is using this feature as the background for a play of light that completely transform the mass of the building at night into an aerial expression of the shape. In that sense, the light settings seamlessly integrated provide more than an extension, but provide an other expression of the architecture, while staying in the boundaries of the same physical shape.

1.D: MATERIALITY

This project is a remarkable illustration of the use of light as a spatial material, able to transform the feeling of a building from a the concrete mass of a column to an aerial spirit of a tower. It uses the properties of reflected light to literally create a space in between the two skins of the architecture, while other points of lights are redrawing the external limits of the form by an alignements of graphic rings of light.

Figure 51 - Tower of wind, Yokohama, 1986

2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

The drastic transformation that light is creating in this project, participes of a feeling of wonder. Toyo Ito uses light in a powerful manner here to almost make disappear a piece of architecture which is by daylight perceived as a concrete mass. Somehow, it almost looks like a magic trick, close to the technological sublime we have been investigating in the precedent part. The architecture at night infuses the feelings of lightness, blurring edges and moving architecture that Pallasmaa describes when talking about the atmosphere of a place. Toyo Ito brought here a new direction for media architecture, emphasizing the human perceptive quality that electronic and light, when combined, can achieve.

2.B : RESPONSIVENESS

The core of the project is based on the idea to integrate environmental behaviour into the architecture through the expression of light. The wind Tower was the first architectural project using captors and computation to gather datas from the surrounding and translate them into an artistic expression. The diurnale expression of the architecture becomes an “alive” and dynamic Landmark, connecting in real time with the surrounding atmospheric activities.

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

The goal was to promote the area for a commemorative anniversary. The light was a mean to create a new diurnal landmark, with its dynamism communicating the expression of the live around. The type of information delivered was referring to the activity of the environment.

3.B : FORM OF THE MESSAGE

The mean of expression uses light under a two forms : reflected and direct. But both converge into the creation of a new visual presence of the piece of architecture. This type of communication is abstract and refers to ambient communication, as well as calm technology as they are directed to peripheral attention. The message is not delivered under the form of a focus textual message, neither is an abstract pattern. The message is actually the architecture itself, that light transforms continuously.

3.C : CONTEXTUALISATION OF THE MESSAGE

This project is highly contextualised as the dynamic light is meant to be the direct expression of the live around, gathered through sensors. The dynamic feature connects the building to its environment through the light expression of its physicality.

4.DESIGN PROCESS

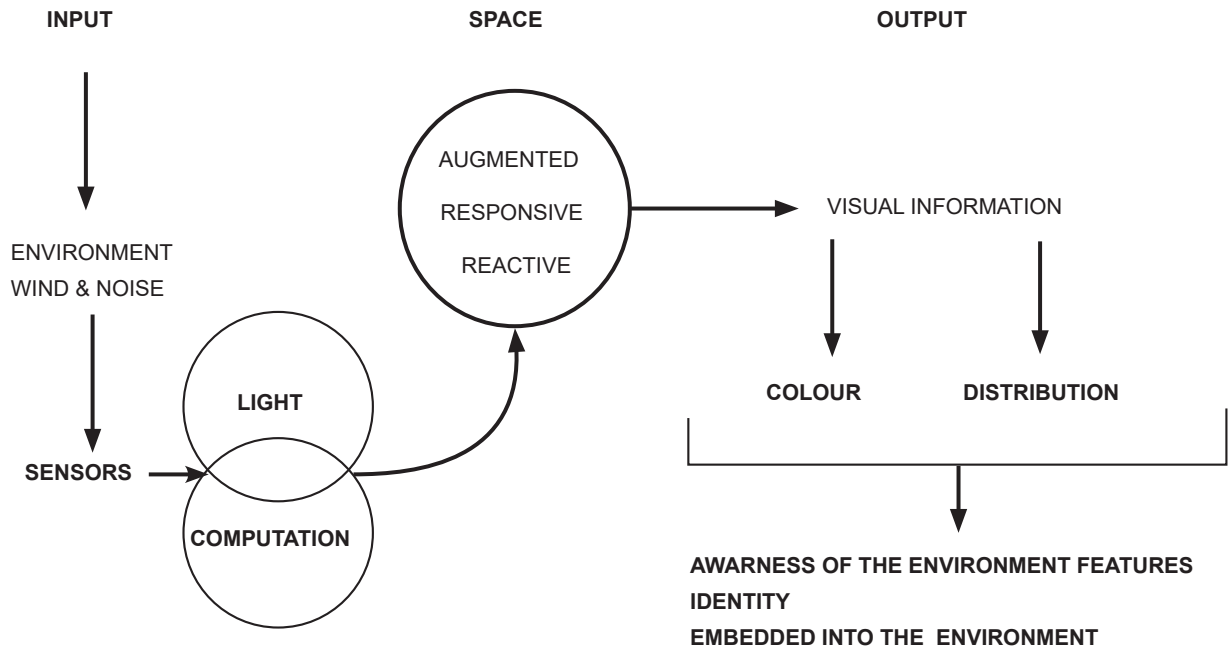
4.A : FIELD OF PRACTICE

Architecture. There is no mention of any lighting designer involved in this project on the literature available.

4.B : COMPUTING PART

This project is one of the first example of computing applied to architecture; it is also refers as the pioneer in Media architecture. Despite this affiliation, the information available on the computing part is very limited, which seems incredible. Therefore we don't know the level of computation involved in the creative process of this project.

Figures 52 to 54 - Tower of wind, Yokohama, 1986



Figures 55 - Responsiveness scheme - Tower of wind, Yokohama, 1986

05

Figure 56 - DUNE, Rotterdam, Netherlands, Studio Roosegaarde

DUNE

Rotterdam, Netherlands

Studio Roosegaarde

2006-2012


Figures 57 & 58 - DUNE, Rotterdam, Netherlands, Studio Roosegaarde

DESCRIPTION

Dune is a public interactive art installation that interacts with the visitors. Formed by a modular system made of hundred of fibers sticks equipped with LED at their top, a white light is triggered by the movement and sound of the visitors, creating a responsive environment. The dynamic and fluid light pattern follows the movement of the visitor along his walk, evoquing natural movement and landscape-feeling. In his TED Talk (2011, 'Using Technology for poetry'), the designer Daan Roosegaarde explains that his main interest was the kind of social interaction the installation would create. The main idea behind this installation was to enhance social interaction in public space, with the audience participation at the center of the piece. In an interview given in 2006 he says :

> *'While watching how people react on the work, I realized this : the main ingredient is the human interaction itself. [...] I would like the invite the visitor to become a participant instead of an observer. But with Dune 4.0 it goes one step further; the visitor becomes a performer. Once we had Abramovic doing performances while audience was watching. But here the audience becomes an essential element of the identity of the work itself. All this happens in a supernatural environment; you are walking through a corridor. It is here that all the technology merges with your body, as a realtime extension of your skin-feeling like an 'Alice in technoland.'*
> *(Daan Roosegaarde talks about Dune 4.0, Dec.10 2006, Regine)*

The main point of his reflection is the participatif character of the installation, where the piece exists only thanks to the visitor performance. Initially designed as an interactive art installation for Rotterdam Mass River (where it has finally been permanently installed), this installation has

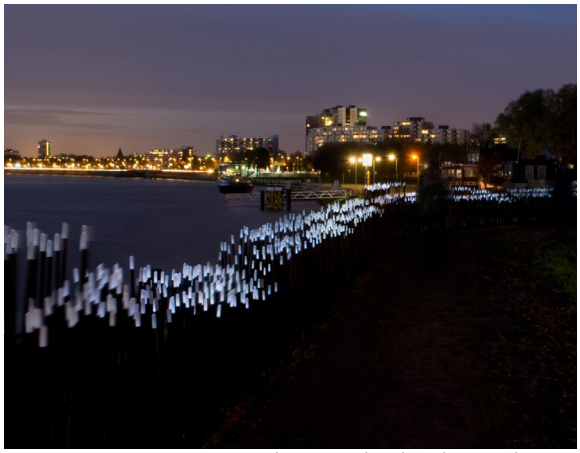


Figure 59 - DUNE, Rotterdam, Netherlands, Studio Roosegaarde

Figure 60- DUNE 4.1, Rotterdam, Maastunel, Netherlands, Studio Roosegaarde

been shown in many different locations. It has been the occasion to observe and analysis people's reaction within differents cultures and contexts. In the same TED Talk (2011), Roosegaarde explains that the reaction of people where different in Asia, where children was mimicking the sound of the art piece trying to engage a dialogue, than in Los Angeles, where people were enjoying the bright light mimicking of their movement in a kind of egotic reaction, or than in Slovenia where people's reaction was more reserved. These exemple shows that the cultural context is crucial in any interactive set up; as people action-reaction is at the center of the work, socio-cultural behaviour and spatial context will always impact the type and level of interaction. Roosegaarde explains than for each presentation, the pieces has evolved based on the previous one, creating different storytelling and scenari for fitting different contexts. He also refers to behaviours where people embrace the space installation as their own personalised space, generating new type of moment of life in the public space : couples taking pictures of their wedding with the installation around; dancers, using the piece as a source of information about their movement when rehearsing.

Another feature of this piece, that distinguishes it from many other installation, is its scale and its tactility. People can touch the fibers, like in a field of straws, instead of being overwhelmed by a gigantic facade or interface. The space-making in this case happens at a human scale within the architecture or the urban space. Because the way to interact is intuitive (movements and sounds), people feel like being a part of it, as the light 'walk with you, but in the same time has its own mind' (D.Roosegaarde). The installation is also able to react in the same time to different people's presences, and creates a unic reaction under the form of moving light pattern. So the interface with technology and between people is neither intrusive, nor overwhelming. The techno-landscape is experienced as a mirror or an extension of human collectivity. This case exemplifies how technology, can mediate a social sphere and create awareness of the environment.

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

This piece has not been originally designed as an architectural setting. It's first realisation was a temporary installation conceived to take place outside, as part of a landscape environment. However, its modularity has allowed it to be mounted in different type of spaces, from landscape, to urban corridor, church, exhibition art galleries, or urban settings. The scale, modularity and nature inspired shape, made it an element easy and flexible to be implanted in many different typology of spaces.

1.B : PROPORTION AND DENSITY

The density varies in regards to the number of modules aligned together. The proportion is quite unusually for a media-installation, generally used to the bigger scale or architecture. This one embrace the human body scale, to facilitate the interaction with the participants. The body is literally embraced by the light, which makes it easier to feel it at a human scale. It emphasized the connection of light with differents senses, including the act of touching, hearing and seeing on a unic experience. In that sense, it perfectly illustrates how the embodiment concept can apply to technology with light and computation.

1.C : FORMAL EXTENSION OF THE BUILDING

Is not relevant for this installation

1.D: MATERIALITY

The light here is not materialised by a point light similar to a pixel, but rather like a small luminous extension placed at the extremity of a stick, with strong natural connotation. The overall installation remind some luminescent phenomenon that can be found in nature.

2 . EXPERIENTIAL CRITERIA

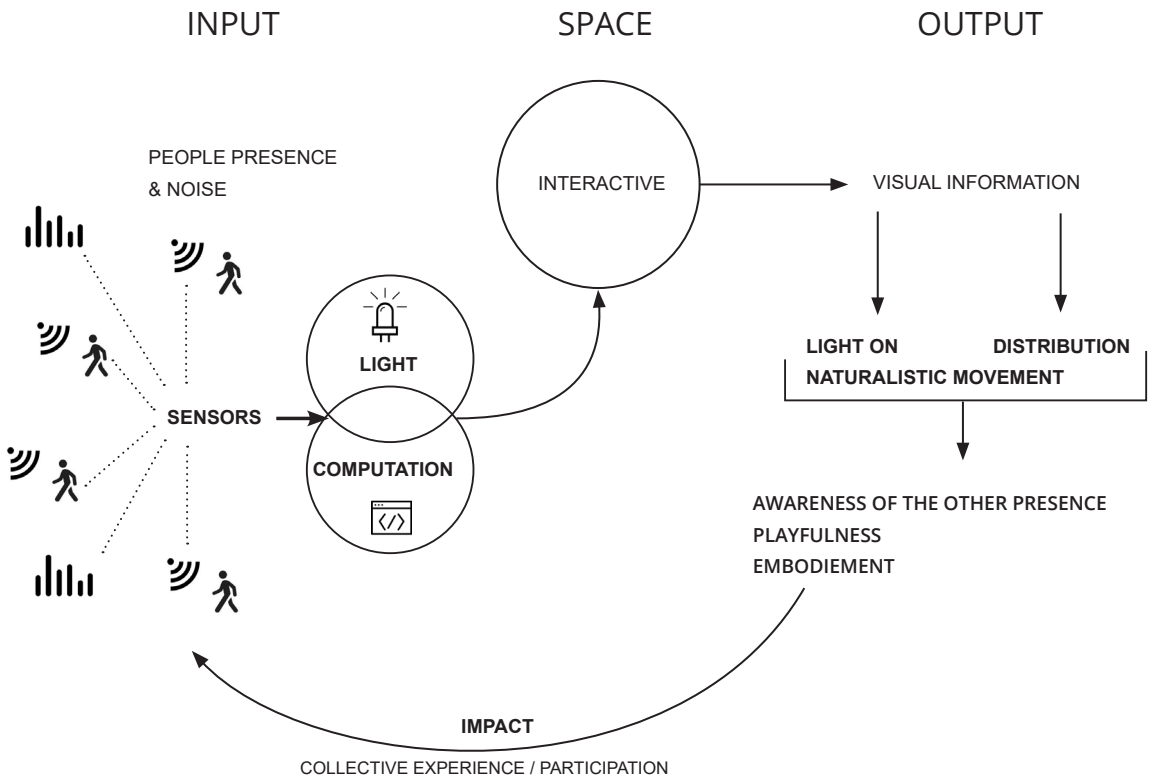
2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

Despite its scale, closer to the human body than to architecture, this piece has a strong connotative atmospheric qualities. First, the light sources distribution at the bottom edge of flexible sticks, create a random distribution closer to a natural setting than to a pixel grid or geometrical arrangement. Then, the movement of the light emphasizes the idea of fluidity, again closer to the type of movement found in nature than the on/off switch of a light source. It creates a feel-

ing of softness, close to the blurred effect that Pallasmaa evoks to talk about the feeling of atmosphere. One of the remarkable feature of this piece is probably its scale. It demonstrates that atmospheric condition can happen at a human scale, and does not necessary appeal for an architectural scale.

2.B : RESPONSIVNESS

This piece illustrates the principle of interactive landscape. The dynamic light pattern is triggered by the movement and sound of the passer-by, creating an echo to their move. It allows a simultaneous interaction with differents participants, proposing an illuminant expression of a collective event, happening at the human scale. As it does not force people to interact in a spectacular way, it places the activators and the observers on the same level, fostering a collective memory in front of a memorable event. The mean of interaction is intuitive and uses body movement and sound to interact. There is no interface in between people and the light response, which enhance the embodied connection with the piece.



Figures 61- Interactive Scheme - DUNE, Rotterdam, Netherlands, Studio Roosegaarde

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

The goal of this installation is to make people interact in a intuitive way. There is no specific message to be delivered, other than inviting people to participate on a collective performance happening at a human scale. As the installation can embrace many people interaction at the same time, it has the potential to trigger encounter and communication between people.

3.B : FORM OF THE MESSAGE

The form of the message is embodied by the dynamism of light that creates an abstract, but nature like movement, as the interpretation of people's interaction around.

3.C : CONTEXTUALISATION OF THE MESSAGE

This piece is deeply contextualised, as it needs people's participation to work. The installation delivers into the space, a real-time illuminant response to the moving bodies and sounds of its environment.

4.DESIGN PROCESS

4.A : FIELD OF PRACTICE

The studio defines itself as a "social design lab", putting forward the creation of landscapes that connect people, technology and space. The head of design describe himself as an artist.

4.B : COMPUTING PART

The computing part is highly important in this piece has it has necessitated the development of a specific software in order to translate people's input into a light response that is arranged in an organic way, far from looking like a pixels grid or display. One particular point to note here, is the vocabulary employed. It is relevant of the sphere in which belong the piece, as each new installation of the light piece is called an "iteration", which refers to a programmatic way of thinking. It means than the installation is in constant evolution, adapting its performance to the previous ones.

06

Figure 62 - BAY LIGHTS , San Francisco, Leo Villareal, 2012

THE BAY LIGHTS

San Francisco, USA

Leo Villareal

2012

Figure 63 - BAY LIGHTS , San Francisco, Leo Villareal, 2012

DESCRIPTION

For many years, San Francisco's image has been tightly bound to its red-painted steel Golden Gate Bridge, attracting international tourists, while on the other side of the city, the less iconic Oakland-Bay-Bridge was seen as an utilitarian and was barely noticeable in the collective 'image of the city' (to employ kevin Lynch terminology). The site specific and generativ light art installation, designed to commemorate the 75th anniversary of its opening, has changed this configuration. Bay Lights, from the artist Leo Villareal, was firstly temporary implemented for a two year round, from 2013 to 2015, before being installed back, permanently since January 2016, cementing the light to the identity of the bridge on the mind of billions people.

