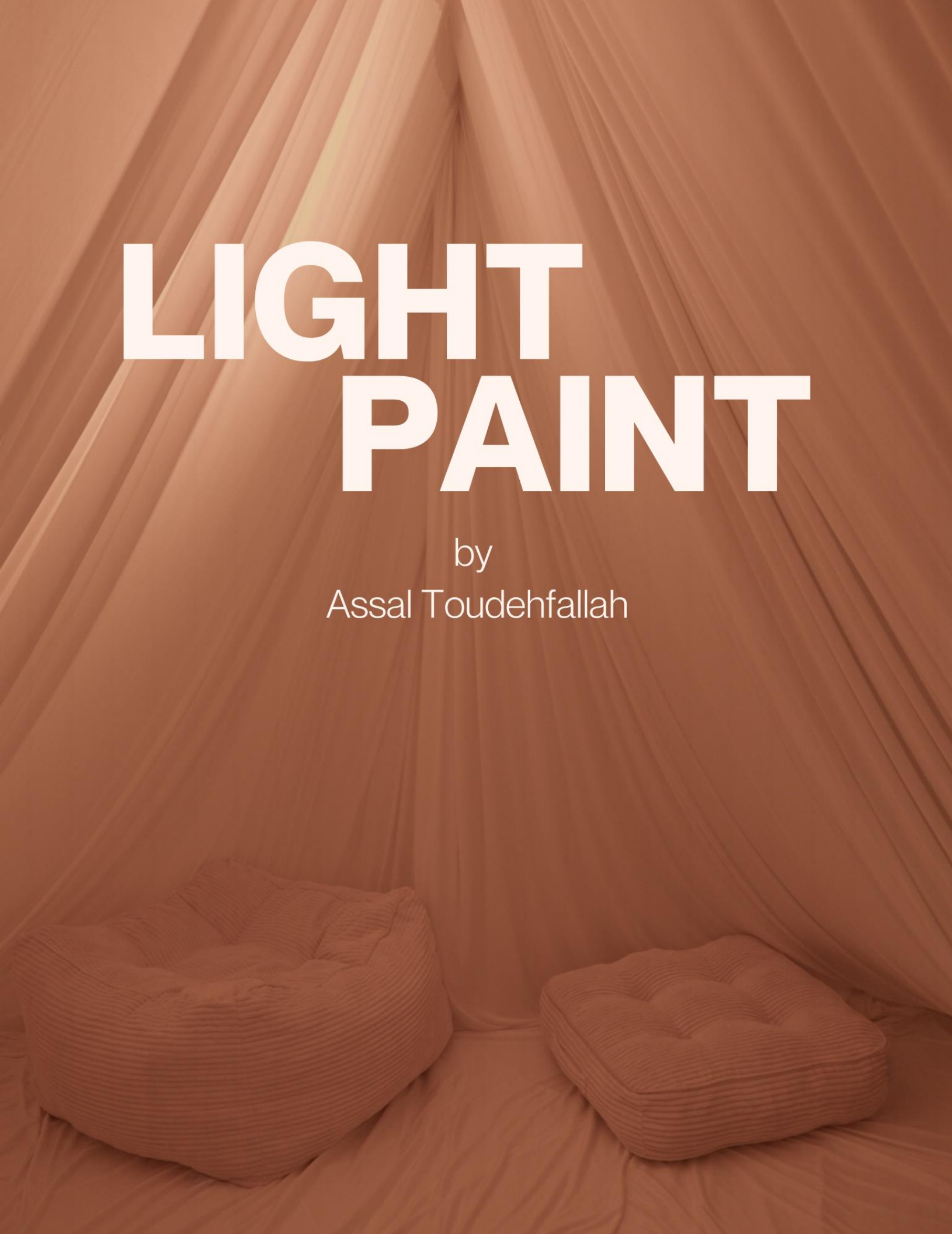

LIGHT PAINT

by

Assal Toudehfallah

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A thesis exhibition presented to OCAD University in partial fulfillment of the requirements for the degree of Master of Fine Arts in Digital Futures

OCADU Waterfront Campus, March 26th – 30th, Toronto, Ontario, Canada, 2026

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Abstract

Light Paint is a time-based, interactive installation that seeks to materialize light and colour in order to investigate their relationship with human perception. I propose that interactive light installations can offer robust sensory and cultural experiences. By considering affect theory to examine humans' embodied relationship to light, *Light Paint* creates an immersive ecosystem where participant(s) engage with light, colour, and each other, in the course of a pre-determined durational experience. *Light Paint* employs Research-Creation and Iterative Prototyping methodologies to generate an affective environment where viewers can become active participants in an evolving perceptual experience.

Keywords

affect, immersion, duration, embodiment, interactivity, perception, agency

Acknowledgments

Though this project bears my name, it echoes the voices and the guiding hands of all who supported me. It is through this collaboration that *Light Paint* reached fruition.

To this end I would like to thank my primary advisor, Simone Jones who spent countless hours offering guidance and critique to ensure *Light Paint* would see the light of day. Your unwavering support and expertise have been invaluable.

To my secondary advisor Veronika Szkudlarek, who asked thought-provoking questions and guided me to find my direction. Thank you for entertaining the ever-so abstract topics of this paper and supporting me with your generous advice.

To my editor, Lyla Rye, thank you for unravelling my tangled writing. And to Inder Sidhu, who spent hours with me to improve the clarity of my work.

To my fellow Digital Futures students — Aranya Khurana, G. Blekkenhorst, Peter Oke, and Golnoush Mir Salari — who not only offered advice, but much needed distraction and lengthy conversations. Most specifically, thank you to Joshua Jacob Pothen and Pavel Padtykalau who offered a continuous stream of encouragement and assistance, and whom without this project would have been utterly different.

To my partner, Cassandra Yurich, who held my hand through moments of hesitation and nurtured me back to certainty. And to her family who supported me with unconditional love and an endless supply of food.

To my dear friend Anika Debroy who was ever-so patient with me and reminded me of my strength when I waivered.

Lastly, to my brother who has a steadfast belief in my capabilities. And to my parents, who lovingly raised me and made great sacrifices for me to have an opportune future. It is with your love and support that I braved this project.

To my grandfather, my Baba Bozorg,

who taught me to stay curious.

And to my grandmother, Maman Nazi,

who instilled the love of learning and teaching in me.

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1. Introduction

Light has various definitions across different fields. To a physicist, light is a form of electromagnetic radiation, and to an archaeologist it is a critical component of human evolution from the discovery of fire to organizing our lives around the sun.[1] To an artist, however, light is conceived within the "experience of vision" and perception.[2] Light has engrained itself within the human psyche to create a symbiotic relationship with humankind.[3] Natural light had long determined the natural cycles and rhythms that people lived by. This led people to create artificial light. This new form of light allowed humans to live outside of natural systems and enabled granular control over colour, intensity, direction and shape.

Paradoxically, light is an immaterial material. Light enables perception of visual phenomena, yet we cannot see light itself. *Light Paint* explores light as a material by utilizing its various properties such as brightness and colour within the context of an interactive installation. To achieve this, *Light Paint,* takes on a monochromatic and minimalist aesthetic and uses fabric to create its own spatial boundaries within the installation room. The installation has a duration of 20 minutes and allows for up to three participants to interact with the lights, the installation space, and each other. The overall goal of *Light Paint* is to foster a sense of agency within participants through their encounter(s) with the installation. This section outlines my connection to this subject and lays out the scope and the limitations of the overall project.

1.1. Researcher's Background

Over the past few years, I have immersed myself within the world of lighting design. I am trained as a gaffer—lighting technician—for film and television. Although I have yet to work on larger sets, I have noticed some immense gaps in how lighting is approached even by the most skilled. Numerous movies and series utilize lighting in a purposeful matter, but in my experience, lighting is often neglected despite its immense effect on the emotional trajectory of the story it helps to portray.

Watching movies through the lens of a gaffer reveals the uninspired nature of lighting in recent years. I believe this could be attributed to the simplification of lighting equipment, that lowers the barrier to entry into the profession. This allows young creatives to attempt complex lighting projects without building an eye for it. A lighting designer requires an immense amount of technical expertise to be successful. I suspect that the immense need for knowledge of electricity, equipment, and safety has veiled the artistic heart of lighting design. Lighting designers must learn how to balance technical expertise with artistic choices, a skill that can only be learned through experience.

Lighting design is comparable to masterful painters who implement a variety of lighting techniques to create intentional effects.[4] Notably, many great lighting technicians look to paintings for inspiration to integrate similar lighting techniques within their films to create specific moods or references. By using this approach in my professional practice as a gaffer, I aim to connect the technical and emotive sides of lighting, so that the movie's narrative and lighting form a symbiotic relationship with one another. This means that every choice made about light, shadow, and colour is made with the film's story in mind and intentionally employed

to create an emotive response. In the absence of an explicit narrative, my installation *Light Paint* utilizes colour and light that is informed by Iranian architecture and spiritual spaces to create an emotional connection with its audience. *Light Paint* is an interactive, durational experience that enables personal and cultural perceptions of light and colour to be explored through active viewer participation.

1.2. Scope and Limitations

Light has a myriad of definitions across various fields such as art history, psychology, architecture, and urban design. To narrow this definition, I will only discuss visible light in my installation as it is found in the works and the research endeavours of related artists and thinkers. By narrowing my focus to light on the visible spectrum, I will reference various light artists who do the same and incorporate colour into my installation based upon their findings.

Colour is as broad a term as light and could be deemed a bi-product of light.[5] As such, colour too will be limited to a specific Iranian-inspired colour palette. While some of my colour choices were informed by my understanding of colour theory, colour theory alone is not the focus of the project. Rather, I seek to explore how culture informs perceptions of colour in architectural spaces as inspired by my Iranian upbringing. In order to evaluate how each participant perceives the installation's light and colour choices, I will incorporate Research Ethics Board (REB) approved testing and surveying processes to gain clarity and answer the research questions identified in Section 2.

The physical manifestation of *Light Paint* will avoid any use of a screen or screen-like presence because it often elicits predictable responses to light in viewers. For example, in 2025 I collaborated with peers on an installation comprised of light cues and rear projection. Despite

clear spatial cues in the installation, numerous people chose to treat the floating projection as a touchscreen and expected it to behave as such. I also intend to avoid using machine learning and computer vision in this project as they lie outside of my field of practice and expertise and to keep the focus on direct human interaction with the light.

Light Paint employs standard theatrical and DMX-lighting fixtures controlled by physical computing. Using sensors and an Arduino micro-controller, I have created an interactive environment where the viewer becomes a participant. Importantly, although participants do interact with the installation, I do not consider the work to be co-creative. Instead, *Light Paint* highlights that responsive light systems can affect a participant's perception. This responsivity of the artwork to audience involvement integrates ideas from affect theory and interactive art while also questioning notions of agency.

2. Research Questions

2.1. Primary Research Question

1. How can responsive lighting foster an evolving, interactive relationship between viewers, light, and colour within dynamic environments?

2.2. Secondary Research Questions

2. In what ways does pre-determined duration within interactive lighting installations influence the participant's sense of agency and participation within the installation?

3. How can interactive light and colour systems dynamically alter spatial perception in immersive and interactive installations?

3. Literature & Contextual Review

This research explores how interactions between light and humans can synthesize perception through the lens of affect and agency theories. As a participatory experience, *Light Paint* exists as an interactive installation that provides an opportunity for agency to take shape. This occurs through the active engagement of the participant in relation to the light-reactive installation. To examine this, *Light Paint* draws from fields and practices pertaining to interactive installations that use light and their effects on human behaviour.

In addition, this section reviews how the works of James Turrell, Olafur Eliasson, Rafael Lozano-Hemmer and Steve McQueen have come to inspire *Light Paint and* outlines why they are conceptually relevant to my notions about light and colour, affect, and interaction. Turrell, Eliasson, Lozano-Hemmer and McQueen's works do overlap in how they engage with light, colour, space and interaction. For the purposes of this document, I will be selecting aspects of their works to address their relationships to how *Light Paint* functions.

3.1. Understanding Light and Colour

As proposed in the introduction, we can understand light to be an immaterial material. Therein lies the question, how can this paradoxical notion be true? Light is not limited to the physiological experience of vision. By illuminating our surroundings and the objects within them, light also plays a fundamental role in our embodied perception of the world.[6] Importantly, light further extends beyond vision and into the body to occupy symbolic, aesthetic and cultural roles.

3.1.1. Light and Space

Fatemeh Ahani in *Natural light in traditional architecture of Iran* classifies the roles of light in architecture through the following categories: climatic, psychological, aesthetic, spiritual and symbolic.[7] She explains that Iranian architecture manipulates natural light rather than relying on artificial illumination. For example, due to the high intensity of sunlight in Central Iran, great care was taken to orient houses according to the direction of both sunlight and wind.[8] This explains the climatic role of light in the design of traditional architecture. Other techniques were used traditionally such as Orosi —latticed— windows paired with coloured glass, and window wells to minimize direct sun exposure. Mirrors and other reflective surfaces were also employed to brighten rooms.[9]

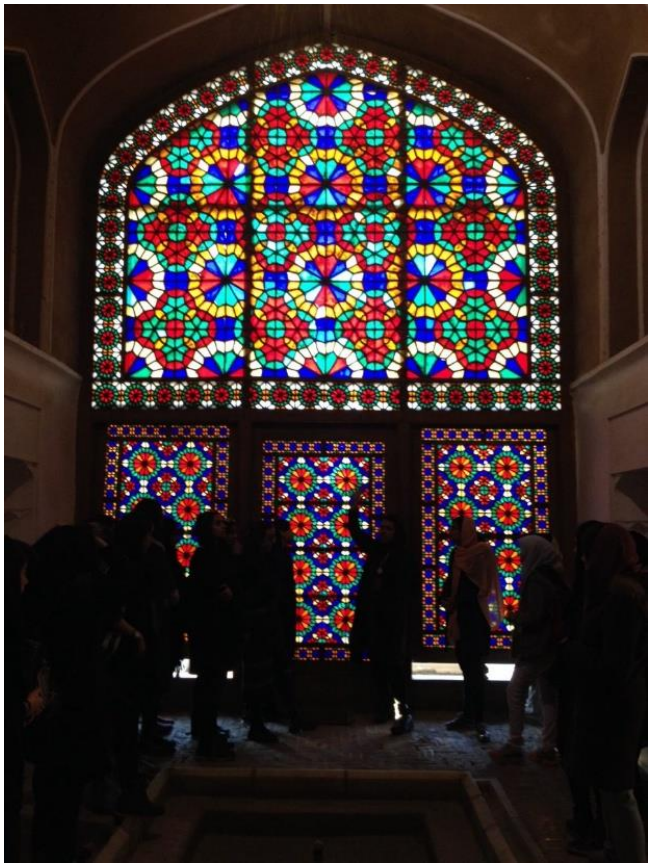


Figure 1. Orosi Window, Yazd, Iran, (Photography by Author, 2016)

Meanwhile, the creation of shadows was just as important in both the climatic and spiritual roles of light. As shadows offer coolness in a hot climate, the shadow, within Iranian culture, symbolizes life and safety. “To be under someone’s shadow” is a Persian idiom meaning to have someone’s protection. This safety was portrayed by the comfort that Orosi windows and window wells offer.[10] Within these examples, shadow is not seen as the lack of light but rather as protection from the sun both physically and metaphorically.

To deepen the roots of this metaphor; historically light and fire were considered sacred to Aryans (the first Inhabitants of Iran), leading to the construction of fire temples.[11] Ultimately light and fire became core in many religious ceremonies.[12] This inspiration can be seen in the metaphor of light and how it engenders metaphysical connotations of the omnipresent Divine in the architecture of spiritual spaces. This metaphor frames light as “a virtue of the sky, of heaven, of truth” and “of realization”.[13] Within Iranian architecture, this metaphor then influences the aesthetics of Orosi windows. These traditional Iranian stained-glass windows are often present in religious spaces. It is through them that light is modified while transforming the space itself. The multicoloured light that pours in through these windows help create beautiful light rays and a spiritual atmosphere.[14]

In its early stages, *Light Paint* was deeply inspired by Orosi windows and their ability to purposefully modify light to transform the architectural space it exists in. Light can be modified by changing its physical properties such as colour, intensity, shape and texture. Texture in lighting can be observed in the quality of the shadows. For example, Orosi windows alter the colour and the texture of light by casting both light and shadow through the coloured panes and contrasting black lines that fall onto the surfaces of the architecture. While the coloured glass alters the hue of the light, the black lines create ornamental shadows.

An early iteration of *Light Paint* involved shining a spotlight through a hand painted stained-glass pane that was fabricated based on the design of traditional Orosi windows (see Figure 2). This was essentially a hand-made Gobo similar to those used in lighting design for film and theatre with the purpose of changing the texture of the light. Both the spotlight and the stained-glass modified the light resulting in a striking pattern of light rays and colours. I observed that despite the ethereal quality of this light, the light was confined to a circle — as per the limitations of the Gobo— which hindered the potential for it to transform the architectural space to alongside the light.

Figure 2. Hand painted glass pane for Light Paint's first prototype, (Photograph by Author, September 2025)

In other words, the handmade Gobo created an intense spotlight effect which did not create the immersive environment I sought to fabricate. Without immersion, I found that the space was not changed by the light. Rather the light simply existed in the space, visually striking but not transformative.

Figure 3. The first iteration of *Light Paint.* (Photograph by author, Toronto, September 2025), Room dimensions 9ftx14ft.

Nevertheless, as intended, the colours of the light rays did evoke a feeling similar to that of spiritual spaces and older Iranian homes which continue to house these windows. In relation to Ahani's views on the spiritual and symbolic roles of light,[15] my observations raised the question of whether altering and shaping light in different manners would allow for emergent perceptions of the space.

3.1.2. Colour

" In visual perception a color is almost never seen as it really is

-- as it physically is.

This fact makes color the most relative medium in art".[16]

Akin to light, colour is a physiological experience that requires the presence of a source (light), a detector (the eye), and an object.[17] Any changes to these three components will shift the perception of colour. Josef Albers suggests this could be due to our poor visual memory and our limited vocabulary regarding colour.[18] Accordingly, while colours are innumerable in their hues and shades, we do not often think about a colour if it does not have a name. This linguistic relativity of colour affects our perception of hues which can shift based upon the language spoken and whether the colour is named in that vocabulary.[19] In addition, it has been proven that the human eye is not a reliable detector of colour as the experience of colour differs amongst individuals and our perception of colour actually dulls as we age.[20]

The cultural perception of colour is a notable factor. While physiological and linguistic perceptions of light and colour affect human emotions, cultural relativity attaches associations on a broader scale.[21] Different cultures may have differing perspectives and relationships to colour. For example, in both Iranian and English cultures, the colour red is symbolically associated with bashfulness, illness, anger, and danger. Meanwhile, the colour green has nearly opposing associations in each culture. In Persian, the colour green signifies health, abundance, and growth, whereas in English it is linked to illness, naivety, and envy.[22]

Colour is deeply engrained in the Persian language and spirituality. Iranian mystic and poet, Rumi writes about how our physical and symbolic perceptions of light affect each other in a cyclical manner:

"As there is no seeing outward colors without light,

So it is with the mental colors within.

Outward colors arise from the light of sun and stars,

And inward colors from the Light on high.

The light that lights the eye is also the heart's Light;

The eye's light proceeds from the Light of the heart." [23]

Beyond the spiritual effects of light and colour, from an aesthetic standpoint, colours interact with each other to create dynamic perceptual effects. A coloured light source, for instance, will change the perceived hue of an object; a bright pink item tends to appear dull if placed under highly saturated light. Albers' famous experiments exploring the relationship between colours demonstrate how different hues affect each other if placed side by side.[24] For example, as shown in one of Albers' experiments, if a block of dulled orange was placed amidst a vibrant sky-blue, it will appear brighter and bolder. However, if the same block of colour was placed next to a truely bold orange, it will appear rather brown-ish in comparison.[25] While the colour has remained the same, our eyes take spatial colours and light into account when perceiving hues radically shifting how we view both hue and saturation.

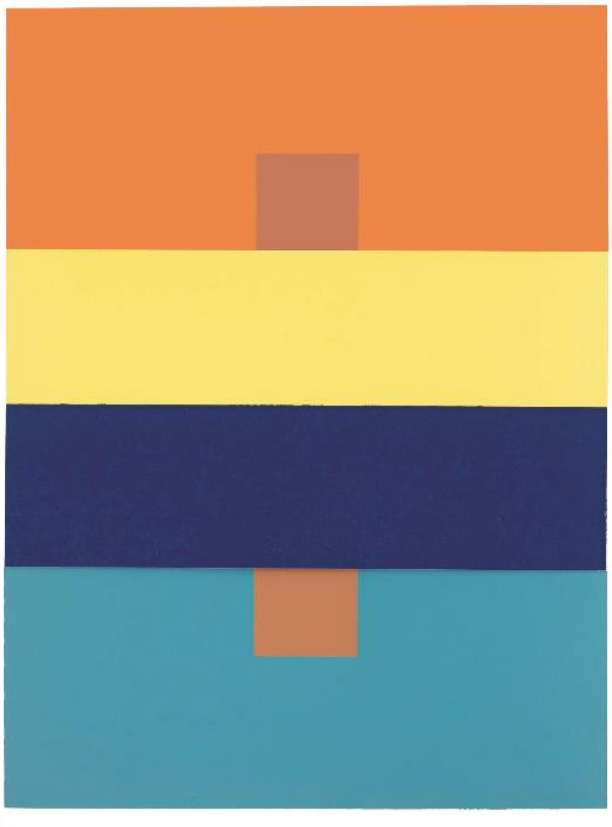


Figure 4. Scan of Josef Albers's lithogram. (Page from Joseph Albers, *Interaction of Color*, Plate IV-I, 1963, Yale University Press)

Pigments are used in a similar fashion to light in Iranian architecture to create spiritual spaces.[26] The colour palette of *Light Paint* draws on my Iranian cultural heritage. I was inspired by a distinctly Iranian colour palette where the most common colours are azure, teal, yellow and Persian red. These are seen in the mosaics of mosques, traditional stained-glass windows, and Persian rugs. It is believed that these colours were used so often because of their effectiveness to shield against sunlight without fading.[27] They were employed in the aforementioned Orosi windows because they are an efficient way to reduce the intensity of the sun without sacrificing light levels.[28]

3.1.3. Diffused Colours and Spatial Perception

Building upon Albers' findings, *Light Paint* uses soft, diffused light as opposed to the hard, directional light of the Orosi windows. This softness allows for the colours to interact with one another, blend and create new hues, and fill the installation room in a soft wash of light and colour. This employs Albers' findings regarding the interaction of colours and our subjective perception of hue. *Light Paint* uses this softness to add a sense of serenity into the room thus shifting the participant's perception. This notion of spatial perception as it relates to diffusion, can also be seen in the works of James Turrell.

Often referred to as a "master of light", James Turrell is an American artist best known for his work in the field of site-specific light art.[29] His installations are minimal, refined spaces which manipulate light and colour to craft a perceptual affect in the viewer. In their perceptual simplicity, Turrell mystifies his viewers by allowing them to step into his work as though stepping into paintings.[30] Turrell's works are immersive experiences that allow for a participant's awareness of their spatial perception to be the driving force in how they experience the installation.

Figure 5. Image of James Turell's installation, This installation closely resembles Prototype 2 in *Dhatu*. (Photograph by Florian Holzherr, 2009).

Space is integral to how Turrell frames light. Similar to Albers's theory on how colours interact, Turrell explores how he can change our perception of hues and light, by altering our perception of the space.[31] Turrell does this by bringing attention to the light through the design of the space in which the light lives. *Light Paint,* as an installation, brings attention to light by diffusing it through sheer fabric. In addition, the whiteness of the installation space removes all distractions and narrows the viewers' focus onto the light itself. In this way, the colour of the light can completely change the perceived colour of the room and colours that the participants introduce into the space — for example with colourful clothing.

Figure 6. Current Iteration of *Light Paint.* Colour, light, and fabric are the central visual components of the installation. (Photograph by Author, Toronto, March 2026), Dimensions 8ftx12ft.