The artist Leo Villareal describes his architectural work as highly site-specific. Questioned about the challenge to work on architectural project, he points out the importance of integrating the piece into the building without disturbing the architecture (Villareal, 2013, p.36). On the same manner, he talks of his process as being himself working with and within the environment, as he does not deliver the light piece as a final state to be implemented, but works on site, to "craft" the programming side of it : "Each piece is made site-specifically, so I have to sit with it and work with it." (source : Leo Villareal, talk on The Bay Lights, SFMOMA, 2013, February the 7th)

Bay Lights is made of over 25 000 white LEDs lights, of one inch diameter each, spaced every each foot on a cable, attached to the structure of the bridge as a layer of points light, visible from the city northeast side, while not disturbing the drivers using the bridge itself. The monochromatic and atmospheric patterns are auto-generated by a program, which means that they

will never repeat themselves. The moving illumination is an ever-ending open-process that the artists assumes as the condition for people's freedom to connect with the piece.

Leo Villareal describes his practice at the merging point of code (computation) and light. Coming from an education in Art and Interactive telecommunication, his interest lies the visualisation of code sequences with light. As his practice depends on settings rules and systems, he find himself closer to Sol LeWitt and peter Halley, than in the lineage of Dan Flavin and James Turrell. (Talk in SFMOMA, 2013).

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

The points lights are distributed following the existing structure of the bridge. It underlines its linear feature, providing a diurnal image true to its physicality. As the piece can be seen from afar only, the level of integration into the architecture is not as demanding as per for a building that can be experienced at a closer distance.

1.B : PROPORTION AND DENSITY

The proportion and density of the light installation follow the structure of the architecture. The points lights are splitted into two groups. The top of each linear structure is highlighted by a point light that always stays on. It creates a diurnale silhouette in a dotted line that allows to locate and frame discretely the overall presence of the bridge. The second group is formed by lines of leds arranged along each structure the of bridge. They form a loose linear grid of dynamic points lights, that can be related to a very low resolution display.

1.C : FORMAL EXTENSION OF THE BUILDING

The light setting follows the rhythm of the architecture's upper structure. By night, the upper part of the bridge is illuminated, providing a floating image of the bridge into the darkness around.

1.D: MATERIALITY

There is no play with materialite in this piece. The light is used as a direct point light source, bright enough to be visible from afar.

2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

As an ever-changing state, the Bay Lights is meant to be seen from many different states and viewpoints. It provides an accumulation of experiences over time connected to the environment, something memorable to which people can connect with, in tune with the life of the city. The dynamic contrast of brightness confers the illusion that some parts of the bridges are sometimes disappearing on the darkness, emphasizing the swaying effect on the structure. The types of patterns displayed are produced by a generative process, which means that there is no beginning nor end on the sequences. The design process stays open. The patterns will never repeat themselves. According to the artist, it creates an open-ended place, where people can gather, contemplate and share a collective feeling of beauty, or sublime, with the freedom of individual interpretation; a space of contemplation that let you enjoy the experience, with no feeling to be pushed to do something.

> *'All of these systems and geometrical structures are connected to beauty, or what we perceives as beauty, because we respond to them. [...] the connection leads to what people call "beautiful" or "sublime". I certainly take inspiration from things that I find in nature, natural system in the sky, and things we see all the time, but I am trying to distill how those things work and evoke them in an abstract way.*
> *(Leo Villareal in the interviewed by Jan Garden Castro, p.35)*

Creating a sense of ownership, the collective dimension is put forward as a shared experienced to which people can relate to, and therefore foster a sense of community, while keeping the individual freedom in the space. In videos showing the installation, people comment on the illuminated bridge on these terme :

"You have to watch it for a while "

" It is unpredictable"

" I love the scale of it"

"I think it is very representative of the bay"

2.B : RESPONSIVENESS

Regarding the responsivity of the piece, the artist refers to the highly dynamic bridge's environment, with car traffic, flowing water around, and daylight as source of information for the light dynamism. While he used information collected from the environment, he however distanciates his practice from the use of data collected by sensors and directly mapped out into light patterns without interpretation or translation. He considers that, as an artist working on, and engaging with the site, he has the responsibility to be the sensor himself, and therefore being attuned with phenomenon happening on site, filter them, and make decision about how to translate them back to the world. The notion of choice is central to the project, but instead of being placed in the final outcome, the decision-making is happening on the programming part.

> *' [...] I am trying to expand what I can do with my sequences, and in particular with the Bay Bridge, where there's so much to respond to. I am taking input from the water, the wind and the traffic. I am interpreting anything that moves and creating my sequences in response, so that it will feel very appropriate to the space. On one visit, I was on the cable walk on a cloudy day, and suddenly the clouds opened and light came down on the water- it was a sublime moment. I was taking notes, photographs, video - working directly with the interaction of light and water oscillations that I saw up there - and thinking : How am I going to ask my programmer to simulate these systems ? '*
> *(Leo Villareal in the interviewed by Jan Garden Castro, p.37)*

He refers to his approach as setting the conditions, or the framework for the light patterns to behave in an appropriate way regarding the site it will be implemented, instead of setting up a final piece of work with a premeditated outlook. In that sense, he describes his practice as a sort of "orchestration", in reference to a music practice, insisting on the time spent to "craft the tool and go way beyond the loop", with the central idea of emergence behaviour in his work.

> *"There are a couple of different phases in my process. The first, discovering what is possible is open-ended. I have a certain idea when I begin with a piece, but I am interesting with emergent behaviour - creating the conditions for something to happen. I don't know the outcome exactly. During the randomness of that process, I am hoping for a moment when I can grab something - a sequence that is compelling. After the discovery phase, I combine and layer the sequences. This is a process of refining, and its becomes very rich. Then, the refined sequences are displayed in a random order for a random amount of time. It all goes through an exacting process, but in the end, it's always dynamically reshuffled."*
> *(Leo Villareal in the interviewed by Jan Garden Castro, p.33)*

According to the artist, the generative process is what allows people to connect wit the piece, as it unfold a never-ending process of discovery. However, we cannot talk about responsiveness for this piece, because the real-time content is actually an interpretation of the artist through generatives algorithms.

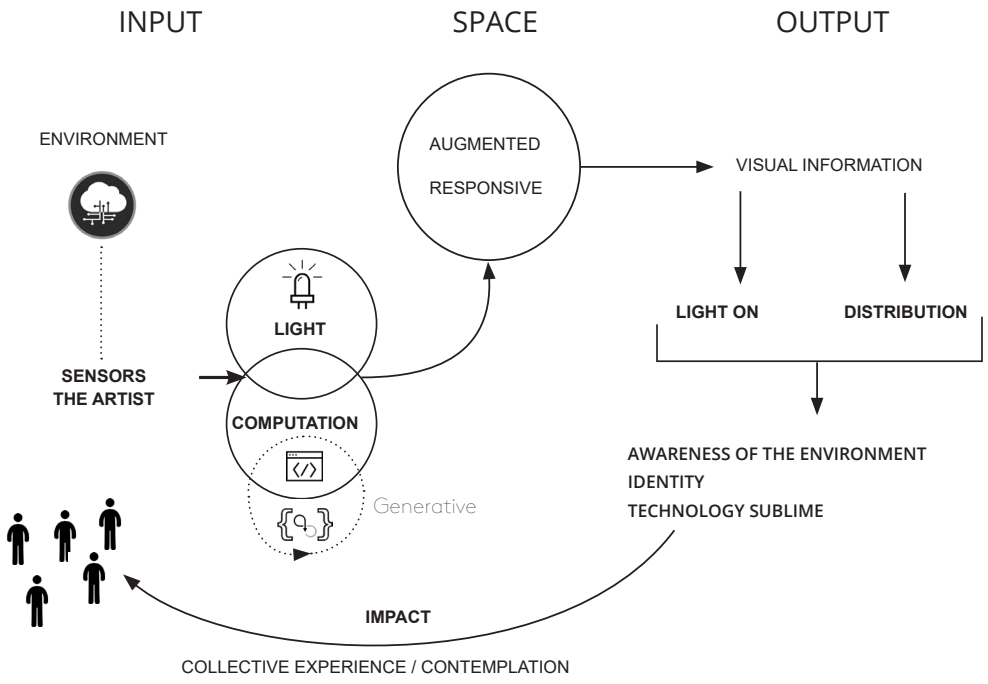


Figure 64 - Responsiveness scheme - BAY LIGHTS , San Francisco, Leo Villareal, 2012

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

The primary goal was clearly to reinvigorate the bridge's image, so it becomes part of the collective idea of the San Francisco's identity. Then, the artist mentioned how the human scale is important on his work, as he wants people to be able to share a collective feeling in front of the piece.

3.B : FORM OF THE MESSAGE

The message is delivered through the form of abstract patterns of direct monochromatic points lights. The different level of brightnesses are ordonated by a generative system. Leo Villareal insists on his work being abstract and generative, with no reference to images or texts. He grounds his work very much on the abstract translation of the dynamics embedded on the site. In an interview, he also specifically relates to its choice for LED points light source as a visual tool, able to convey the feeling of "softness", "atmospherique quality", or "energetic feeling" (Leo Villareal in the interviewed by Jan Garden Castro, p.35).

3.C : CONTEXTUALISATION OF THE MESSAGE

While the artist used the information collected from the environment (movement of car traffic, water and daylight) as a source of inspiration, he stays the filter of these informations. The context is expressed through an interpretation that is randomly processed by a generative system of programmation. Therefore the expression of the context is mediated, a position than the artist assumes as part of his role.

4.DESIGN PROCESS

4.A : FIELD OF PRACTICE

The field of practice in this case belong to public Art, dealing with light and computation.

4.B : COMPUTING PART

In Leo Villareal's practice, the light is considered as a dynamic tool of code visualization. Generative programming is at the core of his practice. It allows the notion of discovery, versus a pre-meditation of the final outcome. From a practical design view-point, the generative process relies on real-time control of light, as this design approach is very much based on testing iterations. For that reason, the artist has created custom tools that allow him to have flexibility while using precise control over speed and movement in real-time.

This generative approach, is part of the ongoing discussion and trend in the art and design worlds : the generative approach as conception is challenging the design process and role of designers, and raises many questions about decision-making and authorship.

Figure 65 - BAY LIGHTS , San Francisco, Leo Villareal, 2012

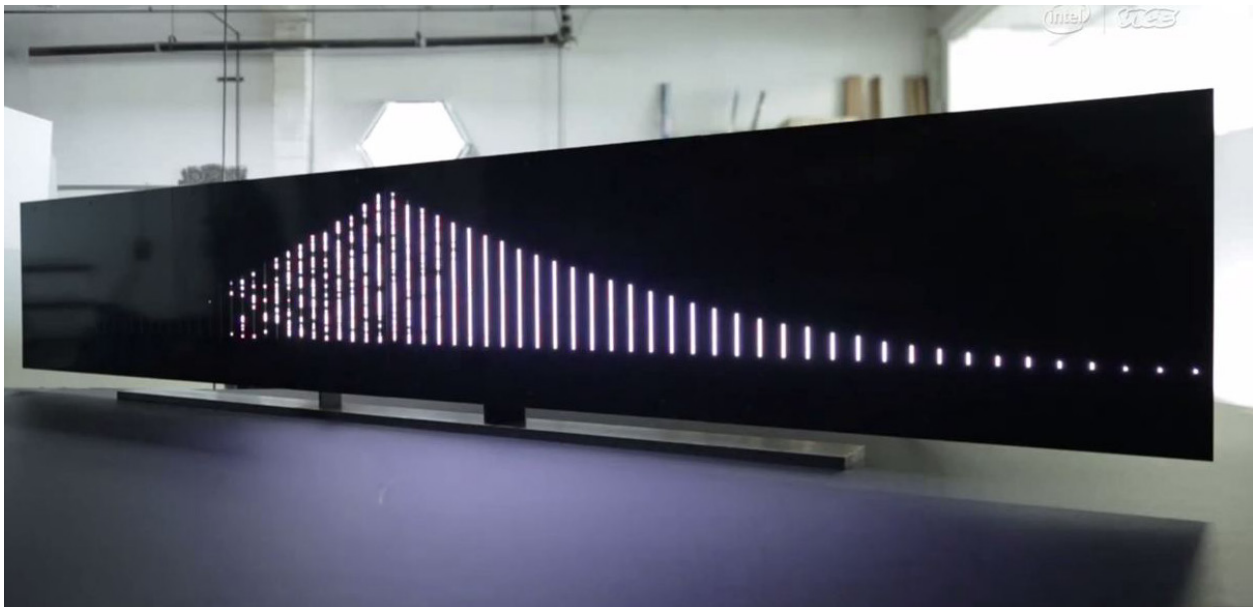


Figure 66 - BAY LIGHTS simulation , Leo Villareal, 2012

07

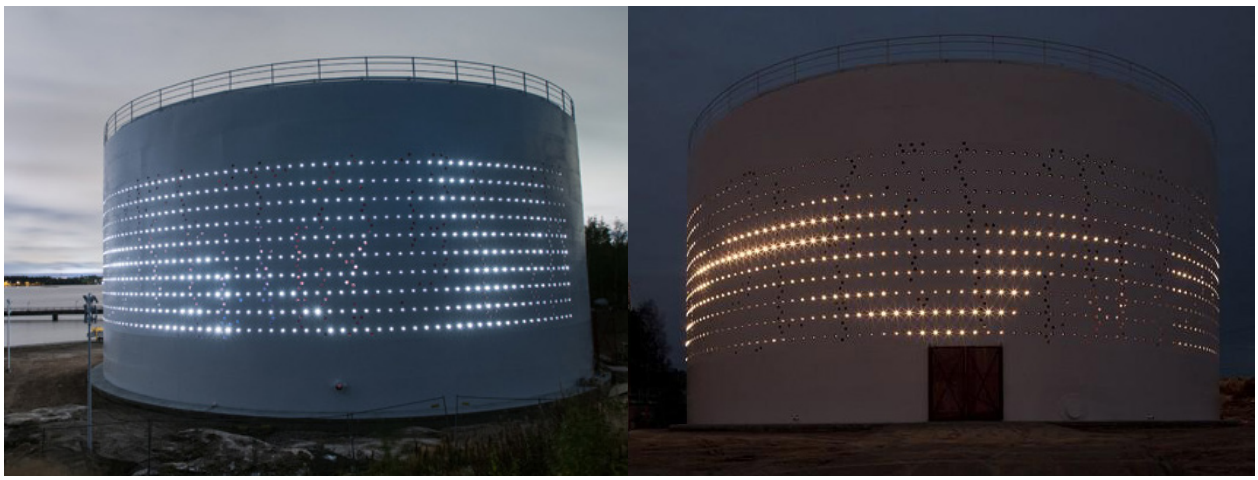
Figure 67 - SILO, Helsinki, Finland, LDC, 2012

SILO

Helsinki, Finland

LDC

2012



Figures 68 & 69 - SILO, Helsinki, Finland, LDC, 2012

DESCRIPTION

In 2011, the city of Helsinki launched a competition to transform the last remaining and abandoned oil silo of the once thriving port of the city, into a permanent urban light art installation. Located on the waterfront, the 17th meter-tall drum with its 36 mt diameter, is visible from the city. The municipality wanted to transform this historical building into a landmark and public space for the area, with the aim to promote the ongoing development of the city into a new residential area as a “district of light”, while marking the event of Helsinki chosen as the World Design Capital in 2012.

The Studio Lighting Design Collective won the competition with a dynamic and generative design concept, inspired by the natural environmental context. The design consists of drilling thousand of 150mm diameters holes into the drum, allowing the daylight penetration inside, into the form of bright and slowly moving dots patterns. Through the day, the silo appears like shimmering from outside, thanks to the polished stainless steel discs of around 50 mm diameter, sitting flush in front of the holes, and flickering with the wind .

Figures 70 & 71 - SILO, Helsinki, Finland, LDC, 2012

The placement of the holes are following two distincts grids. One has been inspired by the original rust patterns that covered the interior silo's, photographed by the designers team and abstracted into a random grid of dots. This grid is layered and mixte with an evenly distributed other one, that determine the placement of the placement of the holes mounted with a LED light point (Traxon - Dot XL-9 RGB), and constitutes as such a low resolution grid of 1280 points that can be individually controlled.

The development of the light pattern has been inspired by the silo's environment analysis, prevailed by wind and swarming patterns of birds. In this project, the datas gathered from the environmental condition, are controlling the instant switch on/off of each light points, creating a real-time dynamic pattern of light as the translation of atmospheriques information gathered and measured around.

Figures 72 - SILO, Helsinki, Finland, LDC, 2012 - Interior

Figures 73 - SILO, Helsinki, Finland, LDC, 2012 - Interior detail

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

Even though this installation is a refurbishment, the lighting setup uses the architecture of the silo itself to integrate the light in it. A remarkable feature of the installation is the double usage of perforation : on one end, it let the digital light to shining outside, while on the other end the sunshine can penetrate the inner volume of the architecture. It creates a double play of light patterns, a dialogue between artificial and natural light.

1.B : PROPORTION AND DENSITY

The light setting is arranged according to a loose and even grid all around the flat surface of the silo. This distribution allow the moving light patterns to run through its surface without being interrupted. The space in between the lights points is large enough, so it does not looks like a display of any sort.

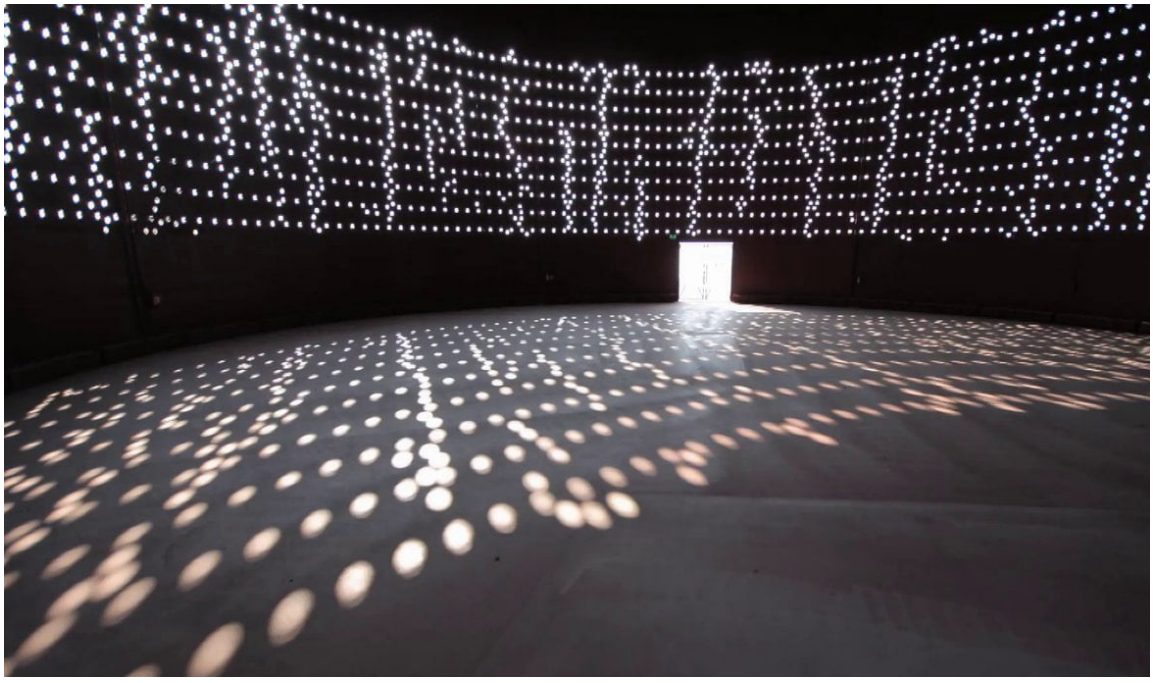
1.C : FORMAL EXTENSION OF THE BUILDING

The architectural form of the silo being quite simple, the light is distributed in a way that reflects this simplicity, without creating any interruption. The fact that the dynamic light can run all around its circumference, enhances the round shape of the architecture and therefore supports it,in providing a feeling of circularity.

1.D: MATERIALITY

This installation plays with materiality at several levels. In creating a pattern with the perforation on the building matrice, it invigorates and animates the architecture that did not have any particular feature on that sort on its original state. Then, the use of mirror emphasized the play of light, providing an additional light effect with a flickering brightness .

Figures 74 - SILO, Helsinki, Finland, LDC, 2012 - Interior



Figures 75 - SILO, Helsinki, Finland, LDC, 2012 - Interior

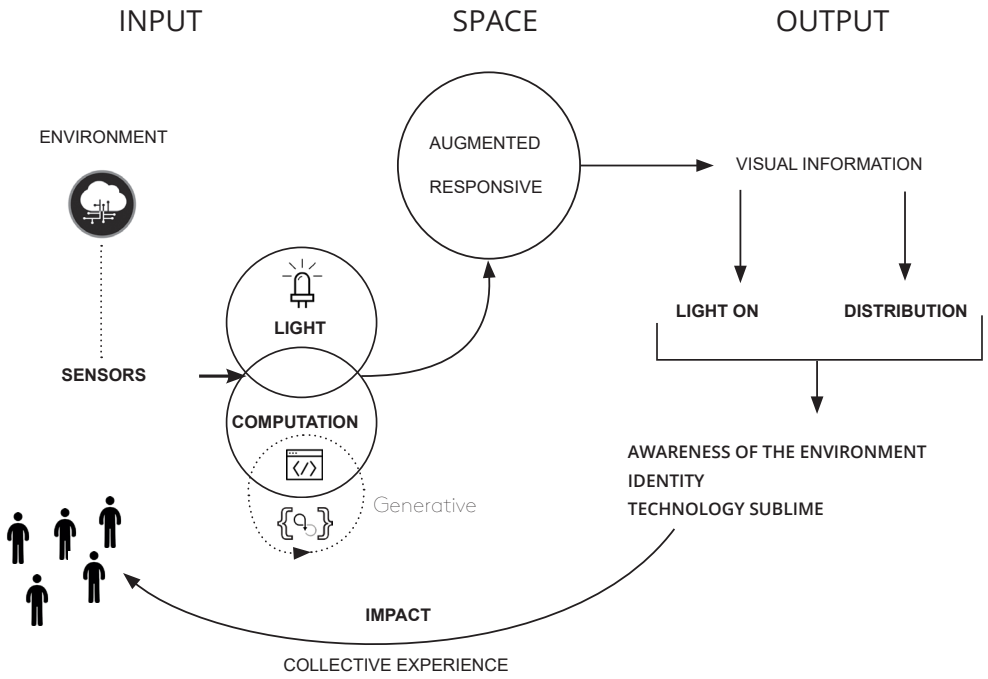
2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE

There is no doubt that this piece is deeply atmospheric. Its combines a sense of materiality, the expression of the nature dynamic around, and the play with daylight providing an additional sense of time to the piece. All these elements converge in a subtle flickering effects of differents type of lights, that even though aligned with several temporalities, respond to each other. The effects created are abstracts and does not convey any sort of focus images. They all are directed to an experience of the space that involves a peripheral awareness and an embodied presence.

2.B : RESPONSIVENESS

Sensors are tuned to detect the wind around the silo. They are then translated into an abstract pattern of light, mimicking swarms of birds. One the key element of the project is the generative characters of the light patterns, allowing to avoid any sequence repetition. Referring to the concept of Ambient communication, it is based on the observation of nature to find rules that can be encoded as algorithms. The aim is to create a non repetitive patterns of light , as a form of communication, that can be received effortlessly, without user Interface. As the light responds in real-time to the inputs coming from the environment, this installation can be described as responsive.



Figures 76 - Responsive scheme - SILO, Helsinki, Finland, LDC

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

The main goal of the installation was to promote the new district of the city in creating a new landmark that will be part of the city identity. The retrofit light installation also gives a new meaning and purpose to the space, as it has been transformed in a civic place for communal activities.

3.B : FORM OF THE MESSAGE

The message is expressed by monochromatic point of dynamic lights creating an organic and abstract type of patterns, close to the swarm move.

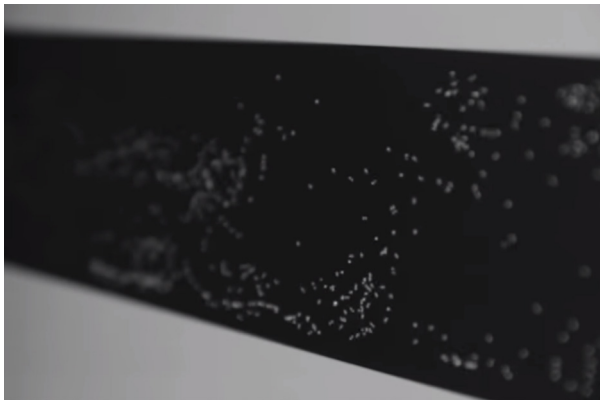
3.C : CONTEXTUALISATION OF THE MESSAGE

The installation contextualise the message in two ways. First in using the physical traces of time on the silo walls to arrange the patterns of holes, it prolongates and translates the spirit of the space in a new form. Then, the movement of light patterns being directly correlated to the wind outside, the architecture expresses a new type of connection with its surroundings.

Figures 77 - SILO, model testing

Figures 78 - SILO, 3D model testing

Figures 79 - SILO, Testing on site



Figures 80 - SILO, program visualisation

4.DESIGN PROCESS

4.A : FIELD OF PRACTICE

LDC is a lighting design studio with a particular approach based on digital content application.

4.B : COMPUTING PART

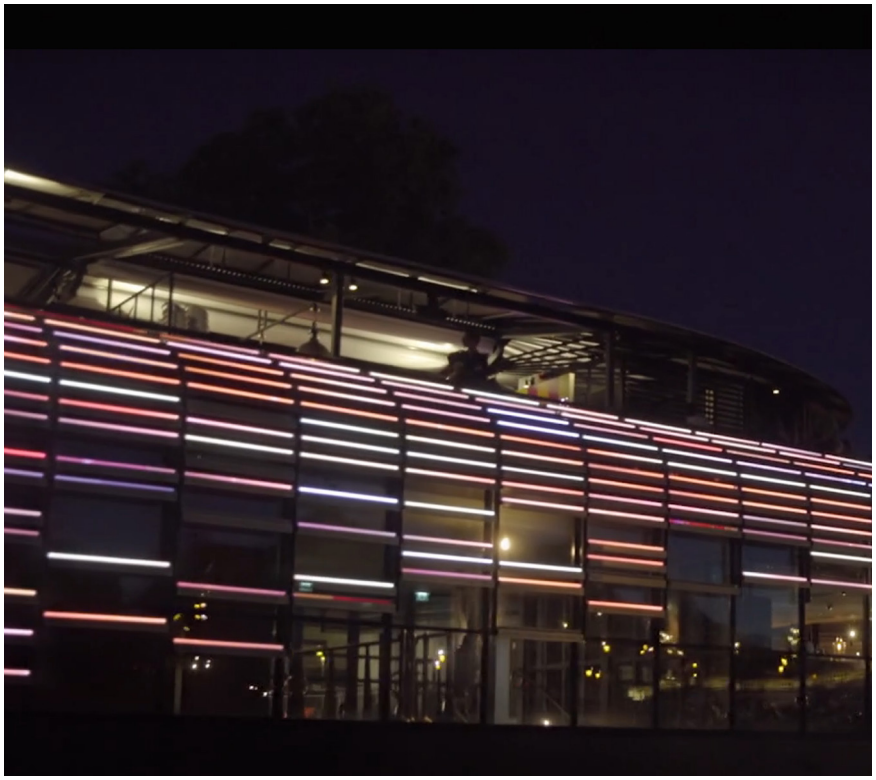
For this project, he LCD design studio teamed up with the creative technologists of Tecné Collective, originally working in the field of programmatic and audio reactive live visuals.

Together, they developed a control application system in OpenFrameworks (an open-source software using C++ toolkit for creative coding), enabling each points of light to react in real-time to the selected parameters, such as wind speed, direction and temperature. On the Open-Frameworks discussion Forum, the creative technologist of Tecne collective writes :

> *"To create the light animations, the application draws a particle system, using algorithms related to flocking and swarm simulations in openFrameworks. But as their resolution is low (the silo is 128 x 10 led lights), they decide to use the influence of the amount of particles in an area to drive the color, instead of drawing individual particles. The application reads an rss from a nearby weather station every 5 minutes, and they use mainly the wind speed to change the behaviour of the movements. The wind direction and temperature affects the particles, but in more subtle way and they implemented special "presets" for special climatological events (clear nights, heavy snow, etc)."*

The use and design of particles system is a technique of computer graphic initially used in the game industry for motion and animation simulation. This project illustrates how the two differents fields of lighting and 'creative computing' can be combined in an unic project.

08



Figures 81 - ELYTRE, Paris, Yannick Jacquet, 2017

ELYTRE

Paris, Pont Alexandre III

Yannick Jacquet

2017

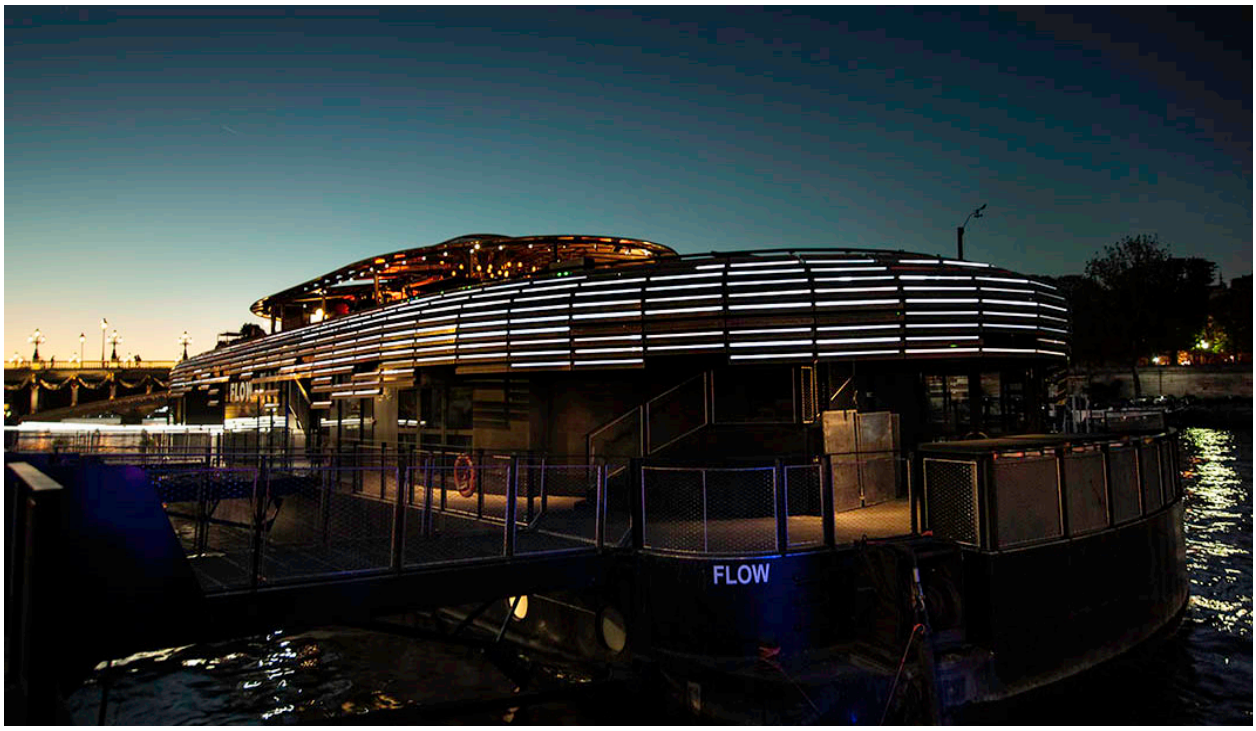
Figures 82 - ELYTRE, Paris, Yannick Jacquet, 2017

DESCRIPTION

This light piece is a permanent installation featured for Le Flow, a floating building moored along a pedestrian area on the banks of the Seine, located at the foot of the bridge Alexandre III in Paris. The installation is fine-tune with its immediate surrounding as the light evolves in response to its environment.

The top part of the floating architecture is covered by LEDs light strips under micro-perforated anti-sun panels, that are both a decorative and practical as they deflect the sun's rays. The boat is equipped with sensors that measure the temperature, humidity, wind speed, direction, and atmospheric pressure. All these data are interpreted by a custom made program that feed in real time the installation. At night, the light shines through the holes of the panels and reveals a slow shift of light nuances, as a response to the data collected from the environment. In a constant state of flow, the piece is permanently subject to hardly perceptible shifts of tones.The colours are used in a "pointillist technique", where each point of coloured light is slightly different from the next one, to create a more shaded and nuanced effect , with a wider variation in the colour pallette. The temporality of the installation is based on the overlap of the different annual,

monthly and weekly cycles, of the natural phenomenons measured by the sensors. Each change of state takes several weeks or even months to happen, bringing very subtle, almmost imperceptible shift in colours, intensity and patterns of light. The designer explains that this work is about the passage of time and the exploration of slowness. As its rhythm is very slow, It requires to stop and watch the installation for a while to appreciate the change of nuances.



Figures 83 - ELYTRE, Paris, Yannick Jacquet, 2017

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

The light is physically integrated on te top part of the cocoon like architectural shape, creating the feeling of a light floating roof, without blocking the view from the barge. The light distribution matches perfectly the shape of the architecture, and looks like an integral part of it. Because of the gradient nuances shift, the light creates a linear pattern all around the shape that distinguishes it from the pixel aesthetic of the Leds points lights.

1.B : PROPORTION AND DENSITY

The distribution is arranged all over the ring shape, but the density evolves from an overall covering on the top, to a space out linear effects, giving an additional rhythm to the floating barge. The architecture does not have the scale of a media-facade, and is experienced from a closer distance, which invites to experience the light effects on a body and more intimate scale.

1.C : FORMAL EXTENSION OF THE BUILDING

The linear distribution of the light proposes a nocturnal version of the barge close to its physical presence, without needed to covering it all. The arrangement of the top of the architecture is enough to suggest its presence, which is also reflected by the water all around.

1.D: MATERIALITY

The installation uses a custom design pattern of perforated holes in the anti-sun panels so it gives a “pointillist” effect of the light coloured shades.