An earlier prototype of *Light Paint* revealed the importance of blurring the edges of a space and its resulting effects in perception. This prototype took place in a barren, empty room with a concealed light fixture. As evident through observation alone, this caused a sense of evident curiosity in the participants who walked around the room looking for something to happen. The final installation will take place in a room entirely covered with white fabric which blurs the hard edges of the architecture and can easily take on the hue of the lights. As such, not only is the light

diffused, but so are the boundaries of the space as the fabric seamlessly meets the ground. In this way, the room itself contributes to how the light and colours affect the participant, thus resulting in an embodied perception of the space.

Figure 7. Prototype 2 before a participant step in, (Photograph by Author, Toronto, October 2025), Installation Dimensions 12ftx20ft.

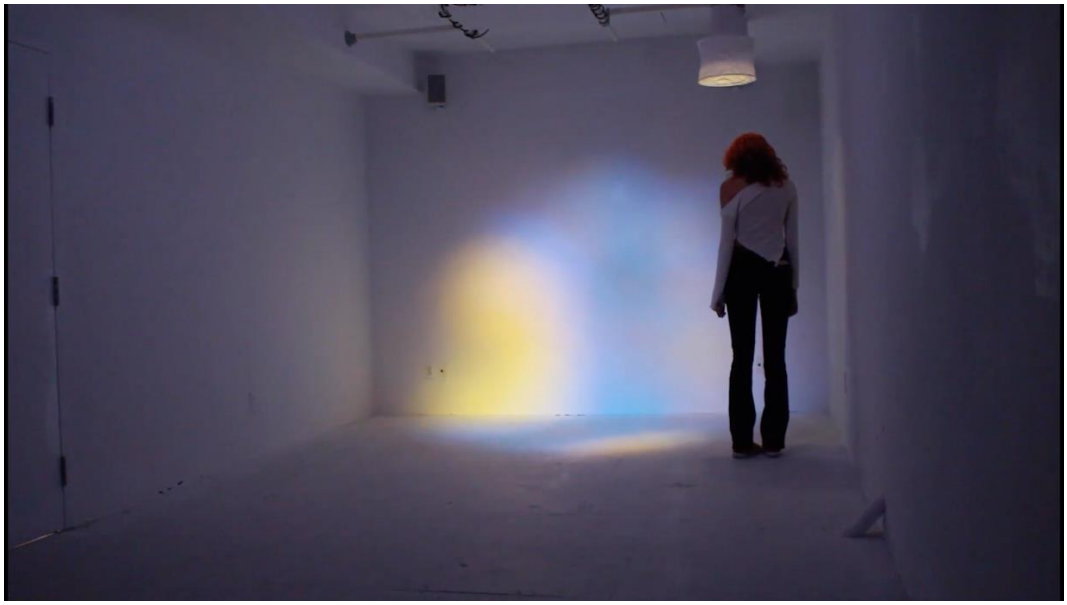


Figure 8. Prototype 2 In the presence of a participant, (Photograph by Author, Toronto, October 2025), Installation Dimensions 12ftx20ft.

Moreover, at the core of Turrell's work lies the "thingness" of light which he characterizes as something that occupies space. To Turrell, light is as physical as sound and air, in that they have a physical presence despite being invisible.[32] His installations bring attention to light itself as a material which exists in space. In a similar fashion, I concern myself with both the materiality and immateriality of light and attempt to centre it as a affective presence in *Light Paint.* The challenge of this being that we do not see light itself, rather how it affects us and the space around us.

The way the light surrounds my installation shifts our spatial perception, both in how colours manifest themselves, and in our understanding of the dimensions of the space itself. Given that the installation room is completely white, it alters according to the colour of the lights (See Figure 9).And, given that the LED lights used shine highly saturated colours, it can completely change the perceived hue of the room and colours the participants introduce into the space. For example, a participants' clothes may shift their perceptual colour based upon the colour of the lights, as explored in previous sections. One participant even directly mentioned how they were fascinated by how the colour of their sweater shifted throughout the installation's duration.

Figure 9. Photo of person under multiple colours of *Light Paint.* Notably, the colours of the clothing shifts under different lights. (Photograph by Author, Toronto, March 2026), Dimensions 8ftx12ft.

The space of *Light Paint* itself helps to guide the participant to focus on such details, especially when comparing the final installation to an earlier prototype (see Figure 10). The most notable difference between the two versions is the space itself, which is still discernable as a square room in the older version, whereas the architecture of the final version is blurred and softened. It is in this minimal, site-specific approach that *Light Paint* borrows from the works of James Turrell to alter perception as it relates to light and colour.

Figure 10. Comparing prototype 3 to the current version of *Light Paint.* The drapery of the fabric has completely changed the lights and the space. (Photography by Author, Toronto, December 2-25 and March 2026).

3.2. Affect Theory

3.2.1. Embodied Affect

Visual perception of light and colour are some of the ways in which we embody spatial and durational experience. Affect theory studies how our bodies affect our minds and our dynamic relationship to other bodies.[33] Affect, as defined by Brian Massumi, in *Parables for the Virtual: Movement, Affect, Sensation (2021)*, can be understood as pre-personal, relational or even generative. This definition supports my premise that the light system integrated within *Light Paint* is not just a tool, but a sensory agent shaping a human-computer experience. Massumi challenges traditional cognitive approaches to perception as a response that happens after an event and argues that affect theory can be understood as pre-conscious intensities that move through the body and space. In other words, affect can be sensed before it can be named. These concepts support the intention of *Light Paint* as an interactive installation whereby users are encouraged to instinctively and pre-consciously respond to light.

Affect is a transindividual event where the individual is not yet separated from the collective.[34] To be affected is to affect another. We exist in a collective space where our mind and body are constantly influenced by our surroundings. As Massumi writes, "to affect and to be affected is to be open to the world, to be active in it and to be patient in its return activity".[35] Similarly, to enter and participate in *Light Paint*, is to open an affective channel between participant and light. This installation relies on more than the encounter between light and humans; it aims to encourage affective embodiment through the deliberate actions of the participants.

The generation of affect between multiple participants within the installation is far more complex than the relationship between participants and the lights. While the lights are coded to

react based upon sensor readings of participant movement, relations between light and participants is unpredictable. In *Light Paint*, every affective encounter requires a multitude of choices from all parties. The installation can house up to three participants at once. If there are multiple participants, the behaviour and colour of the light reflects the dynamic relationships among them.

Each participant is dedicated a spectrum of colours that they can shift and alter based upon their position in the space and their gestures. For example, the first participant will be assigned blue, teal, and yellow which will appear based upon their location in the installation. When the second participant joins in, they will be automatically assigned a second light fixture with orange, peach, and pink as their colours. Similarly, the third participant is assigned the third fixture and the colours peach, purple, and blue (See Figure 11).

Figure 11. Installation lights reacting to Participant 3 moving, while the first two participants are observing. (Figure by Author, Toronto, February 2026), Dimensions 8ftx12ft.

At this point, all colour spectrums are visible and individually controlled. Given that each person is assigned an array of colours, the emergent hue of the installation relies on how the participants choose to interact, or not interact, with each other (See Figure 12). Then, the participants and the lights together become part of a reactive and affective relationship. Importantly, there are multiple forms of affective embodiment as we are each likely to experience it differently.[36] Affect is ever changing as our bodies and minds are in a constant tumultuous relationship with our surroundings.

Figure 12. The lights visible with two participants in the installation. This can manifest differently based upon positional data. (Photograph by Author, Toronto, March 2026).

Let us untangle the theory of affect as such: our bodies are constantly affected by surrounding stimuli. We exist in a constant push and pull with the space around us, from the sounds of talking, or the chirping of the birds, to the sensation of physical objects we are in contact with. At the same time, we have a similar effect on the bodies surrounding us: both human (participants), and non-humans bodies (lights). Both are continuously affected through our interactions across space and time. We simply cannot escape affect, even when we fail to recognize it.

In the case of *Light Paint*, this translates to how the user can develop a sense of affect in relation to light within the installation space. From this emerges both a relationship between the light and participant(s), and the emotional resonance felt in the body. *Light Paint* is an ecosystem of space and light which creates an affective chain reaction that the participant enters. This ecosystem allows the participant to rely on the installation to create an emergent and ever-changing perceptual space that evolves throughout the duration of the installation.

When the participant first enters the installation, the lights respond by a change in their intensity, colour, or both. As observed during user-testing, some participants would immediately make a secondary movement —re-trace their step or move further in— in response to the light changing, which then initiates another lighting shift. Meanwhile, some participants would completely disregard the changes and head directly to the cushions placed on the floor throughout the installation. Although neither choice is invalid, it completely shifts the progression of the events that unfold in the installation. *Light Paint* generates and displays affect as a manifestation of reciprocity between us and all that surrounds us.

3.2.2. Affective Agency

As stated by Massumi, the presence of reciprocity itself is an indication of agency.[37] In *Light Paint,* participant agency is essential to the experience of affective immersion within the installation. Massumi describes agency as a systemization of intelligence that instigates action.[38] Within this framework, agency is an expression of intelligence when deliberate action by the participant is required. In *Light Paint,* this would help explain people's choices in response to the changing lights and the presence of other participants in the installation. Each choice can be viewed as an active and agential movement. For movement to be agential, it must be voluntary.

According to Massumi, voluntary movement can only occur when human agency is present.[39] Accordingly, *Light Paint* primarily focuses on how participants voluntarily choose to interact with the lights and each other during the time spent in the installation.

Figure 13. Photo of participant lying down and observing the lights in Light Paint. Choosing not to observe rather than interact is an agential movement. (Photograph by Author, Toronto, February 2026), Dimensions 8ftx12ft.

Using dynamic lighting, coding and viewer interaction, *Light Paint* creates a co-agential, symbiotic relationship between lights and participants. As previously mentioned, the reactive lights within *Light Paint,* create a sense of affect within participants. In response, some participants — as evident through surveys and observation— respond to the changing light with a form of voluntary movement, revealing the presence of agency. In contrast, participants who chose to disregard the interactive potential of the lights and focused on the space alone, noted a lack of agency in their survey responses. Even though both groups expressed having an experience of spatial embodiment, the latter lacked a sense of immersion. The reaction of the lights, paired with

the agential movements of the participants, creates a network of interaction within which the sense of immersion is reinforced. Interaction, alongside immersion and embodiment, results in the emergent perception of the light and colours present in the installation.

3.2.3. Game Theory and Agency

In game theory, agency and immersion emerge through a process of decision-making by player(s). In *Games: Agency as Art.* (2020), C. Thi Nguyen, a philosopher of art and games, presents a compelling theory of how games function as aesthetic structures that shape and constrain agency. Nguyen's concept of "agential modes" describes how games guide players through structured patterns of decision-making, allowing them to inhabit temporary, alternative ways of acting and perceiving.[40] Within the boundaries of *Light Paint*, this notion of structure and choice, even if cause and effect is illusive, can evoke a sense of agency within multiple participants that occupy the interactive installation.

Through this lens, interactivity becomes a designed aesthetic experience rather than mere input-output mechanics. *Light Paint* aims to sculpt user agency and immersion through motion, reactivity, and embodied interaction. The agential aspect is directly relevant to the exploration of the interactive lighting environment, where user movement and response shape both the space and the experience. Thus, agency extends beyond free choice: it is aesthetic, scaffolded, and relational.

To exemplify this type of agential exploration, I will refer to Urs Fischer's robotic installation called *PLAY* (2018). The installation takes place in a room filled with multiple, ordinary, office chairs, where, as the participants walk through the space, the chairs move in reaction to the participants. It is the visitors gradually discovering the nature of the interaction which gives the installation its meaning. In an interview, Fischer discusses how "It's the human

who projects onto the object. The object is nothing and everything, you know? The chair is just a chair; it could be something else".[41]

Urs Fischer kept the installation as simple as possible to allow participants to take control of the interaction within the space. Fischer noted how, on interacting, participants were likely to ascribe behavioural perceptions upon the chairs based on their colour. For example, participants assumed the red chair was being aggressive due to their preconceived notions of the meaning of the color red. Interestingly, these biases are cultural, not universal. This installation, and Fischer's observations of it, describe how the agency of participants to engage with, or *play,* with the robotic chairs, is where immersion and relationality is born. By choosing to interact with the installation, an evolving relationship emerges between the chairs and the participants.