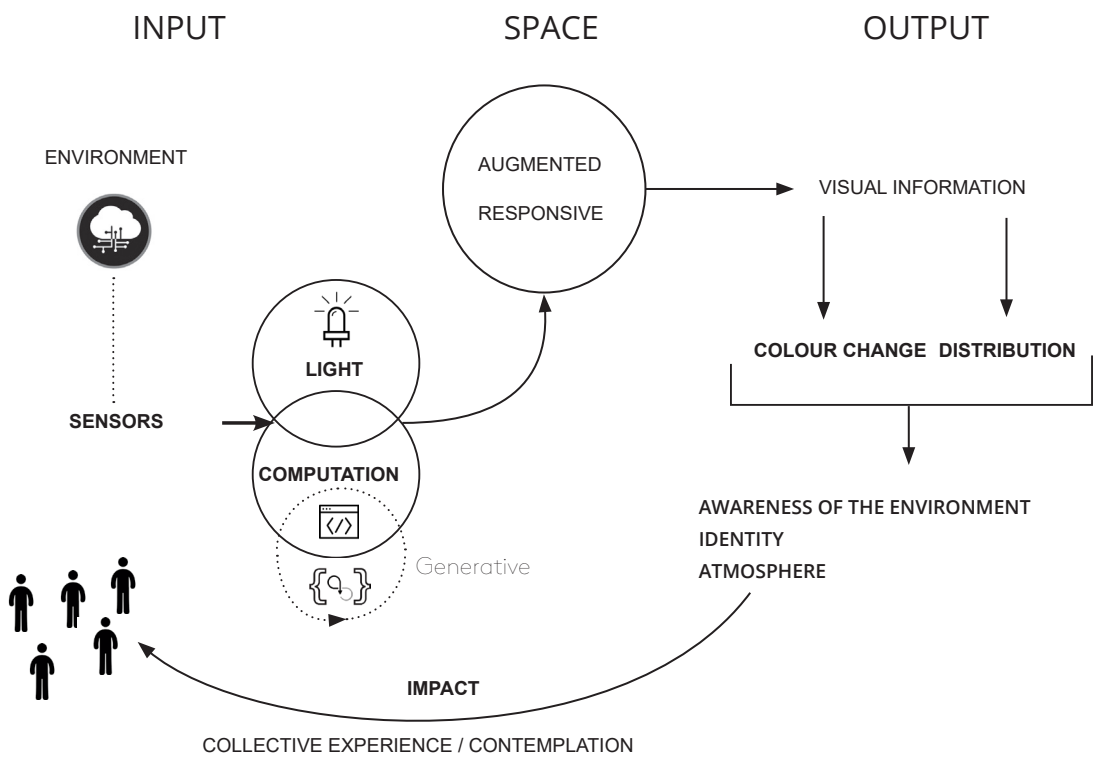
2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

This installation clearly plays with slowness and is very close to the concept of atmosphere as described by Pallasmaa as an “always continuum”. The fact that the observer can intuitively understand that the light is moving but without being able to clearly identify the movement of the light relates to an atmospherique ambiance. Lastly the light shift being connected to weather phenomenons like atmospheric pressure, humidity, or wind speed support the reading of the piece, as an atmospheric installation.

2.B : RESPONSIVENESS

The installation is a generative one, which means that it reacts in real time to information gather from its environment. The particularity of this case is its slow rhythm. The change can not be perceived in a short slot of time. The nocturnal version of the architecture is in a constant state of change, related to different cycles that are taking place at different time scale. Therefore the light is changing according to different rhythms combined together and can never be the same.This is an invitation to come back at different times of the year to experience the evolution of the lighting as a living element of the architecture.



Figures 84 - Responsive scheme, ELYTRE, Paris, Yannick Jacquet, 2017

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

By creating an evocation of the atmospheric changing states, the lighting setup wants to become an invitation for people to stop, stay, look at the change, and experience a different pace of time in the city. As the change is hardly perceptible, but still can be felt, it relies on the both concepts of ambient communication and calm technology.

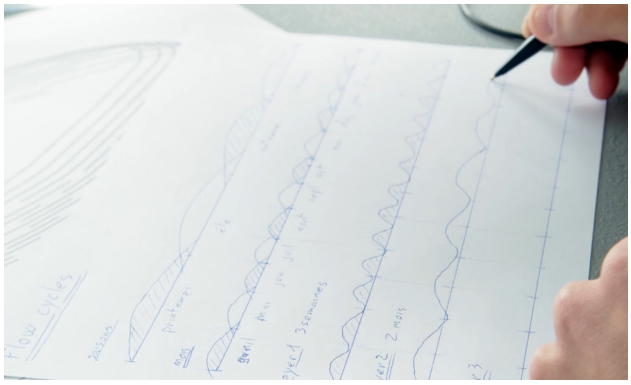
3.B : FORM OF THE MESSAGE

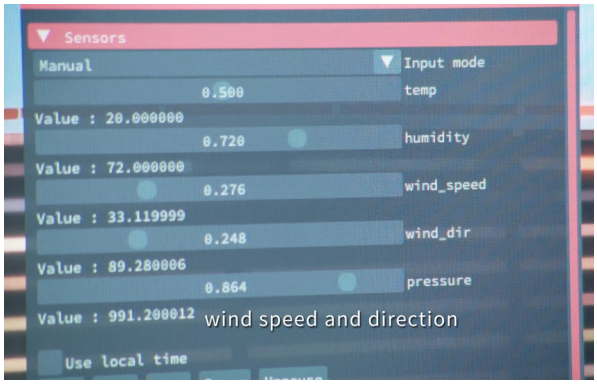
The information is provided by the mean of a slow colour nuances changes. It relies of the unconscious level of awareness, through the feeling of the constant installation change.

3.C : CONTEXTUALISATION OF THE MESSAGE

As the content is always reacting to the data coming from the environment, the piece is tightly bounds to its surroundings. It is an visual interpretation of atmospheric phenomenon around.

Figures 85 - ELYTRE, Paris, Yannick Jacquet, 2017





Figures 86 & 87 - ELYTRE, Paris, Yannick Jacquet, 2017 - Design process

4.DESIGN PROCESS

4.A : FIELD OF PRACTICE

Yannick Jacquet is an audio-visual artists coming from a graphic design background. His work is related to art installation, performances and scenography deeply connected to architecture.

4.B : COMPUTING PART

As this piece is a generative light installation, it therefore relies deeply on the software development that allows to treat the data and feed the installation with the appropriate information. Like in the other generative and highly responsive light installations, the computing part is critical in the success of the light installation. Therefore it has been custom design to fit the responsive need of the installation.

09

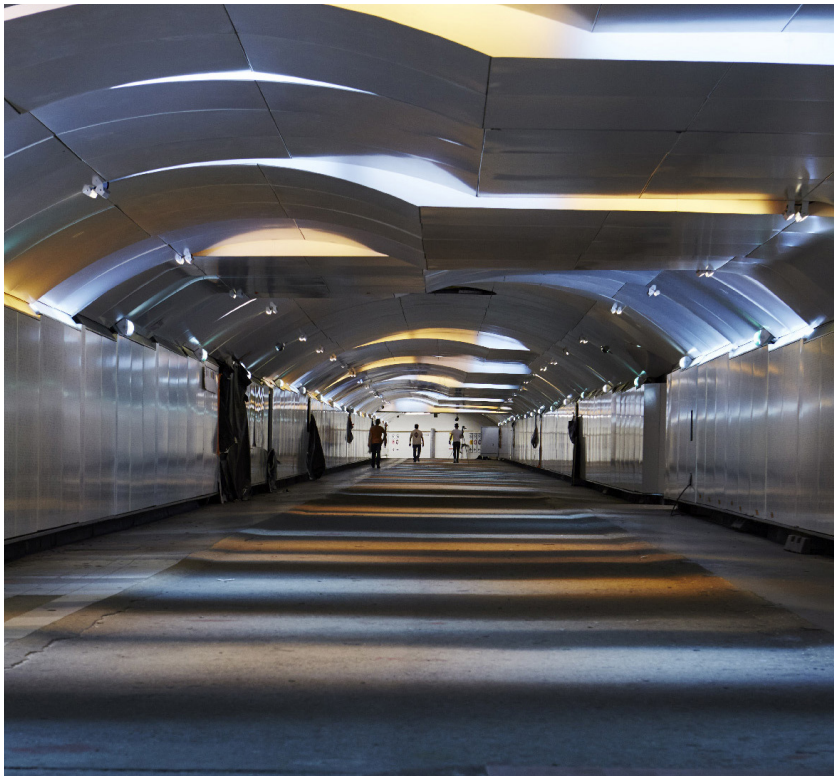


Figure 88 - STATION LES HALLES, Paris, Agence ON, 2017

STATION LES HALLES

Paris

Agence ON

2017


Figures 89 & 90 - STATION LES HALLES, Paris, Agence ON, 2017

DESCRIPTION

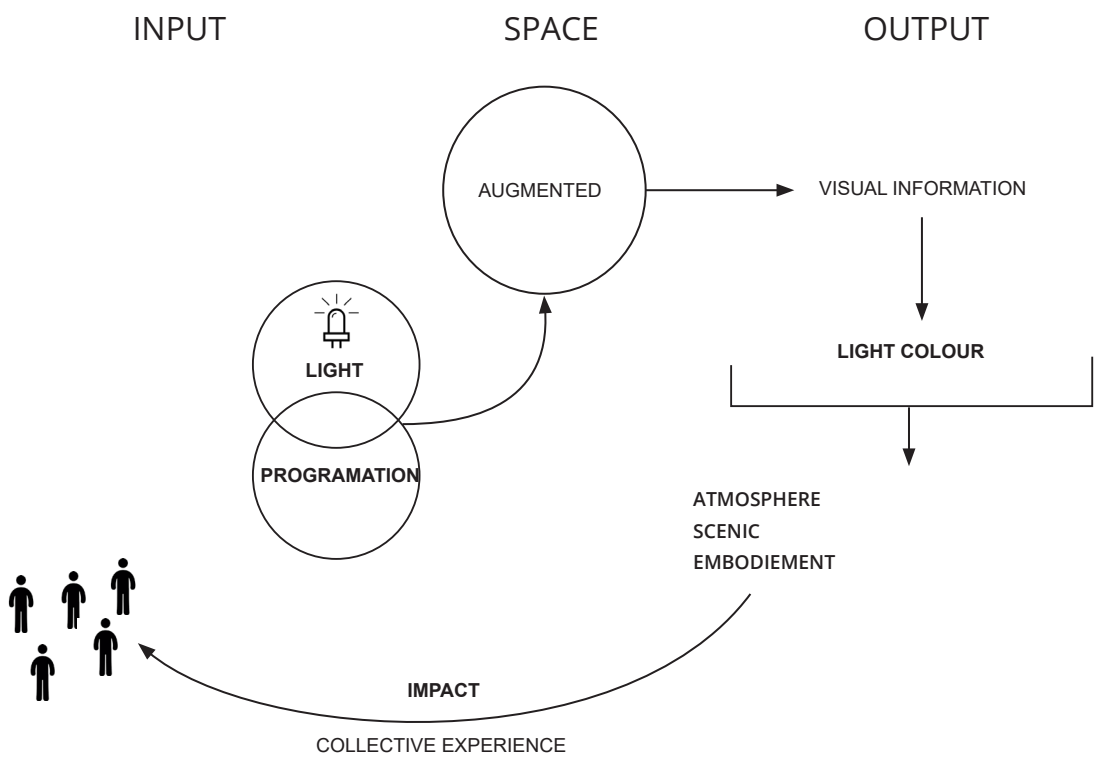
Following the rehabilitation of the central quarter les Halles in Paris, the corridor CR250, liaising both central stations of Châtelet and Les halles, has been refurbished. Located at the core of a transport network, this corridor is an important transitional area of the city, that can be crowded at some time of the day.

The lighting designer Vincent Thiesson from Agence On, explains the core concept of the project as simulating ambiances coming from daylight, in an enclosed environment that does not received any natural light. According to him, the project has been based on the principle that light can influence our mood. To achieve this goal, the concept is articulated around different layers of lights and a scenarios of dynamic colour change.

A first layer of light provide the functional and necessary level of light on the ground for the users being able to walk safely through the corridor. A second layer of light, produced by an asymmetric luminaire placed along the walls, provides a vertical illuminance with a maximum of uniformity on the wall, and a good colour rendering index, so that the informations stay readable despite the addition of a dynamic ambiance. A third layer lights up the ceiling with two different lighting principles. A linear led, integrated in the cornice and covered by a frosted glass, diffuses an indirect light on the vaults, while the hollow part of the ceiling are equipped with a recessed lighting system combining LED light sources of three different colour temperatures : ambre, warm white (3000K) and cold white (6500K). These last ones create a graphical light that conveys a sense of rhythm to the corridor, while changing the coloured ambiance of the corridor following a predetermined scenario. Run by the DMX protocol, five different lighting scenario, inspired by the daylight behaviour, are set up to follow each others in an interval of 3 minutes 20 seconds, which is the necessary time to get from one end to the other of the corridor.

This project is one of the few of dynamic lighting project completed by an architectural lighting design studio. The expertise in architectural lighting is recognizable by the way the project is described, precisely chiseled with technical details about integration or types of lamp used. However, the concept is missing, if not of content, at least of explanation. Its communication puts forward the technical aspect of it, as if it was the main achievement. It demonstrates somehow the weakness of the concept. Furthermore, the control of light is traditionally used, setting predetermined scenari with no particular relation to the space, except the time span of the light change. The project does not use fully the programmability potential allows by the LED lighting.

However, despite the use of dynamic light that seems a bit anecdotic, this project is one of the very few composing with light as a volumetric element. The different layers are illuminating the space and animating it, while fulfilling different requirements of visibility and ambiance: level of horizontal illuminance, vertical illuminance, direct and indirect light, CRI... For this reason, this project illustrates how light can compose a space with differents volumetric effects, a common approach whithin the field of architectural lighting, while using a dynamic feature.



Figures 91 - Dynamic Scheme - STATION LES HALLES, Paris, Agence ON, 2017

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

This case demonstrates a perfect integration of the light into the built environment. The light sources are in most of the case integrated into the structure, taking advantage of the architectural elements in place. The volume of the corridor is revealed by a light composition playing with different layers, following a method usually applied in architectural lighting. (refers to Richard Kelly composition with light)

1.B : PROPORTION AND DENSITY

The light is perfectly fitted to the scale of the space, and takes advantage of its physical configuration to create a new dynamism into this transitional area. The “arches of light”, adapted to the dimension of the corridor, invite to cross the space, without being overwhelming.

Figures 92 & 93 - STATION LES HALLES, Paris, Agence ON, 2017

1.C : FORMAL EXTENSION OF THE BUILDING

The light set up takes advantage of the corridor shape, creating arches of light, as a way to enhance the form of this transitional space.

1.D: MATERIALITY

The light installation uses different materials to create diffuse and reflected light effects (frosted glass, metallic ceiling pieces), that are perfectly integrated into the overall space.

2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

In this case, the light highly participates to change the atmosphere of the space. This is even the main feature in the refurbishment of a type of space that is not easy to transform due to their function (high traffic transitional area). In that sense, light here is the key element changing the perception of a space, from a dull transitional area to a non intrusive physical experience.

2.B : RESPONSIVENESS

The dynamism of light is explained as matching the time needed to cross over the corridor by pedestrians. However, this timing is set in advance like in a traditional scenario. It is not directly affected by the environment, like the number and rhythm of the present people, or related to the daylight outside. In that sense it does not bring any new information related to the surrounding. The dynamism here is more an additional artefact to the overall look, than conveying an additional meaning to the space. In that sense it does not take full advantage of the digital technology possibilities.

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

In this case, the dynamism of light is more an additional setting to change the mood and atmosphere rather than conveying any information about the space.

3.B : FORM OF THE MESSAGE

As there is no message here, this criteria cannot be applied.

3.C : CONTEXTUALISATION OF THE MESSAGE

Same as per 3.B

4.DESIGN PROCESS

4.A : FIELD OF PRACTICE

This case has clearly been designed by an architectural lighting firm. The high level of integration details is relevant of this type of practice. However, the way the project is described, published and therefore communicated, is mainly focusing on this part, putting forward the technical skills, at the expenses of the design concept behind.

4.B : COMPUTING PART

If the dynamic character of this case is put forward as something new in this type of space, the analysis has revealed that the computation is non-existent here. The dynamic light relies on a traditional use of a pre-programmed DMX protocol, that does not use any feature of new technologies in this field.

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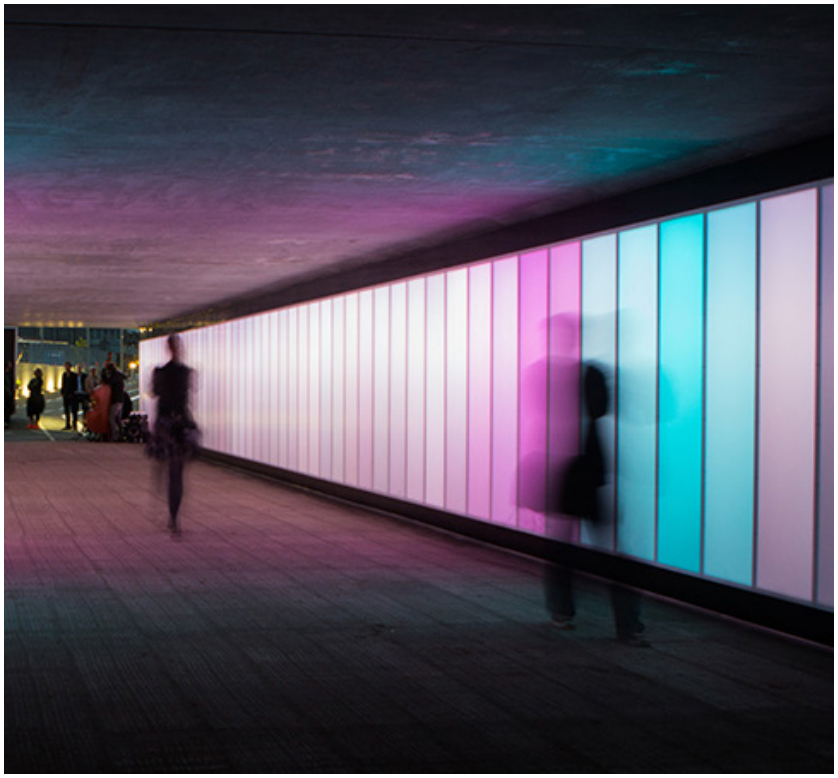


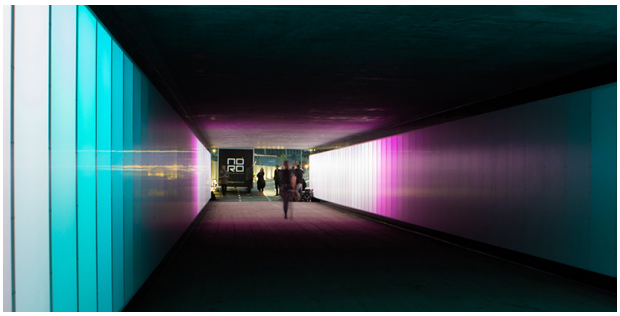
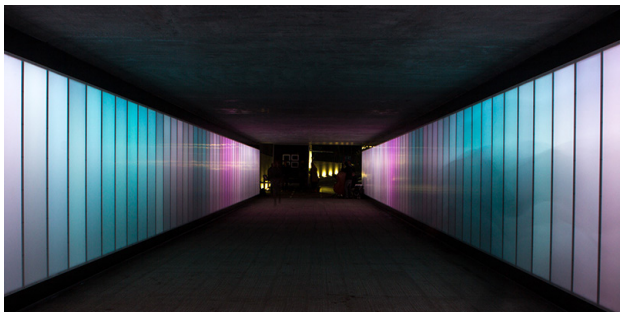
Figure 94 : INTERFERENCE, Kollision , Kolding , Denmark, 2014

INTERFERENCE

Kolding, Denamrak

Kollision

2014

Figures 95 & 96 : INTERFERENCE, Kollision , Kolding , Denmark, 2014

DESCRIPTION

Interference is a permanent interactive installation by the company Kollision, taking place in a tunnel for pedestrians and bicycles in the city of Kolding, in Denmark. The project is based on the idea that urban life is characterised by two opposing desires : belonging to a community while staying anonymous in the middle of the crown. According to the designers, this initial idea drove the project toward an interactive lighting concept, focusing on creating a space of light as a spatial materialisation of a social space.

The project consists of the installation of light panels on each side of the 36 m tunnel walls, integrating RGB LED lighting, infrared sensors, and hardware components. The movement of each passerby is detected by the sensors and processed by a microcontroller (Raspberry-Pi) that triggers a light response into the tunnel. The panels, when turn on by the detection of movement, illuminate from their diffuse surface the space of the tunnel in a dynamic way.

Several light scenari can be triggered, depending on the number of people entering the space of the interaction:

1 - If one person enter the tunnel : the movement of the person activates dynamic light in front of the user and follow him/her through the tunnel, turning off when the person has left the era.

2 - If several persons are entering the tunnel at the same time, they trigger the dynamic illumination of panels at different points, creating a space of light that will collide in the anticipation of their encounter. In this manner, the light makes people aware of the other's presence and spatially visualise the point of their mutual physical interference.

Because the crontole of the light is a key feature on the project, Kollision has developed their own software, as well as electronic components, to collect data and shape the rules able to interpret them into a dynamic light pattern.

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

The physical features of the space does not present any special character to support.Therefore the light setting is fully integrated as a luminous surface along the both sides of the tunnel.

1.B : PROPORTION AND DENSITY

The light panels are covering the wall surfaces of the both sides. This scale is needed, due to the interactive caractere of the installation. It does provides a new feature in the space at the scale of it.

1.C : FORMAL EXTENSION OF THE BUILDING

As the light panels are installed all along the length of the tunnel, they extend as well as express its physical presence in the surrounding.

1.D: MATERIALITY

The lights sources are covered by diffused panels, in order to create dynamic coloured effect express as surface rather than point lights.

Figure 97 : INTERFERENCE, Kollision , Kolding , Denmark, 2014

2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

The light installation relies mainly on people's movements to be activated. Light matches and follows actions. In that sense, it is rather about visualization a space of interaction, than creating an atmosphere where people can dwell. A light phenomenon can be experienced as a brief shared interaction, as it implies people's continuous movement. However, considering the usage of this type of space, this feature fits the transitional character of it.

2.B : RESPONSIVENESS

This installation has been designed so that the passers-by intuitively detects the mechanism of interaction. It provides them with a quick and clear feedback of dynamic light effect, triggered by their body movement. The installation is highly responsive, as it relies on people's movement to be activated.

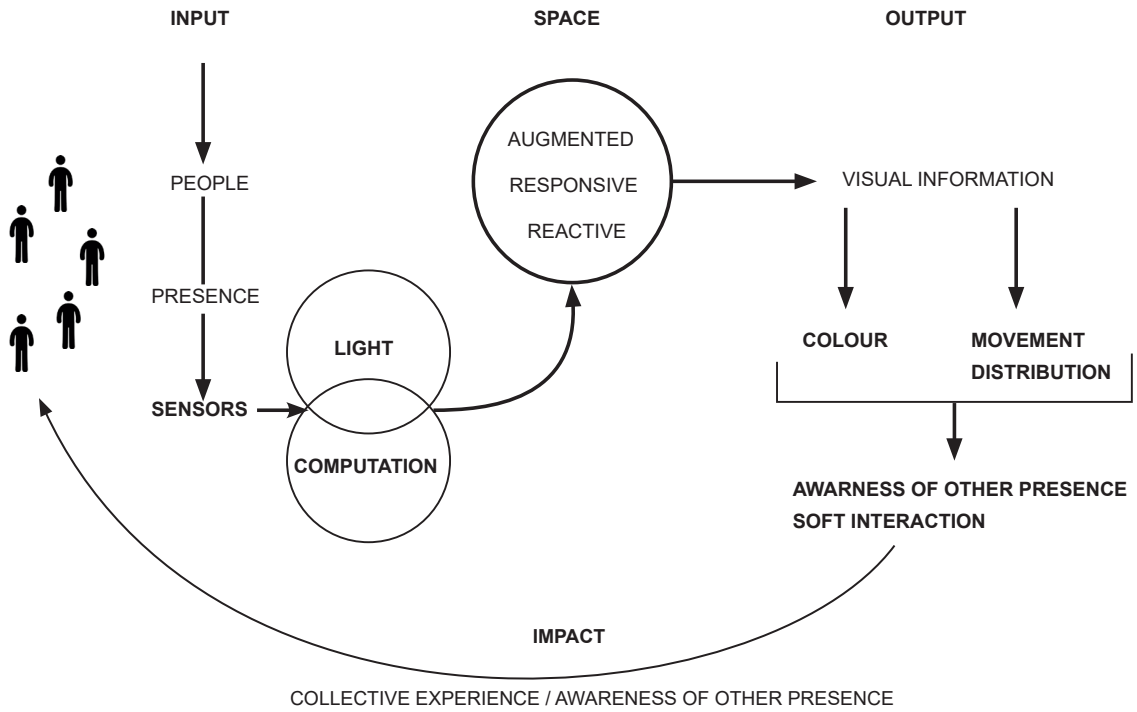


Figure 98 : Responsiveness scheme, INTERFERENCE, Kollision , Kolding , Denmark, 2014

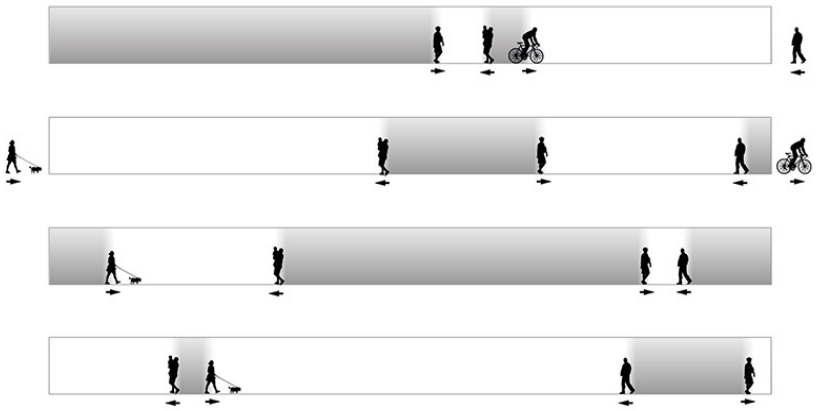


Figure 99 : INTERFERENCE, Kollision , Kolding , Denmark, 2014

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

In this project, light allows the spatial visualisation of the passerby's movements, as well as the perimeter of mutual physical presences. However, the term 'social space' is not explained further on, and the question regarding the type of social interaction expected stays unclear. The spatial configuration is a transitional area where people are not intended to stay. The light installation visualises other's presence but does not foster a particular type of behaviour that would foster further social interaction, in a setting where people might not know each other. In that sense, this installation can be described as interactive, and about presence awareness, but the "social meaning" stays unclear.

3.B : FORM OF THE MESSAGE

The message is expressed under the form of colorful light panels, with a dynamism matching passers-by movement. There is no explanation regarding the colour choice of the setting.

3.C : CONTEXTUALISATION OF THE MESSAGE

The message is highly contextualised as it relies on passer-by presence and movement, to the light being activated. Therefore the dynamic response is a real-time expression of the movement taking place in this transitional space.

4.DESIGN PROCESS

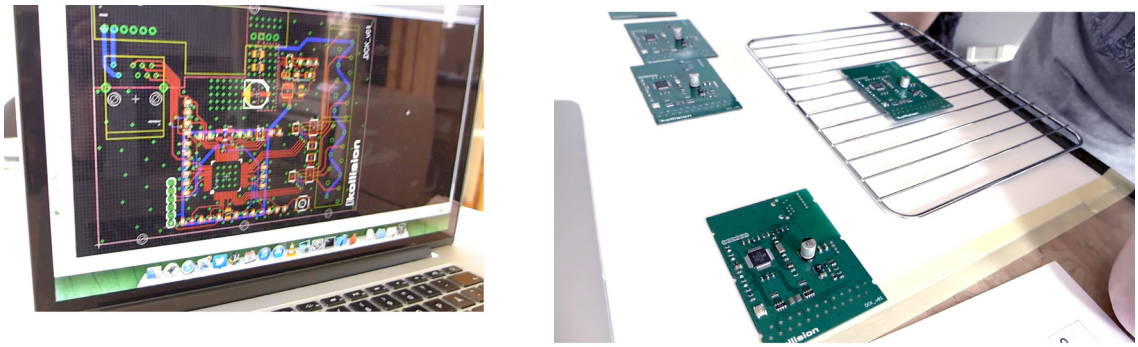
4.A : FIELD OF PRACTICE

In their website, the design studio defines the boundaries of its practice as “interactive communication, interactive design, dynamic media architecture, citizen participation in architectural project and urban development.” There is no mention of lighting as a specific medium, even if this medium represents the majority of their installations.

4.B : COMPUTING PART

This case relies on the development of a specific software as well as bespoke electronics components. Therefore the computing aspect is a major part of the project.

Figures.100 & 101: INTERFERENCE, Kollision , Kolding , Denmark, 2014 - testing on site of the light pannel before implementation



Figures.102 & 103: INTERFERENCE, Kollision , Kolding , Denmark, 2014 : Development of specific electronics componants for the project

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Figure 104 : BOMBARDIER Z50000, Paris Ile de France, Yann Kersale, 2009

BOMBARDIER Z50000 - TRANSILIEN

Paris

2009

Yann Kersale / Snaik Studio

Figure 105 : BOMBARDIER Z50000, Paris Ile de France, Yann Kersale, 2009

DESCRIPTION

The lighting of a new type of train from Bombardier, the model Z50000, has been conceived by the artist Yann Kersale. Very few litterature could be found on this project. However, the lighting design of public transport, assuring the daily commuting of many people between Paris and the suburbs deserves more attention, as public transportation constitutes the space and time of a daily collective moment. This project is noticeable for two main reasons. First, the light has been thought beyond its purely functional aspect, and proposes an ambiance that is not yet common on public transports. Secondly, the lighting setup is dynamic and evolves during the journey. For these reasons, the project has been chosen as a study case deserving to be analysed.

This lighting project is the first concept of public transport in France, realised exclusively with LED sources. As in many exemples, the very few literature available on the project highlights the energy consumption gain but nothing more despite the obvious design effort done in this project. Little is said or written about the lighting scheme in itself, which is quite surprising, as this is the LED technology which is at the origin of this type of dynamic concept on a train.

Based on real observation, we can say that the lighting scheme is articulated around three main light effects. An invisible light source casts a blue light underneath the seats with no legs on the ground, creating a feeling of lightness, or like floating seats. The ceiling of the sitead area is mounted with mini-downlights with a simili-random distribution , as a reminiscence of the stars in the sky. They provide a white and functional light on this part of the train where people are intended to stay longer.

On the platforms, the ceiling is equipped with a diffuse panel covering the surface in between the opening doors. This setting provides in the space a light colour change, matching the rhythm of the train. When it reaches the stations and stops, the light turns bright cold white. When leaving the station, the colour evolves from blue to warmer colours. This dynamic light creates different ambiances while commuting, and communicates in an ambient way, the imminent arrival of the train to the next station.

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

The light setting is adapted to the different areas of the train, and perfectly integrated into the furniture and physical arrangement of the train, so the light sources are disappearing behind the effects created.

1.B : PROPORTION AND DENSITY

The spatial distribution of the different layers of light is fitted to the dimension of the train carriage and its diverse compartments. The light arrangement respect the human scale of this commuting area.

1.C : FORMAL EXTENSION OF THE BUILDING

The light setting materialises the differents areas of the train : the platforms are covered by a panel of dynamic light while the seating areas are delimited by the white points source on the ceiling. In that sense, the light distribution signifies instinctively the differents areas of the carriage.

1.D: MATERIALITY

There is no uses of a specific material in this example, probably for maintenance reason. However, light is approached under different forms, from diffused to points light, to creates differents effects on the different areas of the train.

2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

This setting clearly creates a changing atmosphere in the carriage space. The dynamic light is matching the speed of the train, and follows the same colour pattern from one station to another one. The dynamic light creates an ambient space. The colour change is materialised by the diffused light and therefore fills in the space of the platform with a different coloured mood. The change is smooth, but still stays noticeable at a non-disruptive level, as the visibility is still assured, which link this project to the concept of ambient technology.

2.B : RESPONSIVENESS

The colour change follows the train speed and distance from the stations. There is no mention of any sensors in the litterature available. However, the success of the installation deeply relies on the connection of the carriage to its geographical localisation. The response is not evolving as the same colour change is triggered all the time. However, regarding the type of information carried on, it seems relevant to keep the same forms as a mean of communication.

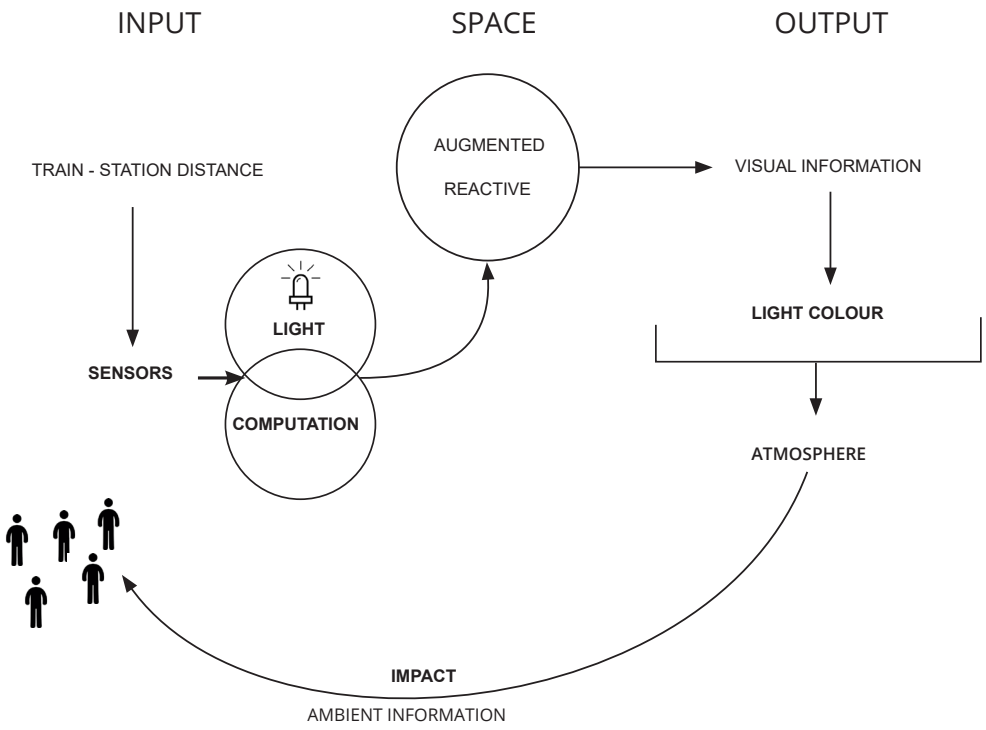


Figure 106 : Reactive scheme - BOMBARDIER Z50000, Paris Ile de France, Yann Kersale, 2009

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

The dynamic light is communicating in an ambient way, the train arrival to the next station. Transportation areas are more used to deal with text based or voice messages to convey commuting information. This study case demonstrates that light can be an ambient element able to convey information at a cognitive level that does not require a full attention to be aware of the train distance to the station.

3.B : FORM OF THE MESSAGE

The message is clearly expressed by the change of the colour on the platforms, where people stand up. The light turns cold white when a station is reached, while the constant and diffused colour change, from blue to warm tones, expresses the commuting time in between each stations.

3.C : CONTEXTUALISATION OF THE MESSAGE

The information contextualise the localisation of the train on its journey. This localisation is restricted to two differents states : either the train has reached a station, either it is in movement. The light expresses these two configurations in real time, matching the pattern of the train journey.