Figure 14. *PLAY* by Urs Fishcer. Chairs react based upon the participant's position. (Photograph by Chad Moore, Choreography by Madeline Hollander, 2019).

Light Paint's immersive quality relies on both visual perception and the experience of the interaction within the space. Something curious occurs when a participant enters a blank white room inhabited only by light: the expected certainty of four solid walls dissolves into a fabric-softened space, producing a subtle perceptual dissonance (See Figure 15). As noted by some participants in the REB testing, this sense of dissonance slowly grew into immersion, which then stimulated agential movements (See Section 5). This links to Fischer's note on how a minimalist installation space can invite participants to explore the installation and play with the lights. In *Light Paint*, light and time spent in the installation helps to structure a sense of agency, crafting a *game of light* with interaction at its heart.

Figure 15. Participant exploring the material of *Light Paint* to understand what causes the light shifts. (Photograph by Author, Toronto, February 2026), Dimensions 8ftx12ft.

4. Interaction & Duration

As an interactive installation, *Light Paint* generates immersion through a relational system in which the space, participants, and duration continually shape one another: as the lights respond to participants' movements, participants in turn retroactively affect the space and each other, producing a dynamic loop of interaction. With *Light Paint* the space is not separate from the interaction but rather intensifies immersion through its presence.

4.1. Embodied Space

Light Paint exists within a space completely draped in white fabric that allows light to shine through; walls and floor meet seamlessly, producing a sense of dislocation and dissonance for participants (See Figure 16). During the user testing of the work, several people who experienced the piece commented on the scale of the room and how it seemed to shift as they spent time within the installation space. Removing the physical boundaries between the walls and the floor removes any direct connection to the architecture of this space. Thus, participants are left unsure if the space is large or small in relation to their bodies. In short, space affects perception, a notion which can be exemplified through the works of Olafur Eliasson.

Figure 16. Participant in the installation space reaching out to the fabric of the installation. (Photograph by Author, Toronto, March, 2026), Dimensions 8ftx12ft.

Olafur Eliasson's works grapple with how space affects humans, both in constructed spaces such as museums, and in nature. The spatial presence in his artwork is meant to alter how viewers engage with them.[42] To Eliasson, light, space, and humans are so deeply intertwined that we tend to "organize our movements" when our spatial surroundings affect our cognition.[43] In essence, the space not only changes our embodied perception, but how we choose to interact with it. Visitors to his installations individually decide the meaning of the space and, in return, the space helps them to turn inward and examine themselves. When this meaning and space-human relationship is established, the observer then can choose to impact the space in return. As Eliasson has observed, "If I have a sense of the space, if I feel that the space is tangible, if I feel there is time … I also feel that I can change the space".[44]

Figure 17. Breathing Earth Sphere, Olafur Eliasson, (Photograph by Kyungsub Shin, 2024).

His work has an ephemerality that I wish to achieve within *Light Paint.* For instance, *Breathing Earth Sphere* (2024), a primary inspiration, is a spherical experience created by 1200 lava stone tiles. The project explores how eliminating traditional spatial boundaries affects perception.[45] The installation removes all corners and any sense of a horizon so that the viewer feels a heightened sense of "presence" in the spatial embodiment.[46] *Light Paint* seeks to have a similar effect through diffusion of the space by draping white fabric that seamlessly meets the ground (See Figure 18). This dislocates the installation room and displaces the participant, thus, helping to create emergent relations to the architectural space itself. The participants have their own personal sense of space due to how they can affect the lights in that space. As a result, *Light Paint* deepens the embodied experience of the space. Softening the site and allowing for participants to see their impact on the lights and installation deepens the visitors' sense of presence and agency.

Figure 18. Participant walking into the installation space interacting with the boundaries of the installation. (Photograph by Author, Toronto, March 2026), Dimensions 8ftx12ft.

Eliasson uses geometry to remove the boundaries of space, while *Light Paint* uses white fabric and cushions to create a monochromatic installation space. In this way, *Light Paint* creates a minimalist installation space by removing architectural boundaries. The image below illustrates how the white fabric and the white cushions absorb the diffused light to create an overall, diffused, monochromatic effect.

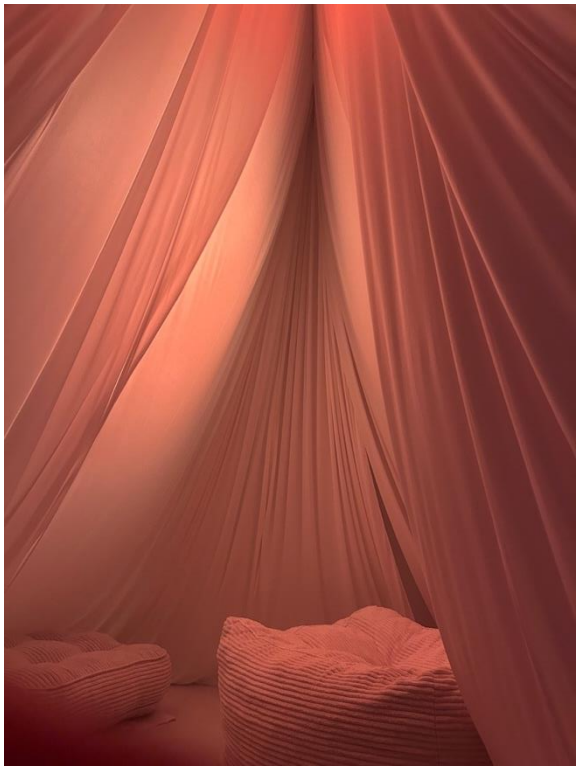


Figure 19. fourth iteration of the installation, (Photography by author, Toronto, February 2026), Dimensions 8ftx12ft.

The monochromic environment allows for the projected lighting to mix with the white materials, creating an opportunity to blur the edges between the different light sources. Blurring the edges of the light enhances the immersion of the space by removing the technical facets of the installation from view. In this way, the installation space is crafted to enable the light and colour in the installation to softly blend to produce what Albers and Turrell describe as a dynamic perceptual shift in the environment. In addition to enhancing embodiment and agency, this spatial displacement affects durational perception.

4.2. Duration and Perception

Light Paint's monochromatic installation space—white fabric and white floor cushions—limits visual stimuli and slows participants' perception of time by reducing sensory input. *Light Paint*, is a time-based installation that ends after 20 minutes of interaction, though as observed in user testing, most participants misjudged the length of their stay. This reveals that participants perception of space and time shifts when architectural elements—which we are accustomed to observing and using to locate ourselves within space— are replaced with a comfortable and soft environment that blurs the boundaries of the space in such a manner that it contributes to the participants' misperception of time.

From this observation, it can be inferred that duration is perceptual. Accordingly, Steve McQueen's views on time can help reinforce the importance of duration within immersive installations. While being known for his filmmaking, McQueen has his roots in the visual arts and photography. As he describes it, art to him is like poetry, whereas film is like a novel in how it incorporates narration.[47] This idea, that art is like poetry and may exist outside of the confines of linear narration, can be linked to how he views the importance of duration in his installation work.

For example, *Bass* is a time-based installation by McQueen that spans a 30,000-square-foot basement with ceiling mounted LED light panels and speakers.[48] By embracing the site of the installation, *Bass* has a sense of grandiosity which wraps the visitors in an auditory-visual spectacle. The installation spans the entire basement of the DIA Beacon in both light and sound, each of which changes at a different pace. The soundtrack lasts 189 minutes while the light lasts around 40minutes, ensuring there is no synchronization between the two.[49]

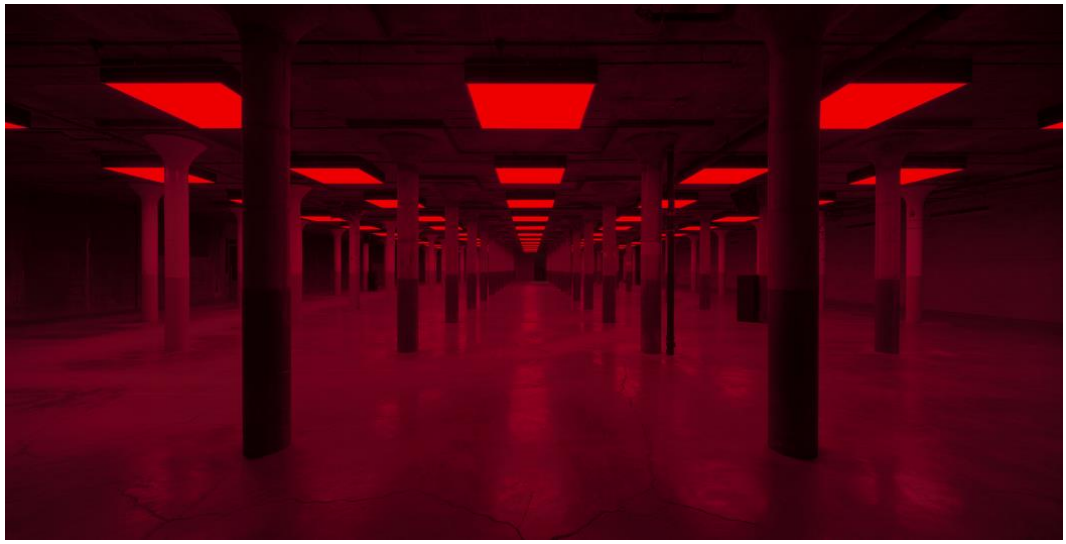


Figure 20. Steve McQueen, *Bass,* Installation view, (Photograph by Bill Jacobson, 2024)

Although *Light Paint* does not have an auditory facet, it does, however, have a set duration of 20 minutes within which participants can choose to explore the space, or stay still and simply observe the lights without interacting. Both *Light Paint* and *Bass* share a minimal aesthetic. This encourages exploration from participants. In addition to linking duration to spatial perception, *Light Paint* incorporates time directly into its behavioral structure by keeping track of how long participants stay within the installation.

Figure 21. *Light Paint,* installation view is minimalist in nature (Photograph by Author, Toronto, March 2026), Dimensions 8ftx12ft.

Light Paint begins in an idle phase but once initiated, the program's internal countdown begins. The longer participants stay within the installation, the more they will see. Stage One of the interaction is purely call-and-response between the light and participants. During this stage, participants are active and engage with the lights and the space (walking around, waving their arms, touching the fabric). This interaction in Stage One will continue until a participant leaves, the time runs out or they choose to sit and relax. Those who choose to sit on the cushions instead of interacting with the space, reach Stage Two where the light mimics the slow flicker and warm glow of firelight, brightening and dimming in a soft, rhythmic tempo that creates a gentle, enveloping atmosphere. During this stage, participants can choose to stay in the space and ponder or engage with the other participants. The installation does eventually end, either when the participants leave, or the interaction completes its pre-determined duration.

As a multi-person experience (three people is the limit due to space constraints and sensor limitations), *Light Paint* also considers that participants may choose to converse with each other and observe the space before indulging in the interactive portion of the installation. When the installation detects there are multiple participants present but have not made significant movement for about 30-60 seconds, it shifts to a pre-programmed sequence of colours and light to create a space ideal for conversation (this is the "fireside sequence"). This results in an experience that is non-interactive, and the changing lights occur at a much slower pace. Once 20 minutes passes, the lights will slowly dim and turn off and envelop the viewer in near-darkness. This is a stark contrast to the bright and dynamic lights that came before and signifies to the participants that the installation has come to an end.

User testing revealed that the participants in *Light Paint* have a distorted idea of how much time has passed while they are in the installation. Of the participants who recorded their time, 78% thought they had spent either more or less time than what transpired. Within this group, 72% also noted how the space affected them, or shifted in appearance and size as time passed.

Participants who recorded the correct time also noted how the space affected them. These participants commented in the REB surveys that duration played a role in their perception of the space. This is noteworthy because it signals that an accurate understanding of the passage of time is not necessary for participants to have an affective experience within the space. What is important is that duration itself is part of the experience.