4.DESIGN PROCESS

4.A : FIELD OF PRACTICE

Yann Kersale is famous french light artist, renowned for his light intervention in architecture. Despite his use of light has unic material, Kersale has always considered himself as an artist using light, rather than a lighting designer.

4.B : COMPUTING PART

Despite the fact that the dynamism of light seems to be connected to the geo-localisation of the train on its journey, the light is actually changing from one state to another one and does not requires a generative computing set up. The responsiveness in this case is closer to a reactive system than an interactive one.

Figure 107 & 108 : BOMBARDIER Z50000, Paris Ile de France, Yann Kersale, 2009

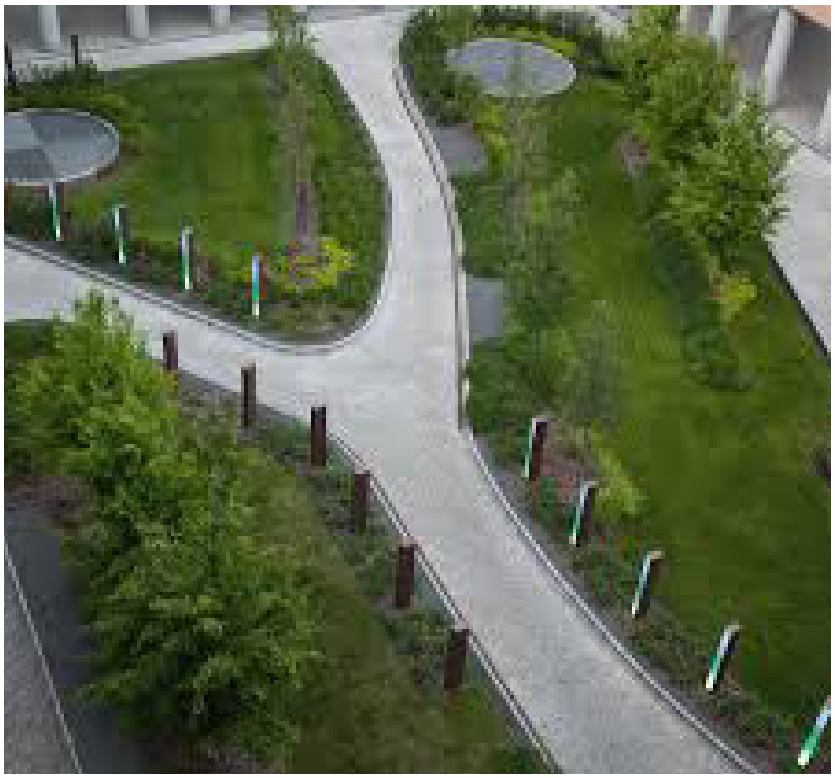


Figure 109 : CUBA GARDEN - AMYGDALA - Bologna It - Fuse Studio

CUBO MEDIA GARDEN - AMYGDALA

Unipol Garden, Bologna, Italy

CUBO GARDEN (2014)
AMYGDALA : January 26th - April 16th 2016

FUSE Studio

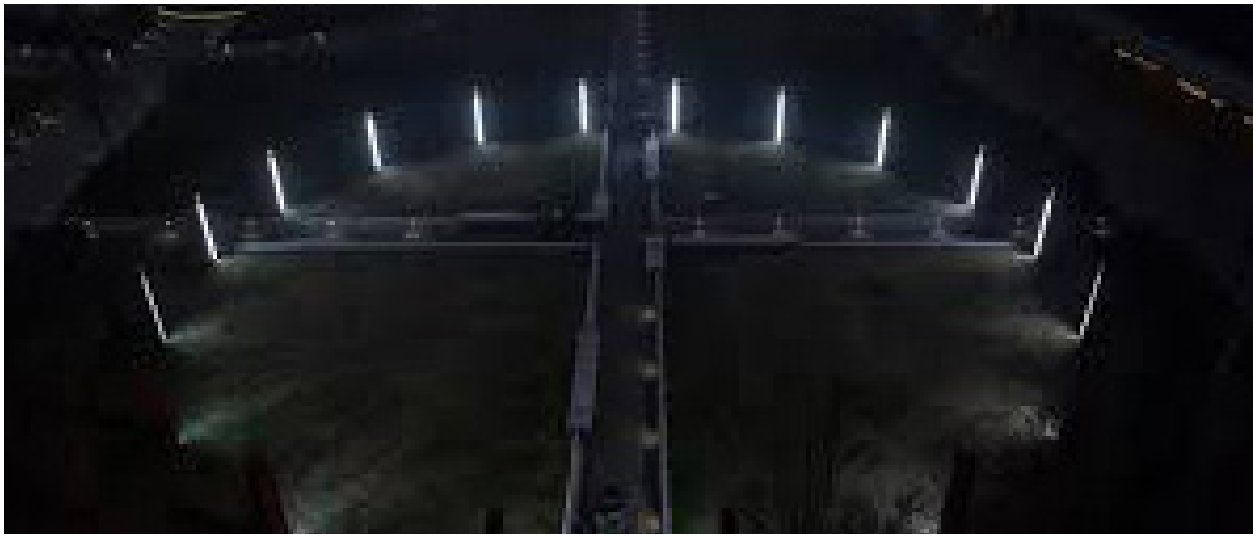


Figure 110 : CUBA GARDEN - AMYGDALA - Bologna It - Fuse Studio

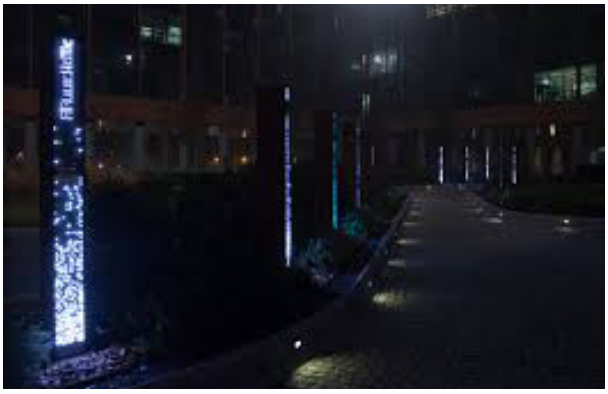
DESCRIPTION

The CUBO Media Garden is a project from FuseStudio which aim to create a narrative space interwoven architecture and multimedia design. The light and sound installation is housed in the garden of the company Unipol, in Bologna, Italy. It is made up of 41 Cor-Ten steel columns, with one face covered by high-luminosity LEDs. Each column contains 3072 RGB Led points lights, that are all individually controllable. The garden, divided in two areas lies in between the two wings of the office building. One part of the light and sound installation marks the path that links these two wings, while the other one defines a circular area with benches at the center, creating a "reversed amphitheatre" situation, where the visitors seated at the center are enveloped by light and sound. The installation has been designed with the aim to be adaptable to different type of contents : from planned shows, to content feed via software channels, or real-time interactive installation.

One of the most interesting content used for this installation was the piece called "AMYGDALA" (2016), in reference to the neurological center of emotional development and memory. The installation exploits the field of "sentiment analysis" or "opinion mining" which uses the analysis of the information retried via languages, text analysis and computational linguistic to identify the emotional status of messages shared by users across digital networks of communication. With the rise of social media and user-generated content this technique of analysis has widely growth especially for social research.

AMYGDALA categorised six states of emotion : happiness, sadness, fear, anger, disgust and amazement. It carries out a text analysis for each tweet, using a lexic of 5000 words that has a different scores for each one of the emotion categorised. Once analysed, a tweet is represented by six values, one for each emotion. The overall emotional states is represented by the percentage of each emotion, resulting from the quantity of tweets linked to the emotion. Over the three month of activity, the installation has been processing around 130 millions tweets.

Each column of light of the CUBO Garden allows to visualize this emotional state in real time, associating colour and abstract patterns to each of the emotional category. In parallel of the light interpretation, an audio part was running sounds textures linked to each emotional states. Light and sounds were diffused in the garden space by the columns, as an interpretation of the continuous flow of thoughts shared on the net via social networks. By making the collective emotional states perceptible via the senses (vision and hearing) on a human body scale, the installation aims to foster the awareness of a collective feeling that would not be possible to grasp otherwise.



Figures 111 & 112 : CUBA GARDEN - AMYGDALA - Bologna It - Fuse Studio

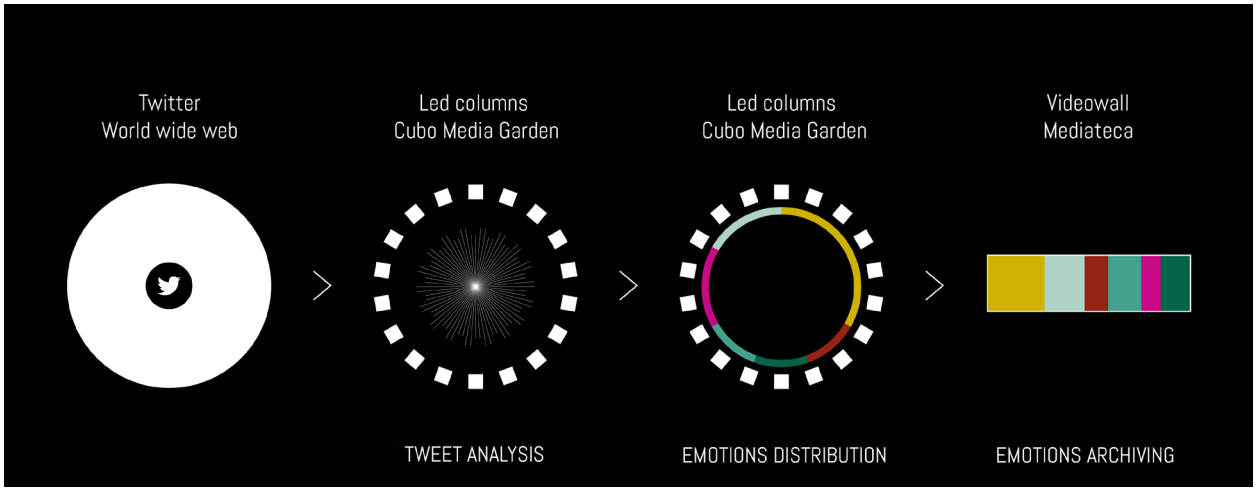


Figure 113 : CUBA GARDEN - AMYGDALA - Bologna It - Fuse Studio

ANALYSIS

1 . PHYSICAL CRITERIA

1.A : PHYSICAL INTEGRATION

In this case, the light is not integrated into the building but rather is part of the garden layout, under the form of quadrilateral CorTen columns of light and sound. By daylight they are visible, due to the use of high-luminance LEDs, but there presence express the spatiality of the garden mainly during night time.

1.B : PROPORTION AND DENSITY

The size of the column is not overwhelming and stays connected to the human scale, in a natural environment surrounding by corporate building. Their disposal on the garden expresses and distinguishes the different areas of the garden, embedded with different functionalities.

1.C : FORMAL EXTENSION OF THE BUILDING

The columns distribution in the garden distinguishes two areas : the leading path where the columns are aligned in between the both wings of the buildings, and a “reversed amphitheater” acting like a place where people can seat, gather and experience at their body scale the envelope of light and sound.

1.D: MATERIALITY

The face of the column equipped with LED, expose them as a grid of direct point lights and therefore belongs to the low-resolution display family.

2 . EXPERIENTIAL CRITERIA

2.A : ATMOSPHERE, SUBLIMITY and CALM TECHNOLOGY

In the case of AMYGDALA, the high speed of the light dynamism conveys the feeling of the flux of information (emotional state of the network) rather than an “atmospheric” sensation. As the change of the light is highly visible it is directed to our conscious process of cognition, it therefore demands our full attention, rather than being an ambient awareness environment. The piece can refers to the concept of embodiment, as it surrounds and immerses the viewer at the center of the dynamic light and sound. The settings proposes a 360 experience, that distinguishes it from the frontal mode of perception, reminiscence of the screen display.

2.B : RESPONSIVENESS

AMYGDALA is highly responsive, as its entire concept relies on a real-time reaction of data gathered from social media. However, despite the data analysis, the users are not directly engaged into the action of the light piece, as they received information abstracted to a collective level, that might not be directly connected to the close context of the piece.

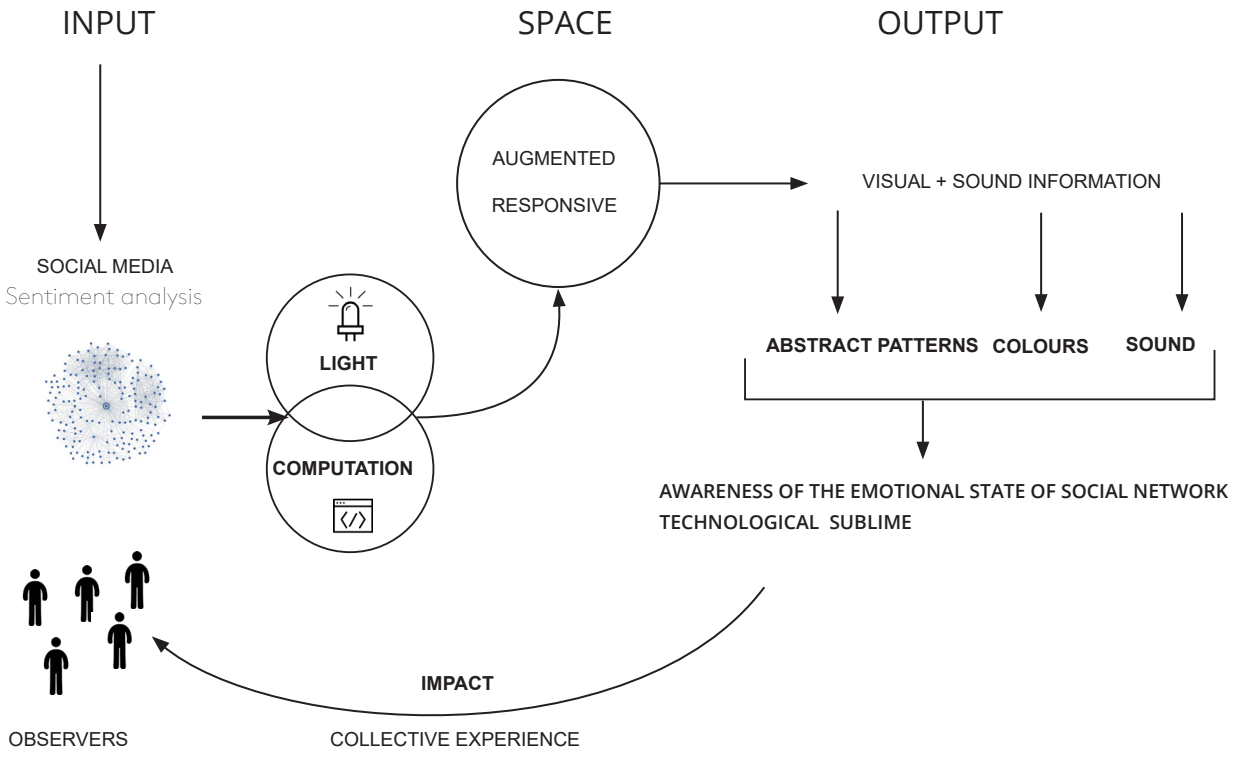


Figure 114 : Interactive Scheme - CUBA GARDEN - AMYGDALA

3. COMMUNICATIVE CRITERIA

3.A: GOAL AND TYPE OF CONTENT

The aim of this installation was clearly to use light and sound as a way to visualize data in an other forms than graphics made for screens. This installation exemplifies the extension or mutation, from the screen to the space, that light as a medium of communication allows.

3.B : FORM OF THE MESSAGE

The message take the form of abstract light pattern, made of different brightness and colours, as well as of texture sounds.

3.C : CONTEXTUALISATION OF THE MESSAGE

In regards to the physical context where this installation takes place, AMYGDALA does not connect clearly to any particular context of its localisation. Also, the number of data gathered relies on a level of abstraction difficult to connect to a site specificity.

4.DESIGN PROCESS

4.A : FIELD OF PRACTICE

The practice of the FuseStudio includes the creation of Narrative environment for architecture, New media for communication, and digital artwork. They describe themself as a studio operating in the field of digital arts and design, exploring the expressive potential offered by the creative use of coding. There is no mention of light as their particular medium of practice.

4.B : COMPUTING PART

Computing is clearly at the center of this project. Light in that sense allows the extension of the creative coding into spatial configuration through light.

STUDY CASES CONCLUSION

1 . PHYSICAL CRITERIA

From the study cases analysis, we can observed that if in most of the cases the miniaturisation of LED allows a seamless integration into the building, the light when integrated in architecture still remains majoritarily an additional layer, rather than an element truly integrated from the beginning in the architectural concept. One of the reason might be that as the current technology facilitate the layering of LED's on a buildings facades, it is an element often used in refurbishment projects. Therefore digital light is used after the building conception as an additional element, with the aim to transform the aspect of the building. It also demonstrates that projects able to integrate light as a digital media, into their initial design concept are still very rare. As the study cases illustrate, the design of light as a digital media implies not only technical features, but also to think about the content and purpose of the messages delivered, as well as its visual representation, in a coherence with the physical context. This type of consideration relies on fields of expertise lying outside of the purely architectural or lighting fields. This implies an additional layer of collaboration, and problematics to integrate into the whole project, which is a still a challenge.