Some participants noted that *Light Paint* reminded them of their childhood or past experiences. This observation ties into what Steve McQueen describes as participants bringing their past lived experiences to their encounters with a work of art.[50] McQueen sees time as both the duration of the piece itself, and embedded within a viewer's past experiences and lineage.[51] With *Light Paint,* many people interviewed for the REB stated that the structure of the fabric reminded them of forts from their childhood or the slowly changing lights were reminiscent of camp bonfires. Accordingly, this suggests that participants access to their past lived experiences affected how they interacted with and perceived the installation.

4.3. Interactive Light Art

Interactive light art installations can promote social interaction and participation.[52] When participation is involved, viewers become agents of embodiment within the artwork. As a result, their sense of immersion is intensified. Contemporary interactive light art is often executed with the use of LEDs, projection mapping, sensors, and programming. The chart below illustrates five important elements of interactive light installations as they are described in "Interactive Light Art: The Illumination of Art and Technology Merging"[53]

Element	**Definition**	**How it is used in *Light Paint***
LEDs	A common component due to their innate ability to provide dynamic and programmable illumination.	- 3 DMX-controlled LED lights - full control over colour, brightness, and duration - allows direct integration with sensors
Sensors and Interactive Interfaces	Allows for the installation to respond to the presence of the participant(s).	- using a millimeter wave sensor - recognizes human presence and maps near-accurate positional data
Real-time Control and Programming	Allows artists to manipulate and adjust the lighting effects and visual content in response to various inputs or parameters.	- sensor data is processed in real-time through an Arduino R4 Wifi and ESP-32 - processed data is sent to the lights via DMX cables
Integration of Space and Environment	Many interactive light art installations are rooted in site-specificity and can interact and respond to the limitations of the surrounding space.	- white drapery and comfortable and plush pillows - this visual aesthetic encourages participants to slow down and interact with the installation
Viewer Engagement and Participation	The purpose of interactive light art is to encourage viewer engagement and participation, thus blurring the boundary between light and the participant.	- lights in the installation react to the presence, movement, and the duration of the participant's stay to encourage engagement.

Table 1 Five elements of interactive installations and how *Light Paint* uses them.

Contemporary interactive light art is a dynamic and immersive form of art.[54] It utilizes space, sensors, artificial and programmable light, real-time processing, and participant interaction to create unique and ephemeral experiences. Accordingly, *Light Paint* incorporates these five elements listed above to invite users to move around the installation space and to explore the boundaries of sensory experiences as relevant to our perceptions of space and time.

The interaction within *Light Paint* is inspired by Rafael Lozano-Hemmer's numerous artworks that engage participants in an exploration of a biometric interface. For example, in *Pulse Topology* (2021-Present), Lozano-Hemmer and his team designed an installation comprised of numerous filament LED lightbulbs that changed based upon the participation and recorded biometrics of individual viewers. The lightbulbs flash according to each visitors' heartbeat that is recorded when they interact with one of the three interfaces placed within the room. Reaching for the interface is a purposeful act on behalf of the visitor, one they do not have to comply with. In fact, Lozano-Hemmer has expressed interest in both those who interact with the interface, and what happens when no one interacts with the installation.[55]

Figure 22. Rafael Lozano-Hemmer, *Pulse Topology,* (Photograph by Pace Gallery, New York City, United States, 2022).

This is deeply connected with the notion of agency. Participants have a choice whether they want to interact or not. Importantly, the interface in *Light Paint* is hidden whereas in *Pulse Topology* it is explicitly present. The hidden nature of the interface in Light Paint encourages exploration as an interaction dynamic. Participants can interact with the shifting lights through bodily movements and exploration, or they can quietly sit and observe, or they can simply choose to engage with others in the room.

Lozano-Hemmer is also interested in how interactive artworks flip the expectations of art in public spaces. Traditionally, we are accustomed to receiving inspiration from the arts in a museum.[56] There is a subversion of expectation in his interactive installations where "it is the artwork that listens to you [the participant], that senses you, that looks at you, and it is the artwork that is expecting you to do something".[57] This interconnection between the participant and the installation in *Pulse Topology,* inspires *Light Paint* whereby an active conversation and relationship is developed between the interactive lights and participants over the course of the 20 minute experience.

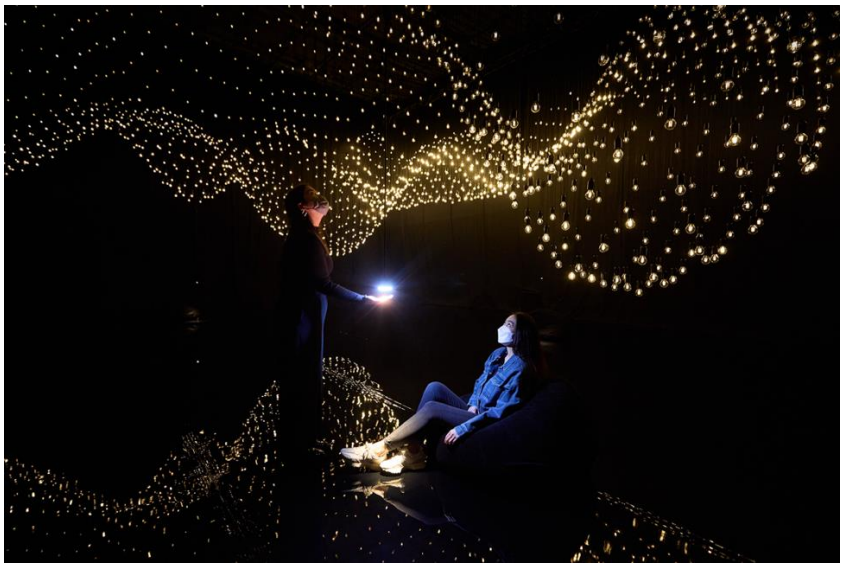


Figure 23. Two participants interacting with the installation space, Rafael Lozano-Hemmer, *Pulse Topology,* (Photograph by West Kowloon Cultural District, Hong Kong, China, 2023)

Though *Light Paint* as an installation only uses the participants' positioning rather than their heartbeat, it still allows the installation to sense and observe the actions of the participants. This means that the installation relies on how participants choose to interact, and whether they interact at all. Accordingly, each participant is likely to experience the installation differently, not just based on personal biases, but also as per their voluntary and agential movements.

Figure 24. Participant interacting with the lights in *Light Paint,* others watching the lights. (Photograph by Author, , Toronto, February 2026), Dimensions 8ftx12ft.

I observed that participants who chose to interact with *Light Paint,* explored the space in a careful and slow manner, likely due to the soft and delicate appearance of the installation and the lack of an obvious interface. This group of participants also expressed a sense of agency within the installation which was not discussed by those who chose to simply observe the space. This is likely due to participants exploration of the work as they tried to understand what made it function. (See Section 5).

5. Methods and Methodologies

Light Paint employs a mixed-methods research approach that combines qualitative and practice-based methodologies: Research-Creation and Iterative Prototyping. As explained by Owen Chapman and Kim Sawchuk in the journal "Research-Creation: Intervention, Analysis and "Family Resemblances"", Research-Creation is a processual method, which works in harmony with the process of cyclical iterative prototyping.[58] While both methodologies focus on the process of creation, Research-Creation focuses on emergent research and iterative prototyping focuses on the physical outcome from the process of prototyping to guide the creation of the installation.

5.1. Research-Creation

Research-Creation is a method of inquiry which integrates the experimental and artistic components of the creative process as an integral part of the study.[59] Two relevant sub-categories within Chapman's breakdown of Research-Creation are "Creation-as-Research" and "Research-from-Creation". The former views the process of creation as grounds for the development of research, while the latter focuses on how the installation itself contributes to the research in the field. Seeing as *Light Paint* explores the perceptual effects of light on colour and architectural space, much of my research derived from the process of creating the installation, the user testing, and the interaction surveys.

Research-Creation allowed me to explore how the installation affected participants' emotions and perceptions over the period of constructing the project. Building and exhibiting various prototypes (iterative prototyping) became a way for me to understand how light can act and respond to user input, revealing theoretical insights through practice.

5.1.1. Creation-as-Research

Creation-as-Research, directly involves projects where creation is a required for the research to emerge.[60] *Light Paint* relies on my development and understanding of the incorporated technologies to facilitate immersion and affect within the installation. To accomplish this, I needed to finalize an exact definition for the abstract topics of my research: light, colour, and affect. Narrowing the definition of these topics has been a lengthy process, as they can encompass a wide array of fields and definitions. Notably, light and colour are studied across numerous fields of study and practices, and choosing to view them through the lens of Iranian architecture greatly informed the integration of affect and perception. Prior to this, in preliminary research, the ephemerality of light and the effect of it on humans was explored through the writings of various light artists and related thinkers. I have been making links between the concept of perception as it relates to light, and the technical and physical aspects of light fixtures through a thorough investigation into the technology and relevant theoretical concepts.

For example, the first light fixture I used was a theatrical Ellipsoidal light which created a circular, spotlight on the ground (See Figure 3). Based upon observation, this light did not create the affective environment required for the installation. While the projected light was striking, I found that constraining the light to a circle pattern on the floor focused the viewer's perception onto the light beam itself and did not draw attention to the potential relationship between the light beam and the room. Based upon my installation tests, I observed that the space *Light Paint* inhabits and creates can be as impactful as the light itself in altering a viewer's perception and overall sense of embodiment.

Figure 25. Prototype 1, Ellipsoidal light created a circular light which did not encompass the room. (Photograph by author, Toronto, September 2025), Dimensions 9ftx14ft.

In addition, controlling the ellipsoidal light with sensors was not possible. From here, I moved to DMX controlled par lights, which not only created a softer light, but are also fully controllable through DMX which is a robust and standardized method of controlling the colour and intensity of light fixtures (See Figure 26). The par lights allowed for a seamless participant to light interaction and filled the entire installation space with colour and light. Making light, colour and space a focus of the installation created a sense of immersion for participants and greatly contributed to the overall affective quality of the experience.

Once the technical aspects were chosen (DMX lights, sensor, microcontroller), the next step was to bring the installation into existence to model a contained and controlled light and human relationship which investigates the effects of light on participants. The research here directly emerged from a process of creation and observation. Creation-as-Research uses prototypal installations to test if the theoretical research is present in the installation.

Figure 26. Prototype 3, DMX-Controlled Par lights allow for the installation space to be completely immersed in colourful light, (Photography by author, Toronto, December 2025), Dimensions 12ftx20ft.

For example, the spotlight used in the early prototypes revealed the ways softened light can have a greater perceptual and affective impact on viewers. Once the light was chosen, it was then revealed that the space itself was hindering affect given it was not encompassing the entire room. To mediate this, I chose to make the room smaller by shaping my own spatial boundaries using fabric. Employing a creation-as-research approach to each installation afforded me the opportunity to make, test and reflect as I moved towards the final installation design.

Figure 27. Prototype 4, The fabric now covers all visible areas of the installation space. (Photograph by Author, Toronto, March 2026), Dimensions 8ftx12ft.

5.1.2. Research-from-Creation

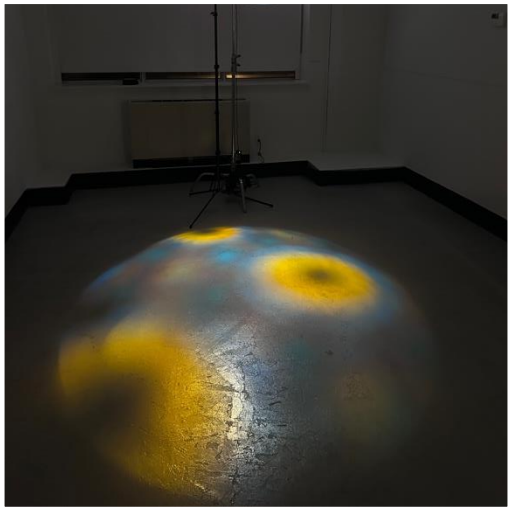
Research-from-Creation renders the installation itself as a form that generates research data to be analyzed.[61] This method ensures that the installation itself can be used to generate research based upon user-responses to design the final form of the installation. For *Light Paint* this took the form of REB approved user testing, as anecdotal input from peers and observations from critiques with professors at OCADU.

Figure 28. Prototype 2, This prototype diffused the edges of the circular light to blend the light into the room, (Photograph by author, Toronto, October 2025), Dimensions 12ftx20ft.

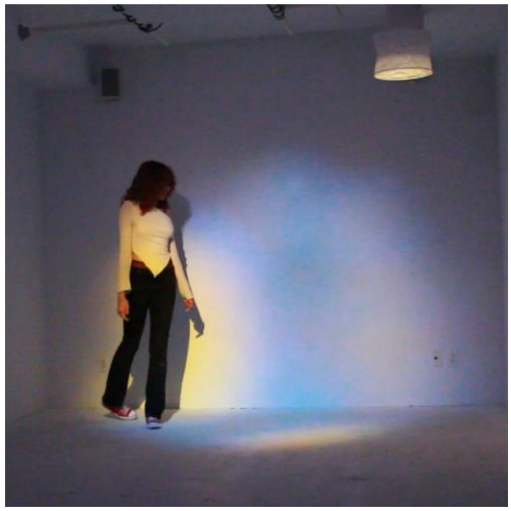
Prototype 2 exemplifies how research evolved through the installation when compared to the future iterations (See Figure 28). When presenting prototype 2, I privileged light and space over interaction in the effort to fabricate a sense of affect in the participants. However, I observed that, while the interaction was entertaining, it did not evoke a sense of relationship between me and the light. From here on, interaction in space came to the forefront of how I looked at affective outcomes of the installation. This is the point where I moved away from the stained glass into

controlling the colours of a light fixture. These colours are still resembling the Iranian colour palette visible in the stained-glass pane but rather allows the participant to directly control what hue will be visible based upon their placement. As visible in the photos below, with each prototype, the light grows more diffused and abstract as the edges of the installation space blur.

Prototype 1 - September 2025



Prototype 2- October 2025



Prototype 3 - December 2025

Prototype 4 - February 2026

Figure 29 Chronological view of all four prototypes. This showcases how the light and the space both blended and became softer as the procss went on, (Photographs by Author, September 2025- March 2026).

5.2. Iterative Prototyping

Iterative Prototyping builds on many fundamental aspects of Research Creation. It is an approach to continuously improving a concept by building on previous prototypes.[62] As a methodology, it helps to develop a system in stages where each test with participants informs the next version. There are five steps to iterative prototyping as explained by Kate Eby, *Light Paint* uses this process closely as illustrated in the table below.

Step	Definition	As applied in *Light Paint*
Planning and Requirements	- mapping out initial requirements - creating a timeline - set expectations	- decide the topic of exploration: material, coding, or user response - choose a date for installation and create a workback schedule
Analysis and Design	- creating the vision for the installation - listing technical requirements and parts	- aesthetic considerations for the room and installation - choose sensors, lights, cables, microcontrollers - acquire fabric, cushions, foam core, tape, etc.

Implementation	- development of the installation	- before installation day:
		  - code the lights based upon sensor readings, and repeatedly debug
		  - measure spaces and order cables and fabrics accordingly
		  - create floor plans for installation day
		- installation day:
		  - set up all aesthetic and technical components
		  - document via photos and videos before testing
		  - fix last minute coding bugs

Testing	- testing both for failures and successes in the installation space - note down the process and outcomes	- test for failures, sensor issues, coding problems, etc. - get insight from peers and advisors - if REB testing: have participants test the piece, then fill out an exit survey
Evaluation and Review	- review notes from testing and implementation stages - compare the iteration with the expectations set in step one. - reset cycle	- review notes and exit surveys, analyze consistent successes and draw backs -determine what went wrong and what worked - analyze if the expectations set in the planning stage were satisfied - decide next steps: what to keep for the next iteration, and what to discard

Table 2 Table displaying five steps of iterative prototyping and how they are implemented in Light Paint

This is a cyclical process where once the prototype is evaluated, it becomes the basis for the next cycle of development.[63] For example, below is a sample diagram for Prototype 2 (See Table 3). This process improves the installation's behaviour and deepens my understanding of how people emotionally and physically respond to light.

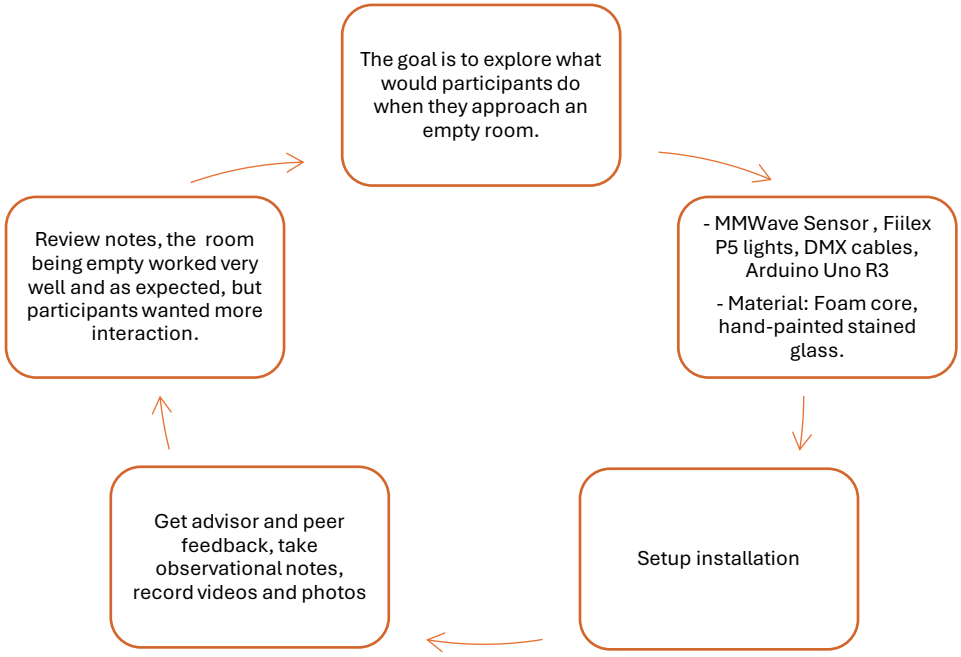


Table 3. Example of one cycle of the iterative prototyping process.

For example, when displaying Prototype 3, I was diffusing the light through fabric but in a contained manner. While the light itself was filling the entire installation space, the fabric was simply hanging from the ceiling. At this stage, the fabric was not disguising the corners of the room, and the architectural features of the space were evident. I found this to be lacking in how effective the installation was in creating a sense of displacement.

Figure 30 Prototype 3, the light travels to evert corner of the room, but the installation does not cover architectural elements. (Photograph by Author, Toronto, December 2025), Dimensions 12ftx20ft.

As such, in Prototype 4, I had draped the entire room with the white fabric in order to create a 'cocoon-like' space where the light and the space of installation appeared indistinguishable from one another. This created a blurring effect that elicited a sense of displacement in the viewer (See Figure 31).

Figure 31. *Light Paint* uses fabric to blur the space. (Photograph by Author, Toronto, March 2026), Dimensions 8ftx12ft.

5.3. Current Iteration

As an interactive and responsive installation, the current version of *Light Paint* aims to offer an interospective place for participants to play in or ponder. The installation takes place in a controlled space where there is fabric draped from ceiling to floor in a canopy-like manner. The floor is entirely covered in similarly soft white material, whereupon three white floor cushions are placed. These cushions are deliberately placed around the edges of the room to leave enough space in the middle for participants to move, play and explore the installation.

Behind the hanging fabric, there are four hidden light fixtures which shine coloured light through the fabric. These lights are all connected using DMX cables which allow the colours and brightness to be remotely controlled. A network of an Arduino Uno R4 Wifi, ESP-32 and a mmWave sensor is used to control these lights. The sensor detects human presence, of up to three participants, and sends this information to the ESP-32 which will then wirelessly relays revised data to the Uno. From here, a microcontroller verifies the data, calculates the colour of the lights,

and sends relative data back via a DMX Master shield to initiate a lighting behaviour.

5.3.1. Behaviour

The behaviour of *Light Paint* is based upon two different modes that are hard coded into the installation: idle/firelight, or interactive:

- Idle or 'firelight': This light pattern is a rotation of various shades of orange, dimming in and out, and moving from one light to another. This is meant to create an effect akin to that of a campfire (See Figure 32).
- Interactive light: As implied by the name, the lights in this stage change upon user interaction. Multiple colours evolve throughout, as explained in greater detail below.

Figure 32. Firelight state of the installation. (Photograph by Author, Toronto, March 2026), Dimensions 8ftx12ft.

By default, when there is no one present in the installations, the lights default to idle/firelight to create an inviting presence which entices potential participants to approach. Upon entering the room, the lights begin to react to the participant, communicating that this is an interactive

installation. This is a critical first step in forming a sense of agency and relationship between the participant and the light. This links to Nguyen's idea of agency as a means to enhance the sense of immersion.

When a participant enters the installation, the software assigns a colour to them that changes depending upon their location in the space. As illustrated in the figure below, when participant 1 is introduced to the space, their assigned colours are yellow, teal, and blue. They can control which colours emerge as they move around the room. In the centre of the room yellow is activated, while at the outer edges blue, with teal emerges as the transitional colour. As for the exact behaviour of the light, when in the centre, only lights 1 and 2 turn on, while if the participant moves into the outer region of the space, the lights shift to 3 and 4.

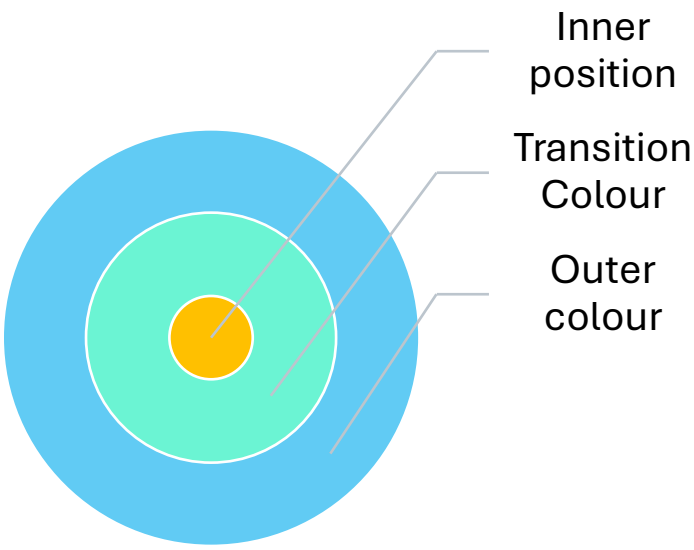


Figure 33. Chart displaying how the interactive lights behave according to positional data of participant 1.

The photos below display how this would look within the space for the first participant. At certain positions, the three colours blend together to create emergent hues. Even though there is no purple in this sequence of lights, when placed next to each other, they appear to be purple.

Figure 34. The dynamic colours as viewed in the space. From left to right: yellow, teal, blue, blend of all three colours (Photography by Author, Toronto, March 2026), Dimensions 8ftx12ft.

Second and third participants are given their colours accordingly: orange, peach, and pink for second participants, and red, orange, and yellow for the third. When more than one participant is detected, each will be dedicated a specific light fixture to control:

- Participant 1 only: all 4 lights
- 2 Participants: Participant 1 (Light 1 and 2), Participant 2 (Lights 3 and 4)
- 3 Participants: Participant 1 (Light 1), Participant 2 (Light 2), Participant 3 (Light 3)

During this stage, participants choose to interact not only with the lights, but with each other. This greatly affects the perceived meaning of the installation. Lastly, when participants choose to abandon the playing area and sit on the floor cushions, all four lights slowly return to the idle/firelight phase. The idle/firelight stage, as evident in user-testing, was very effective in creating the optimal atmosphere for conversation among participants or introspective thinking.

Most users talked about this phase as their favourite and most “comfortable” experience in the installation. Some participants attributed this to the reduced speed of the colour shifts.

Figure 35. Participants experiencing the Firelight Stage. (Photography by Author, Toronto, February 2026).