One of the surprising finding, is the materiality aspect. The majority of the projects are using digital light, not only for its pixel aesthetic, close to the display mode of screens, but are rather taking advantage of the small size of LEDs to integrate them into materials, or play with their distribution to create different types of perception. This shows that the miniaturisation of the LED's has been understood as a creative feature for designing space, out of the lamp and screens culture. Because of its flexibility, it has also allowed a better fitting to the architectural context, with the proportion and distribution of the light matching perfectly each spatial configuration.

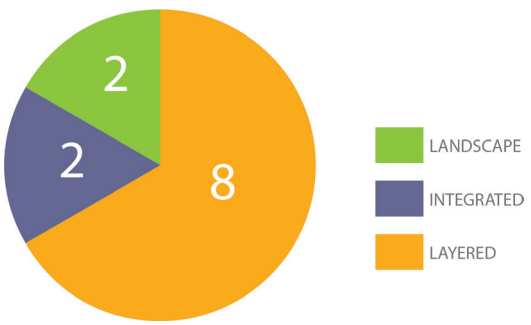


Chart 1. PHYSICAL INTEGRATION
LEDs integrated into the architectural forms or used as an additional layer over the architectural forms

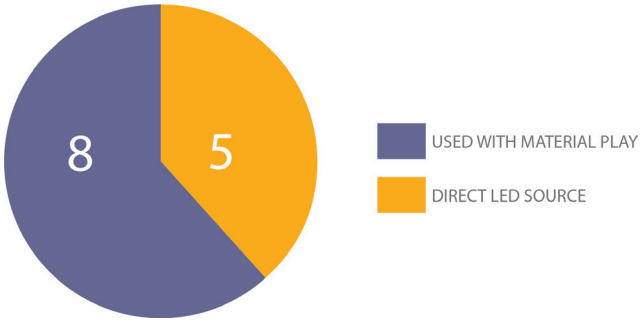


Chart 2. MATERIALITY
LED used as direct light point source or combined with materials play

2 . EXPERIENTIAL CRITERIA

The study cases clearly demonstrate that digital light has distantiated itself from the display thinking. Its instant dynamic possibilities are used beyond the image or textual communication. However, we note that the tendency relies on this feature mainly to catch direct attention, rather than taking advantage of ambient communication and calm technology, which are sharing deep roots with the concept of ambiance. Light and time are deeply connected : natural light has its own rhythm. But as the digital light is, in most of the cases, linked to the frenetic real-time rhythm of datas, it looks like LEDs are inherited of this high speed without questioning the rhythm as an crucial design parameter. This is where study on neuroscience and ambient technology might support new design approach with dynamic light, beyond scenographic effect.

About responsiveness, the study cases demonstrates that the potential for new narratives allowed when light is paired with sensors and computation possibilities are explored through reactive, performative and interactive settings. We must however notify that most of the interaction settings are still mainly temporary installation. Interaction implies question about interface and purpose of action in a public space, which are beyond purely architectural and lighting consideration.

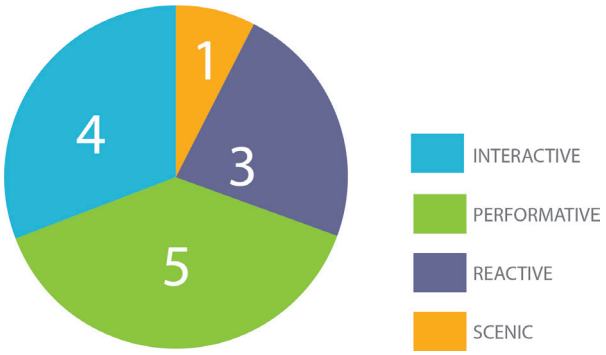


Chart 3. RESPONSIVENESS
Level of responsiveness of dynamic light used in the study cases

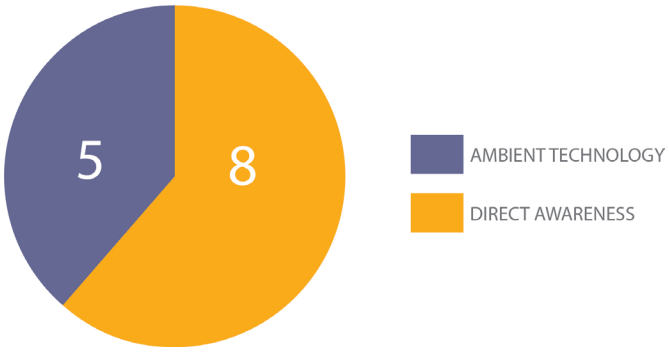


Chart 4. AWARENESS
Level of cognition intended by the dynamic light setting - Ambient technology is adressed to the unfocused and uncousncious level of experience - Direct awareness required direct attention from the user.

3. COMMUNICATION CRITERIA

The topic of communication is clearly at the center of dynamic light. If live content represents the majority of the information treated by computation, half of the projects however are still struggling to integrate dynamic light as a contextualised medium of communication. This is probablement due to the fact that the information available is in most of the case gathered as data. As we saw in the technological background, data are not information. Data are numbers, that need to be connected between them and within their context to start making sense. Using light as a medium for the translation of data based information requires a design thinking at the edges of data visualisation and graphic communication, which are again, beyond the scope of a purely architectural or light practice.However, if the aim of a lighting project is to design further than an automated system, this is the crucial point to cope with.

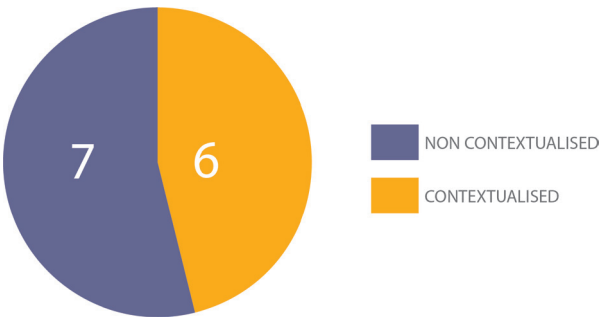


Chart 5. INFORMATION CONTEXTUALISATION
Number of cases with message delivered under the form of light, as a contextualised medium bringing information about of the environment

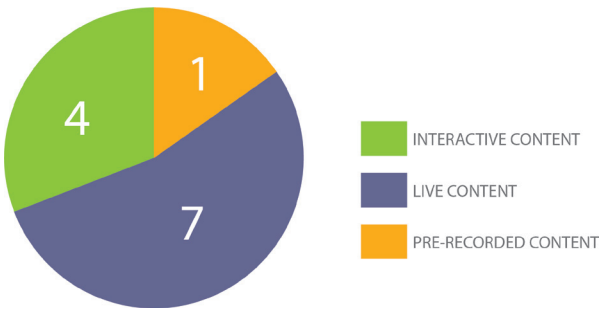


Chart 6. FORM OF THE CONTENT
Programmability types from allowing different levels of connection with context-based information gathered from the environment

4. DESIGN BACKGROUND

The study cases demonstrate that the projects designed by architectural lighting firms are at ease with the integration, composition and use of light properties playing with the different material and spatial configurations of the buildings. However, when dealing with new technologies, such as computation and network based communication, the analysis shows a lack of knowledge, (or interest ?) to integrate these tools and their communicational potential into the design process. The field of media technology clearly leads the practice when dealing with dynamic light paired with computation. It is not surprising, considering that the majority of the projects are requiring the conception of custom software. This situation raises the question of the lighting designer's role on the conception of the 'light scenario'. The computational possibilities allow to step out from pre-defined scenography that limits the creative potential offered by the computational technology. This one presents the opportunity to use light as a response to live content and information embedded into the environment. However, as the light response is mainly triggered by data-based input and processed by generative piece of software, the final light output depends rather on the set of open rules, coming from 'creatively coded' piece of software, than on an predefined scenography to unfold and repeat. This study cases analysis demonstrate that there are still a gap between two fields of practices, that hardly merge on architecture, whereas their potential when combined remains huge.

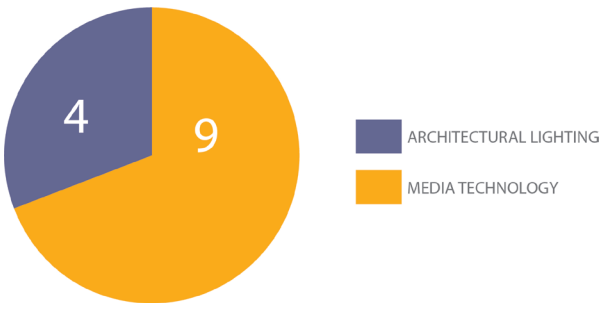


Chart 7. DESIGN PBACKGROUND
Showing the design background of the dynamic light conceptor

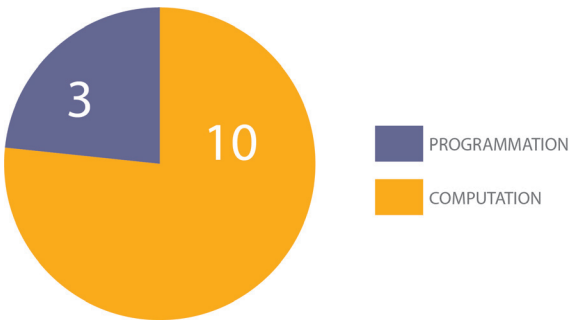


Chart 8. COMPUTATIONAL LEVEL
Demonstrates the level of computation involved in projects dealing with dynamic light

CONCLUSION

The observation of dynamic light spreading our urban environment, as the visible consequence of a lighting technology change, has triggered this research journey. This new dynamic feature light inherits from its digitalization raises new question. How does it affects our experience of the space ? How to integrate such a transient form into the 'perennial' nature of architecture ? What is the design purpose behind it ? The first part of this work has exposed my observation and thought process in order to clarify a problem area and an initial problem statement I could used as a starting point of my research. I have made the hypothesis that there is a fertile creative opportunity in bridging together the culture of light as an architectural element, able to shape and create functional and emotional connection to space, and light as a digital media element, creating new relational connection with the environment, while revealing intangible information about the space we inhabit.

To explore this hypothesis, I have drawn the technological background of digital light and computation within their relation to space and architectural forms. Digital lighting marks a new mode of emitting light, including additional possibilities without any equivalent among the other lighting technologies. Its miniaturisation allows it to become an omniscient and pervasive technology directly embedded in our built environment, closer to our body scale. Its instant and individually programmability creates a versatile and flexible illuminant tool, opening to an ever-changing mode of appearances. Further on, its digital nature allows its connection to digital media and network based communication, moving towards a new spatiale triangulation of architecture, light and computation challenging our way of thinking the relationship of light with architecture. On the same time, computation has moved from the screen to the space, expanding the domain of Human-Computer-Interaction (HCI) to spatial problematic. The physical space becomes enhanced with the use of context-awareness technologies and digital media embedded in our built environment. This new technological environment has lead to the creation of responsive environments, through the realm of ambient intelligence system, following three main steps : sensing, processing and actuation. In the context of architectural lighting, Media Architecture takes the most advantage of these new technological advancements, proposing new way to relate to space and architecture through dynamic light used beyond scenography programmed.

However, I made the observation that the current discourses about digital light are dominated by energy saving and technical consideration, occulting the creative potential opened by the particular features of this technology, such as its dynamic capability. On the other hand, computation is pervading our daily environment, but is still lacking of a consequent theoretical framework to comprehend its impact on our spatial relationship. For this reason, I have been contextualising these technologies in humanistic perspective on part three. Mainly looking at philosophy, social sciences and architectural theories, I have explored the notion of spatiality in order to find conceptual markers describing the human-environment relationship that could be applied to the new triangulation dynamic light, computation and space. I have been investigating three main axes. Space as form, and how lighting actually marks the liberation of architecture form perspective, opening to a more holistic understanding of space. Space as sensation, shows through the concept of embodiment and atmosphere, that dynamic light and media technology could find here an axe of development. Calm technology or the feeling of technological sublime support the notion of ambient technology, focusing on the emotional awareness as a way to connect with our spatial condition. Lastly, space as experience, focusing on the shift of architecture from the formal to the performance or event, demonstrates that the ever-changing state of dynamic light has the potential to become a mean of architectural expression, able to trigger new relation with the environment through the design of reactive, responsive or interactive system.

Going back to the initial problem statement, of how to combine the both culture of architectural and digital media lighting, the part four was an attempt to confront the technological and theoretical backgrounds to real study cases. Twelve existing dynamic light installations have been reviewed through their perspectives, drawing from them the parameters for a critical analysis. The outcome from the study cases are of different sorts. First, they demonstrate that dynamic light has freed itself from the display culture of gigantic screens, to become correlated to another form of communication directly linked to computation. For architecture being able to take advantage of this positive evolution, designers and architects must understand and consider its creative potential as an additional and contextualised form, opening to new relation with space. This understanding is one of the condition for architecture and media technology to converge as a same whole. The study cases demonstrate that the most achieved pieces of dynamic

light integrated into our environment, are conveying real-time contextual information, in relation to the physical environment. Despite this, many dynamic light installation are still often limited to automation or pre-programmed scenari, missing the opportunity to craft a new type of connection with and coming from our environment. However, to achieve this, it requires the ability to make sense of a data-based design process. As we saw in the theoretical background, data are not information; meaning comes from the interpretation made of it. Translating them into dynamic light requires also to deal with communicative problematic : the nature of the content, the way it is addressed, and the level of attention and cognition required (ambient communication, direct awareness, participation) are at the center of a project dealing with dynamic light. The other outcome from the analysis shows that innovation in this way are rather coming from designers or artists with a digital media background rather than an architectural lighting one. The projects conceived by architectural lighting firms clearly demonstrate an advanced understanding and use of light as a spatial tool, composing space with different light layers, and skills when dealing with light integration into architecture and materials. However, their access to the computational possibilities stays limited, and is closer to traditional DMX programmation than an ever-changing generative form.

As the formal aspect of architecture turns out to evolve towards a changing nature, it becomes obvious that dynamic light has the potential to convey information beyond textual, image based message, or repetitive scenography. The current state of dynamic light in architecture clearly shows a gap between the digital media and the lighting culture, whereas both are using the same medium with the aim to enhance space with light. We believe that digital light, under its dynamic form, can overcome this binary vision opposing physical and digital realities, creating a new relation between data-based information and space. It opens to the exploration of the non-visual aspects of a place, as a potential to “augment” it in a meaningful way. However, what comes from this research is that designing in this direction, requires a set of skills overcoming traditional lighting thinking. If this one undoubtedly is necessary to understand the spatial relation through human perception, I bring here as further thoughts, that an understanding of the different levels of cognition, of graphic communication, of data-based information, and computation are required to fully grasp and play with the potential of dynamic light as new meaningful, responsive or interactive narratives.

Further design consideration for dynamic light, computation and architecture

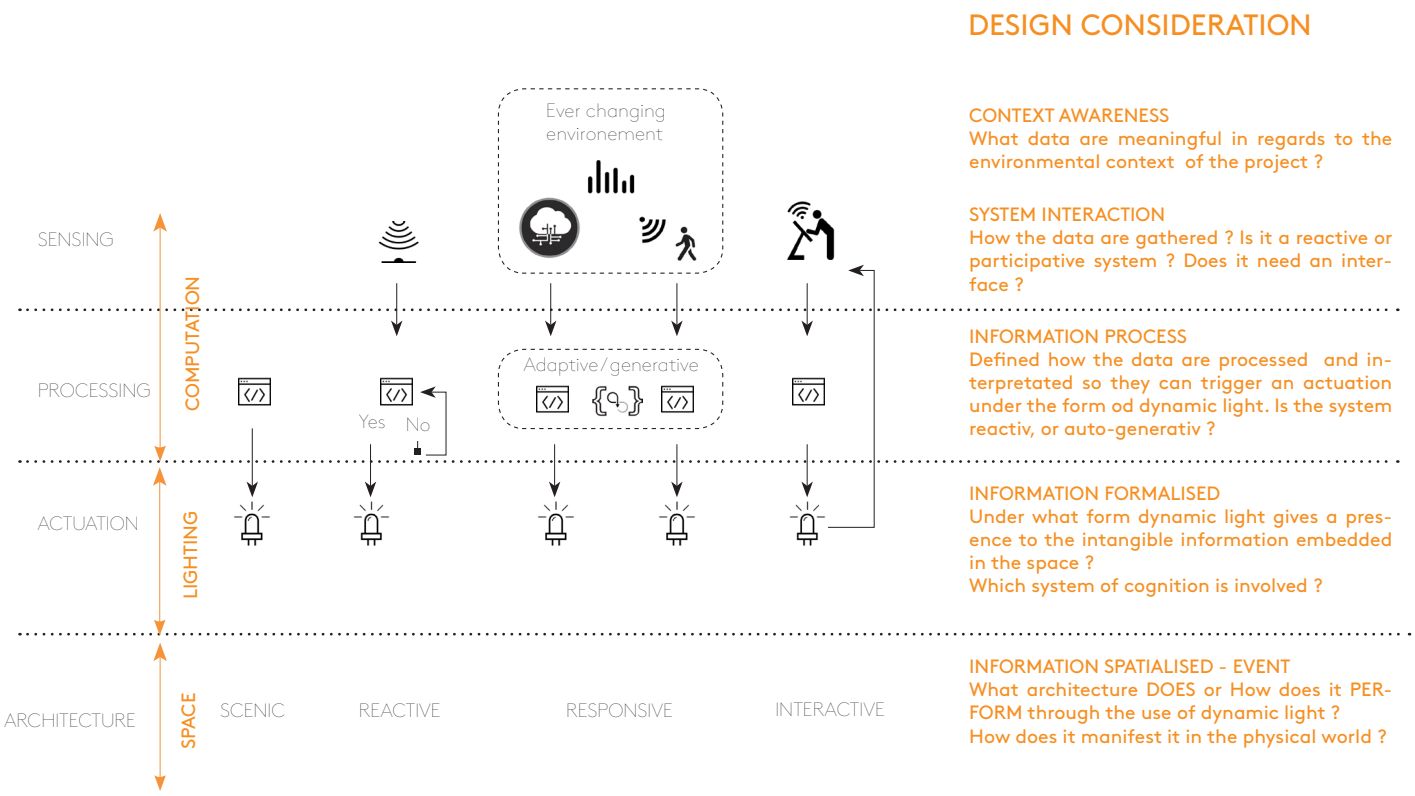


Figure 115. Dynamic Light and conputation - Design consideration

BIBLIOGRAPHY and REFERENCES

Antle A.N (2009), Embodied Child computer interaction: Why embodiment matters, in Interactions, March +April 2009 - accessed 14 May 2018 < http://antle.iat.sfu.ca/Papers/Antle_ACMInteractions09_EmbodimentMatters.pdf >

Addington M., Shodek D. (2005), Smart materials and technologies, Architectural Press

Barker T., (2018), Against Transmission, Media philosophy and the engineering of Time, Bloomsbury academic, London

Benedikt, M. (1991), Cyberspace, First Space, MIT Press, Cambridge

Bohme, G. (2016), The Aesthetic of Atmospheres, Ambiances, Atmospheres and sensory experiences of spaces, Routledge

Bohme G.,(2017), Atmospheric architectures, the aesthetics of felt spaces, London, Bloomsbury

Buci-Glucksmann C., (2003), Esthetique de l'ephemere, Editions Galilee, Paris

Bullivant L. (2005), 4DSpace, Interactive architecture, Architectural Design vol.75, Jan/Feb

Busbea L. (2015), McLuhan's environment: the end (and the beginning) of Architecture, the aggregate website, accessed 15 May, 2018 < http://we-aggregate.org/piece/mcluhans-environment >

Cantrell B. , Holzman J. (2016) Responsives Landscapes, Strategies for responsive technologies in landscape architecture, Routledge

Ciolfi, L., (2004) Understanding spaces as places : extending interaction design paradigms, Cognition Technology and work, February

Costas, M. (1990), Il sublime tecnologico, Salerno, Edisud

Case A., (2015), Calm technology : Designing for billions of devices and the internet of things, O'reilly Media

Dalsgaard, P. and Kortbek, K. J., (2009). Staging Urban Atmospheres in interaction Design. Nordes 3

Descottes, H. (2011), Architectural Lighting : designing with light and space, Princeton Architectural space, NY.