At any point, if participants choose to actively interact with the installation again, the lights will return to the active stage. When 20 minutes has passed, or all participants leave, the installation ends by dimming to darkness. After a few seconds, it returns to the idle/firelight lighting sequence until more participants walk in. Refer to section 5 for details on my rationale for the duration. In general, the intention behind these durational decisions is based upon the time participant(s) spent in the installation, and the choices they made. These choices affected how the lighting of the installation shifted and revealed new ways of controlling them. This allowed both participant and light to create an emergent relationship.

6. Research Process and Outcomes

Light Paint concerns itself with how lighting, colour, interaction and space affect its participants internally. This affective relationship cannot be assumed as each individual is likely to perceive the changing light differently given personal and cultural biases. Each prototype of this installation explores a potentially different relationship with light and colour from the initial interaction with light, and the subsequent affective and perceptual effects as explored in Section 3. Once a prototype is completed, it will be tested either by me, through feedback from peers and advisors, or REB approved user testing to measure the success of the installation in creating affective embodiment. The effectiveness of the initial interaction can be tested through observation alone as it looks at how participants physically move around the space. The emergent affective and perceptual effects of light, however, involve the analysis of internal thoughts of the participants which are accessible by analyzing the exit surveys.

6.1. Process

The REB testing — as it took place on February 25th, 2026 —involved a simple process of allowing participants to experience the installation in a controlled setting. Participants were recruited through printed posters, social media posts, and word of mouth. Willing participants underwent a screening process prior to registration. The screening was to ensure they were above the age of 18 and aware of the potential risks for those with light sensitivity, epilepsy, or electronic implants (e.g. pacemakers). There was some interest by walk-ins on the day of as well. In this scenario, the screening criteria were read out to them. Once screened, consent forms were signed and collected to ensure all participants were comfortable being filmed and informed of the purpose and use of this research.

As to the process of the installation testing, participants either experienced the installation as individuals or in a group of three. For group experiences, the three individuals were either directed to walk in all at once or take turns. This was to properly measure how agency evolves in the installation based upon the manner of entry. It became evident that the interaction was much clearer when people entered one at a time, although two participants noted that they enjoyed the process of discovering what and who were causing changes in the lights.

In terms of duration, every participant was informed that they were free to leave sooner or later than the requested amount of time as I was also analyzing how long the installation sequence should be based upon these results. It is important to note, however, that at this point, my hypothesized ideal time was fifteen minutes. At the fifteen-minute mark, I announced that they have stayed as long as needed but were welcome to stay longer. Most participants stayed between 10-25 minutes. From this, the final time sequence for the installation was decided to be 20 minutes as discussed in Section 5. After the installation experience was completed, participants were offered a survey to complete which measured how their experience linked to the research topic and questions.

6.2. Survey Questions

Below are the survey questions as administered via a Microsoft form. Each participant received a different survey depending on if the installation was experienced individually or in a group.

Questions for participants who experienced the installation alone:

1. How long did you stay within the installation? Did your engagement with the work change over time? If so, how? Please elaborate. For example: Did you feel that an evolving relationship was formed between you and the interactive lighting?
2. How did the dynamic lighting shifts present in the installation affect your interaction with the light and installation?
3. How did your perception of the space/room evolve (if at all) during your time in the installation?
4. Are there any notable experiences that made you feel more connected to the light and the installation? Please elaborate.

<u>Questions for participants who experienced the installation in a group:</u>

1. How long did you stay within the installation? Did your engagement with the work change over time? If so, how? Please elaborate. For example: Did you feel that an evolving relationship was formed between you, the interactive lighting and the other participants?
2. How did the dynamic lighting shifts present in the installation affect your interaction with the light and other participants?
3. How did your perception of the space/room evolve (if at all) during your time in the installation?
4. Are there any notable shared experiences that made you feel more connected to the participants in the installation, the lights, or both? Please elaborate.

6.3. Observation and Survey Results

The outcome of the REB testing, as measured through observational notes and survey responses, clarified if the installation answered the research questions explored in this paper. While my observational notes could commonly note installation interaction failures or common topics of conversation and behaviour, it fell short in regard to elucidating internal thought. To mediate this, each survey question was aimed directly at one or more of the relevant concepts such as agency, affect, interaction, perceptual space and duration. Below is a list of each question with the most common responses. Each question is broken down into multiple sections as they target multiple aspects of *Light Paint.*

Q1: Length of Stay, Engagement with the installation over time.

An overwhelming number of people misjudged how long they stayed in the installation as compared to the time I recorded. From 17 responses, only 3 accurately guessed the time spent . On average, participants stayed in the installation between 15 and 20 minutes. The shortest time, as noted in a survey response, however, was 3 minutes and the longest, 30 minutes. The most commonly estimated times were 10 minutes and 25 minutes, which were generally closer to the actual time spent in the installation space. This observation proves that the installation, whether in its spatial architecture, lighting design, or both, affects the perception of the passage of time.

Q1: Engagement with the installation over time.

The evolution of participants' engagement with the piece throughout the length of their stay was mainly linked to their efforts into understanding the behaviour of the lights. Most participants noted that they began by exploring the patterns of the light, by attempting to cause light changes via movement, touching physical elements in the space, or the sound of their speech. Eventually, they would sit, and slow down to observe the subtle light changes of the firelight sequence.

In contrast, some participants noted that they chose to sit down immediately upon entering the space. Some stayed seated the entire time, while others got up to walk around halfway through the installation to see how it would change. Notably, some participants pointed out that they enjoyed their experience better once the rest of their group had left. Others, however, really emphasized that they preferred the team effort of pattern finding as they could try multiple poses to see how it would change the light in the space.

Q2: Effects of dynamic lighting on interaction with the space and lights

Participants primarily noted that the dynamic lighting greatly contributed to their exploration of the installation through movement. This exploration, done by walking around the space, or trying all the seating options, or moving their arms, served to find out what movements caused visible changes in the lights. Out of the seven people who experienced the installation alone, two noted that the light made them feel calm which inclined them to sit and relax.

Q2: Effects of dynamic lighting on interaction with other participants

While some group responses wrote about spatial exploration, the most common sentiment recorded was how the light affected their interaction with other participants. This occurred in numerous ways; however, it influenced their topics of conversation, or how the shared effort of making the installation change impacted their choices and movements. Similar to individuals, some participants noted that the lights made them feel calm. Additionally, one person noted how the colours of the light affected a change in their colour perception of their sweater.

Q3: Perception of Space/Room

Most responses referred to the space feeling “comfortable” or “safe”. Some attributed this comfort to the material aspects of the space — the fabric, cushions, small scale—while others attributed it to the evolving light sequence. Several answers noted that this sense of comfort made them introspective, while others remarked on how this inclined them to move around to discover the physical space. Participants explored various positions such as standing, sitting, or lying down to experience the space from various perspectives.

Spatial perception was also brought up in that their sense of the space changed the longer they stayed in the installation — either in size, comfort, or both. As participants spent more time in the installation, the more their perceptual understanding of the spatial characteristics of the space changed.

Q4: Notable Experiences

While I recorded a wide range of memorable moments, I observed that those who experienced the installation as individuals had much less to say, while those who experienced it in groups wrote comparatively lengthy answers. The individuals' answers focused on the comfort they experienced from the transitions in the lights and colours, or if the installation reminded them of another comfortable space (e.g. a tent, bedroom, etc.)

The group responses were more varied, though generally focused on moments shared among participants. Most notably, these moments often related to emergent conversation topics or how the participants mutually affected each other via their movements and choices. For example, if one chose to sit/stand others were likely to follow. A few participants pointed out the silence in the room, leading them to observe the sound of their peers' breath or noticing that they were whispering even though there were no instructions given to be quiet. Lastly, numerous answers discussed their favourite colours, particular colour shifts, and the softness of the fabric.

6.4. Outcome

Some outcomes were as I had predicted — such as the success of the spatial perception on affect— while other findings were unexpected. These unexpected outcomes were either related to the emergent conversations among participants about the space or their personal connections to the lights. In contrast, some outcomes related to system failures regarding the lights and interaction. Let's begin with the simple aspect of what worked predictably. This testing very directly answered my query if and how interactive light and colour systems dynamically alter one's spatial perception of the installation room. As for the construction of the room via draped fabric, many compared it to the feeling of going camping, or playing in a childhood fort. The word "comfortable" was the most repeated word that appeared in both my observation notes and survey answers.

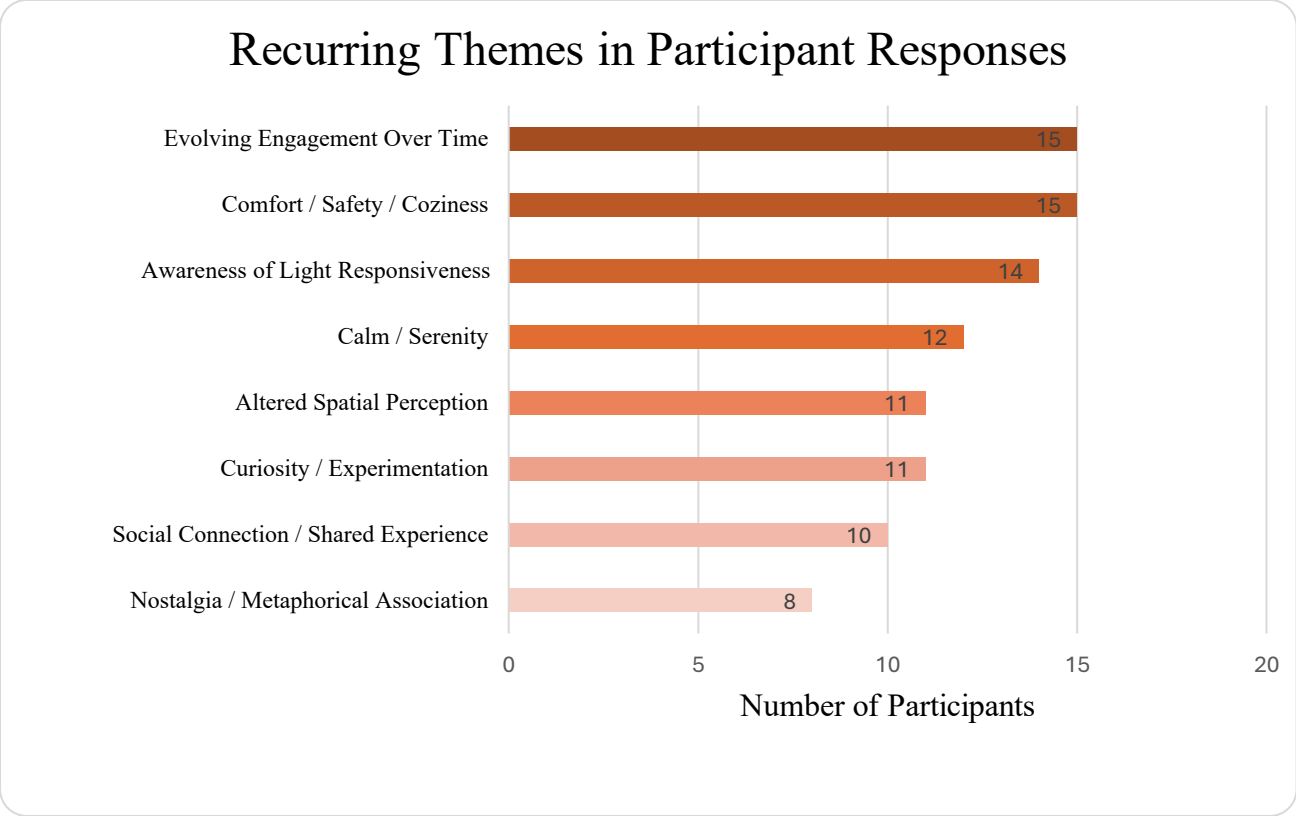


Table 4. Recurring Themes in Participant Responses

Additionally, it was especially the colour of the lights that altered how different participants experienced the space. Each participant, often immediately after they exited, would express which colour was their favourite and why. The most common colours that were noted were the orange of the "firelight" effect, as well as the shade of blue initiated by the first participant's entrance. The orange colour was associated with feeling "warm", comfortable, sunsets, and on one occasion was compared to the feeling of reading a book under the blankets as a child. The blue, in contrast, was related to a sense of peace and the colour of "glaciers". The participants who noted blue as their favourite, claimed it reminded them of the ideas of calmness, coolness and stillness. Undeniably, warmth and cold are paradoxical in their inherent definitions, yet both groups claimed a sense of comfort from their preferred colour. This finding links directly to our personal perceptions and associations with colours. This could be an indicator of how personal relationships with colours, prior to entering the installation, allow for multiple perceptions of the space to emerge.