Dourish, P. (1999) Embodied Interaction : Exploring the Foundation of a new approach to HCI. Accessed 10 May 2018 < https://www.dourish.com/embodied/embodied99.pdf>

Dourish, P. (2001), Where the action is, The foundation of embodied interaction, MIT Press, Cambridge

Durmus S., (2016) Considering the Relationship between Architecture and Philosophy : Toyo Ito's conceptual Architecture, in World of Science, Engeneering and Technology, International Journal of Architecture and Environmental Engineering, vol.10, n7

Evans R., (1995), The projective cast : Architecture and its three geometries, MIT Press

Eisenman, P. (1992), Vision unfolding : architecture in the age of electronic media, in "Intelligent Ambiante", Ars electronica

Eisenman, P. (1993), Folding in time, The singularity of rebstock, in Folding Architecture (AD profile 102), ed. Greg Lynn. London:Academy.

Friedberg, A.,(2006), The virtual window: from Alberti to Microsoft, MAT, MIT Press

Harrison S. and Dourish P. (1996) : re-placing space: the role of place and space in collaborative systems. Proceedings of CSCW'96, pp.67-76. ACM

Heinrich F.(2016), (Big) Data, diagram Aesthetics and the question of beauty, MedieKultur, Journal of media and communication research, 59, 73-94

Hespanhol L., Hank Haeusler M., Tomitsch M., Tscherteu G., (2017), Media Architecture Compendium, Digital placemaking, Stuttgart, Avedition

Hespanhol L., Dalsgaard P., (2015), Social Interaction Design Patterns for urban Media Architecture, Lectures notes in Computer Sciences, LNCS-9298, p.596-613, 2015, Human Computer Interaction - INTERACT 2015

Hank Haeusler M., (2017) From Allopoietic content to Autopoietic content for Media Architecture through a better understanding of architectural Typologies, in Media architecture, using information and media as construction material, Walter de Gruyter GmbH & Co KG

Kersale, Y., Bombardier Train Francilien, accessed 22 April, 2018 <http://www.ykersale.com/realisation/bombardier>

Kahn, L. (1967) Space and the Inspiration, in Louis Kahn, essentials texts, edited by Robert Twombly, NY, 2003 (p.220 to 227)

Kahn, L, (1968) Silence and Light in Louis Kahn, essentials texts, edited by Robert Twombly, NY, 2003 (p.228 to 251)

Karandinou A. (2013), No Matter : Theories and Practices of the Ephemeral in Architecture, Ashgate studies in Architecture series, School of Architecture, University of Portsmouth, UK, Routledge, London and New York

Kennedy, S. (2005), Escaping the bulb culture : The future of LEDs in architectural illumination. LEDs Magazine, 1(1), pp.13-15

Kotnik T., (2014), There is geometry in architecture, p.35-43 in Form-Rule 2014, innsbruck University Press

Laganier, V. (2017), Châtelet - Les Halles : une invitation a un voyage lumineux, in Light Zoom Lumière, 31 Octobre 2017, accessed on 21 April, 2018 <https://www.lightzoomlumiere.fr/realisation/chatelet-halles-invitation-a-voyage-lumineux/>

Lino J.A, Salem B., Rauterberg M. (2010), Responsive environments : user experiences for ambient intelligence, Journal of Ambient intelligence and smart environments, Vol.2 N.4, pp.347-367.

Lyotard, F. (1979), La condition postmoderne, Les editions de Minuit, Paris

McCosker A. and Wilken R. (2014), rethinking 'big data' as a visual knowledge : the sublime and the diagrammatic in data visualisation, Visual Studies, Volume 29, Issue 2, p.155-164

McCullough M., (2004), Digital Ground: Architecture, Pervasive computing, and environmental knowing, MIT

McCullough M., (2013), Ambient commons, Attention in the age of embodied information, MIT

Merleau-Ponty M., (1945) Phénoménologie de la Perception, Paris, Gallimard

Merleau-Ponty M., (1964) The film and the new psychology, In the Sense and the Non-Sense, Evanston : Northwestern University Press

McQuire S., (2008), The Media City. Media, Architecture and Urban Space, Sage Publication, London.

Manovich, L. (2006), The poetic of augmented space,

Mattern, S. (2013), Methodolatry and the Art of measure, the new wave of urban data science, in Places Journal, accessed 01 May, 2018 <https://placesjournal.org/article/methodolatry-and-the-art-of-measure/>

Mink A. (2007), Solid State Lighting, The development of a technology, Lund University / Oslo University, The European Inter-University Association on Society, Science and technology

Nye, D., (1994) American technological sublime, MIT Press, Cambridge, Massachusetts

Ouard T., (2008), Concevoir une ambiance en architecture ?, 1st International Congress on Ambiances, Grenoble, France, Sept

Pine B. and Gilmore J., (1999), Welcome to the experience economy, Harvard Business School Press, Boston.

Pallasmaa J. (1996), The eyes of the skin, Architecture and the senses, Wiley

Pallasmaa J. (2012), In Praise of Vagueness : diffuse perception and uncertain Thought' in Space & Psyche. Edited by Elizabeth Danze and Stephen Sonneberg. Austin: Center for Architecture and Design, University of Texas

Pallasmaa J., (2014), Space, Place and Atmosphere : Peripheral Perception in Existential Experience, in Architectural Atmospheres, on the Experience and Politics of Architecture, Christian Borch (Ed.)

Peon-Veiga A., Rozot N., (2010), Drawing light : A graphical investigation of light : Space and time in lighting design, Parson Journal for information mapping and Parson Institute for information mapping

Rapatzikou T.G, (2004), Gothic motifs in the Fiction of William Gibson, Brill

Sack, W. (2011) Aesthetic of information visualisation. In M.Lovejoy et al.(Eds.), Context providers: conditions of meaning in Media Arts, Bristol:intellect

Saffo P., (2012), Futurist Paul Saffo on Design, in Corporate Design Foundation Journal, vol. 5

Seamon D., (2010), Merleau-Ponty, Perception and Environmental Embodiment: implications for architectural and environmental studies, in Carnal Echoes, Merleau-Ponty and the Flesh of Architecture, Rachel McCann and Patricia M.Locke, 2012-2013 - accessed on 10 May 2018 < https://transitionconsciousness.files.wordpress.com/2012/10/seamon_merleau-ponty_carnal_echoes_chapter_9_9_10.pdf>

Seitinger S. (2010), Liberated Pixels, Alternative Narratives for lighting Future Cities, MIT

Sola-Morales I. (1997), Differences, Topographies of Contemporary Architecture, MIT Press, Cambridge, Writing Architecture Series

Tapia, D.J, De Paz, Y., Bajo J. (2007), Ambient Intelligence Based architecture for Automated Dynamic Environments. In Borrajo, D., Castillo, L., Corchado, J.M. (eds.) CAEPIA 2007, LNCS, vol. 4788, pp.171-180, Springer, Heidelberg (2007).

Till J. (1996), Architecture in Space and Time, - Website consulted on 31/03/2018

Till J. (2013), Architecture depends, MIT Press

Tscherteu G. (2010), Media Architecture Scenes, in MAB Media Architecture Biennale 2012, Aarhus, Nov 15-Dec 15 2012.

Tschumi B.,(2000) Six concepts, in Architecturally Speaking, Practices of Art, Architecture and the Everyday, edited by Alan Read, Routledge

Tuan, Y., (1977), Space and Place, the perspective of experience, University of Minnesota

Trefz E., Jakovich J., (2007), Spatial Interaction Design for Urban Environments : An integrated approach for designing urban user experiences, University of technology, Sydney, Design,Architecture and Building.

Venturi R. (1966), Complexity and contradiction in architecture. New York: The Museum of Modern Art Press

Venturi R., Scott Brown D., Izenour S. (1972), Learning from Las Vegas, Cambridge MA:MIT Press

Villareal, L. (2013), Programming the sublime. A conversation with leo Villareal, interview by Jan garden Castro, in Sculpture Magazine, November 2013.

Walsh Sanderson, S. (2013), Light Emitting Diodes and the Lighting Revolution : the emergence of a Solid-State Lighting Industry, Lally School of Management, Rensselaer Polytechnic Institute, NY.

Weiser M., Brown J.S., (1996), The coming age of calm technology, PowerGrid Journal, vol.1.01

Wackermann J., (2011) Geometry of visual space : what's in a name ?, in Fechner Day 2011, Ra'anana, Israel : The international Society for Psychophysics, p.25-30, accessed on 11 March, 2018 <https://www.researchgate.net/publication/235762577_Geometry_of_visual_space_What's_in_a_name>

Wiethoff A., Gehring S., (2012), Designing Interaction with Media facades : A case study, in DIS 2012, June 11-15, Newcastle, UK.

Wigley, M. (1998), The architecture of atmosphere, Daidalos, p.18-27

William A., Dourish P., (2006), Imagining the City : The cultural Dimension of Urban Computing, IEE Computer Society, issue N.9, Sept.2006, Vol.39, University of California,

Willis S.K, Aurigi A. (2018), Digital and Smart Cities, Routledges

Wouters, N. (2016), Contextualising Media Architecture, design approaches to support social and architectural relevance, KU Leuven, Faculty of engineering science

WEBPAGES

Dan Roosgaarde talks about Dune 4.0 - Decembre 10th, 2006, accessed 8 April 2018 < http://we-make-money-not-art.com/dune_40_develop/>

Dan Roosegaard using technology for poetry, 2011,TED TALK, accessed 8 April 2018 <https://vimeo.com/14826423>

LDC - SILO 468, Original Concept presentation, accessed 15 April 2018 <https://www.youtube.com/watch?v=yPOkMNvzn9g >

LDC-SILO 468 HD, project presentation, accessed 15 April 2018 <https://www.youtube.com/watch?v=oiN_yDoOQjw>

'Making a mesh', a cargo de Tapio Rosenius , UPC School, 6th October 2016, accessed 11 december 2017 <https://vimeo.com/192434138>

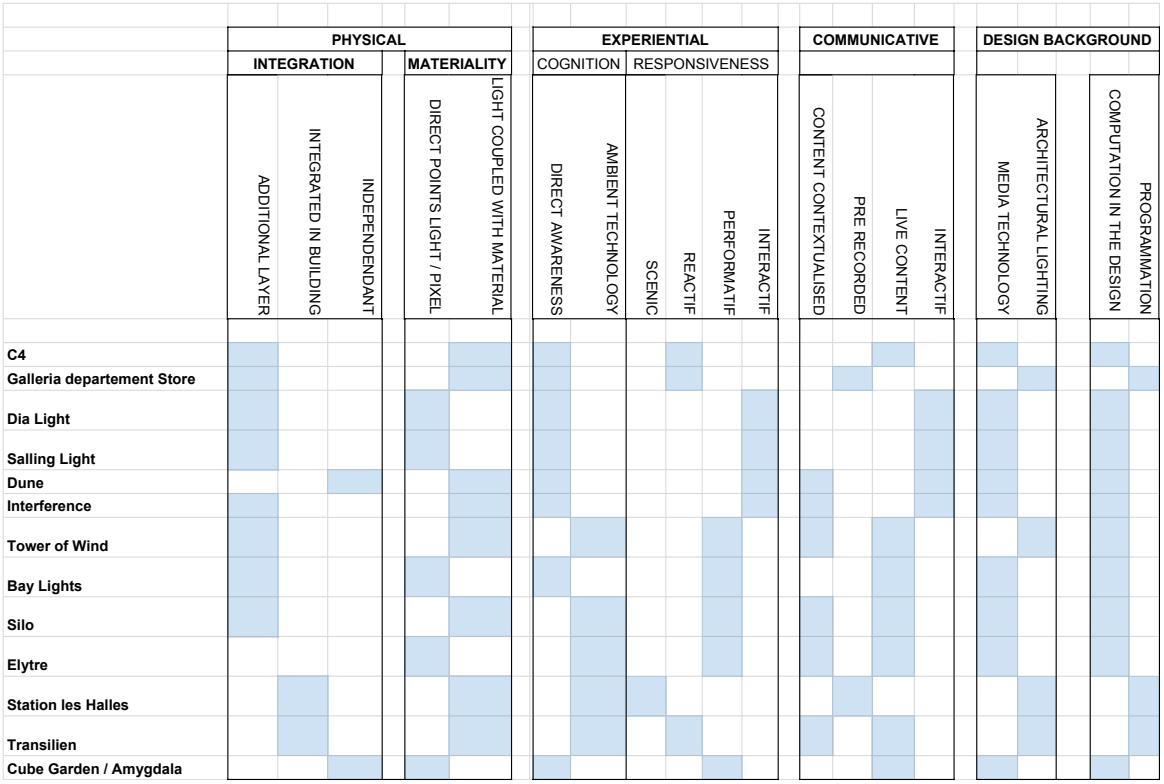
Drakko - SILO 648 - Light Art Installation in Helsinki - Posted in Oct 25, '12 12:03 PM, accessed 15 April 2018 <https://forum.openframeworks.cc/t/silo-648-light-art-installation-in-helsinki/11067>

Leo Villareal on the Bay Lights , Talk on SFMOMA, February the 7th, 2013, accessed 21 April 2018 <https://www.sfmoma.org/leo-villareal-on-the-bay-lights/>

Realities United , " Wasn't there something else yesterday ? ", Vitra Design Museum Interview, accessed 22 April 2018 <https://www.design-museum.de/en/about-design/interviewsåetailseiten/realitiesunited.html>

MIT AmbiantRoom - 1996, accessed 22 April 2018 <http://tangible.media.mit.edu/project/ambientroom/>

APPENDIX



	PHYSICAL						EXPERIENTIAL						COMMUNICATIVE			DESIGN BACKGROUND		
	INTEGRATION			MATERIALITY			COGNITION		RESPONSIVENESS									
	ADDITIONAL LAYER	INTEGRATED IN BUILDING	INDEPENDENDANT	DIRECT POINTS LIGHT / PIXEL	LIGHT COUPLED WITH MATERIAL		DIRECT AWARENESS	AMBIENT TECHNOLOGY	SCENIC	REACTIF	PERFORMATIF	INTERACTIF	CONTENT CONTEXTUALISED	PRE RECORDED	LIVE CONTENT	INTERACTIF	MEDIA TECHNOLOGY	ARCHITECTURAL LIGHTING	COMPUTATION IN THE DESIGN	PROGRAMMATION
C4	■				■		■			■					■		■		■	
Galleria departement Store	■				■		■			■				■				■		■
Dia Light	■			■			■					■				■	■		■	
Salling Light	■			■			■					■				■	■		■	
Dune			■		■		■					■	■			■	■		■	
Interference	■				■		■					■	■			■	■		■	
Tower of Wind	■				■			■			■		■		■			■	■	
Bay Lights	■			■			■				■				■		■		■	
Silo	■				■			■			■		■		■		■		■	
Elytre				■				■			■		■		■		■		■	
Station les Halles		■			■			■	■					■				■		■
Transilien		■			■			■		■			■		■			■		■
Cube Garden / Amygdala			■	■			■				■				■		■		■	

Study case analysis table