Through the process of note-taking and reviewing the results of the surveys, it was further revealed how the installation was not yet successful in communicating interaction and agency. I have concluded that this issue primarily related to the physical layout of the installation itself and sensor and coding failures. I found the installation felt most agential when interactions werfe simple and easily understood. By reducing the complexity of the interactions, the lights appeared more responsive as the changes were easily noticeable. As for the physical layout, the space was too small for participants to comfortably move and explore the space. This resulted in some participants claiming that the space was difficult to traverse and they chose to sit on the cushions instead.

7. Conclusion and Future Work

7.1. Conceptual Findings

Light Paint is a project that began as a simple curiosity about the potential relationships that can occur between humans, light and, colour within an interactive installation. In the age of artificial light, we still associate its properties with safety, warmth and comfort. We have crafted light we can carry in our pockets, that offers little warmth and can be controlled to be nearly any colour. *Light Paint* is an exploration of what can be done with artificial light and how an interactive installation might reveal our relationship with it. My experiments started quite simple: make a light react to a person based on their presence and observe its effects. Throughout this process, my previous knowledge of light was challenged, and my understanding of the perception of light, colour, and space took on greater importance. While previously I viewed light as a narrative device in filmmaking, I have shifted my focus to understanding light as an element that can immerse participants in an interactive experience.

Three research questions were crafted as follows. How does responsive lighting foster an evolving, interactive relationship between participants, light and colour in space? How does the predetermined duration of an interactive installation affect participants' sense of agency? And, how can interactive light and colour systems dynamically alter our spatial perception in immersive and interactive installations?

As previously laid out in detail, these questions were explored through a Research-Creation process alongside my reflections gleaned from REB testing. Responsive lighting fosters an evolving relationship between participants in an installation space by encouraging agential movements. It can guide people to move around space or stay still. It can encourage participants

to talk to other participants or to experience the installation in silence. Participants described the interactive as rewarding, with some pointing to how it started a conversation between them and others in the space.

Once viewers chose to stay and interact with the installation, a pre-determined durational sequence of 20 minutes was initiated. The interaction pattern, in its simplicity, encouraged participants to initiate their agency by exploring the space and playing with the lights. In this way, the pre-determined duration fostered a sense of play and agency and signified the importance of duration in enabling the effectiveness of interactive installations.

To conclude my discussion of the research questions, I have noted that interactive light and colour systems dynamically alter our spatial perception by inviting participants to explore the space. *Light Paint* takes place in a small, minimalist installation space. I observed that many viewers claimed that the space was smaller than anticipated upon entering the installation. However, the space grew perceptually larger the longer they stayed within the installation. In addition, participants associated the space with a specific range of meanings based upon the colours present.

Based on my history as a lighting designer for film, I initially viewed the interactions in *Light Paint* in a linear, and almost scripted manner. Events within the installation were carefully planned to happen in only one specific order. I soon learned that I find interaction more meaningful when agency is present and when participants' choices matter. I also observed that when participants practice curiosity in the installation space, a spiritual connection emerges. This curiosity lends itself to non-linear narratives. The interaction in the installation is now non-linear and cyclical which even allows viewers to not interact at all while still being immersed in the space

and the lights. For me, these diverse outcomes are outside of my direct control and are made possible because the conditions that determine the structure of the installation encourage a participant's sense of agency. As Steve McQueen says, film is a novel and art is poetry.[64] I now see that *Light Paint* began as a novel and ended as a poem.

7.2. Next Steps

This project began as a simple fascination with light and what can be done with it. In the beginning stages, I was both driven and limited by my knowledge of lighting for film and television. After having spent numerous months crafting *Light Paint,* I now find myself questioning how space can affect light, rather than the reverse. I wish to create other offshoots of this project and explore how other spatial configurations change interaction with, and perception of, the lights. Most notably, I am interested in what happens if the installation takes place in a narrow corridor with a maze of light and fabric to walk through. Or what happens if the room reflects the lights through mirrors as opposed to diffusing the light beams through fabric? By opening myself up to new investigation of space, *Light Paint* can be realized as a site-specific project.

Future iterations of the installation will have a deeper focus on spatial perception as it relates to light and colour. Interestingly, as I continued to work on *Light Paint*, I found myself looking deeper into perception as an active element within installation practice. To know that two people can walk away from an installation with drastically different experiences has completely shifted how I approach my own work. It is exciting — and slightly nerve-wracking— that I cannot predict the associations that emerge from my installations; the experience of *Light Paint* is in the eyes of its beholders.

Light Paint has re-ignited my philosophical and spiritual fascination with perception and agency. We all view the world differently; not only do we see through different eyes, but we also see through different minds and hearts. I no longer see light in terms of how it can transform narrative, but also how it affects colour, space, and even time.

8. Glossary

Affect

A pre-conscious embodied entity that emerges through the relationships between bodies, space, and stimuli.[65] In *Light Paint,* affect describes the sensory and emotional charge produced through participants' encounters with responsive light, colour, space, and other participants.

Agency

The participant's capacity to make meaningful choices and act voluntarily within the installation.[66] In *Light Paint,* agency emerges when participants choose how to move, respond to the lights, engage with other participants, or remain still.

Embodiment

The lived, bodily experience of sensing and relating to the installation through movement, perception, and the installation space.

Duration

The designed experience of time within the installation. In *Light Paint,* duration refers both to the work's pre-determined 20-minute structure and to the participant's shifting perception of time as they move through an immersive and light-responsive environment.

Immersion

A heightened state of sensory and perceptual involvement in which participants become absorbed into the installation environment. [67]

Interactivity

The capacity of the installation to respond to participant presence and movement within a specific duration and in real-time.[68]

Perception

The dynamic and subjective process through which participants sense, interpret, and make meaning from light, colour, space, and time.[69]

Note

[1] Papadopoulos and Moyes, *The Oxford Handbook of Light in Archaeology,* 19-20.
[2] Papadopoulos and Moyes, *The Oxford Handbook of Light in Archaeology,* 737.
[3] Deleuze et al., *A Thousand Plateaus : Capitalism and Schizophrenia,* 111.
[4] Hakimi, "Light Art and Profiles of Renowned Light Artists."
[5] Best, *Colour Design: Theories and Applications,* 3.
[6] Papadopoulos and Moyes, *The Oxford Handbook of Light in Archaeology,* 1.
[7] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 25.
[8] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 27-28.
[9] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 27.
[10] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 32-33.
[11] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 30.
[12] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 30-31.
[13] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 31.
[14] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 32-33.
[15] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 30-34.
[16] Albers, *Interaction of Color,* 1.
[17] Best, *Colour Design: Theories and Applications,* 4.
[18] Albers, *Interaction of Color,* 3.
[19] Best, *Colour Design: Theories and Applications,* 7-8.
[20] Best, *Colour Design: Theories and Applications,* 3-4.
[21] Best, *Colour Design: Theories and Applications,* 582.
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[23] Jalāl al-Dīn Rūmī and Whinfield, *Masnavi i Ma'navi,* 23.
[24] Albers, *Interaction of Color,* 8-9.
[25] Albers, *Interaction of Color,* 8-9.
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[27] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 34.
[28] Ahani, "Natural Light in Traditional Architecture of Iran: Lessons to Remember", 27.
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[30] Jacquet, "The Exclusive Interview with James Turrell, Star of Contemporary Art Exhibited in Paris."
[31] "James Turrell: You Who Look | Art + Film."
[32] "James Turrell: You Who Look | Art + Film."
[33] Massumi, *Parables for the Virtual: Movement, Affect, Sensation,* XXX.
[34] Massumi, *Parables for the Virtual: Movement, Affect, Sensation,* XLIV.
[35] Massumi, *Parables for the Virtual: Movement, Affect, Sensation,* XL.
[36] Massumi, *Parables for the Virtual: Movement, Affect, Sensation*, XXXIX.
[37] Massumi, *Parables for the Virtual: Movement, Affect, Sensation,* 139-142.
[38] Massumi, *Parables for the Virtual: Movement, Affect, Sensation,* 139.
[39] Massumi, *Parables for the Virtual: Movement, Affect, Sensation,* 139-140.
[40] Nguyen, *Games: Agency as Art,* 17-19.
[41] Fischer et al., "Play."
[42] Eliasson, *Playing with Space and Light*.
[43] *Olafur Eliasson about "Light Is Life."*
[44] Eliasson, *Playing with Space and Light*.
[45] designboom, "Olafur Eliasson's 'breathing Earth Sphere' Installation in South Korea."
[46] designboom, "Olafur Eliasson's 'breathing Earth Sphere' Installation in South Korea."
[47] *Inside Oscar-Winning Filmmaker Steve McQueen's New Immersive Art Exhibit*.
[48] Werder, "Steve McQueen 'Bass' Dia:Beacon / New York."
[49] Werder, "Steve McQueen 'Bass' Dia:Beacon / New York."

[50] *A Conversation with Steve McQueen and Donna de Salvo*.
[51] *A Conversation with Steve McQueen and Donna de Salvo*.
[52] Jirawat Sookkaew et al., "Interactive Light Art and Human–Computer Interaction Principles", 319.
[53] Jirawat Sookkaew et al., "Interactive Light Art and Human–Computer Interaction Principles", 311-312.
[54] Jirawat Sookkaew et al., "Interactive Light Art and Human–Computer Interaction Principles", 312.
[55] *Artist Talk | Rafael Lozano-Hemmer*.
[56] Pritchett, "Pulse Topology: A Conversation with Artist Rafael Lozano-Hemmer."
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[58] Chapman, "Research-Creation: Intervention, Analysis and 'Family Resemblances'", 11.
[59] Chapman, "Research-Creation: Intervention, Analysis and 'Family Resemblances'", 6.
[60] Chapman, "Research-Creation: Intervention, Analysis and 'Family Resemblances'", 19.
[61] Chapman, "Research-Creation: Intervention, Analysis and 'Family Resemblances'", 16.
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[65] Massumi, *Parables for the Virtual: Movement, Affect, Sensation*.
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9. Appendices

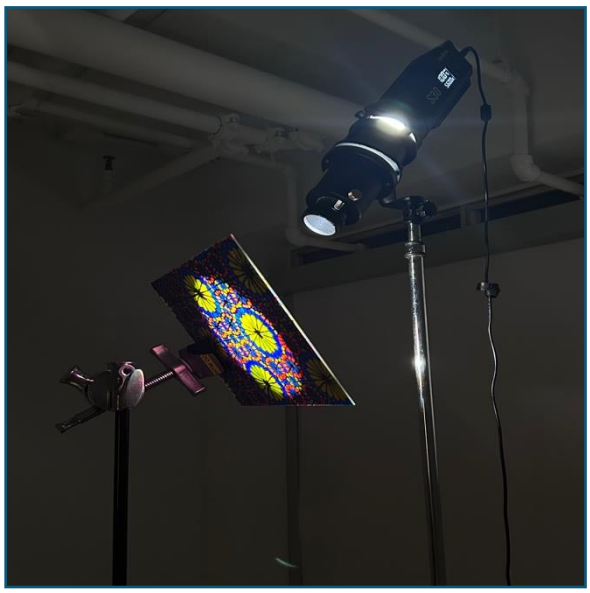
Appendix A: Prototype 1, September 2025, Toronto, 9ftx14ft

The first prototype for *Light Paint* (September 2025) was done by shining a spotlight through a glass-pane I had painted. In theatrical lighting, Source4 or Ellipsoidal light fixtures allow lighting designers to project and modify spotlights to portray images without the use of projectors. A spotlight can easily be shaped using modifiers such as coloured gels, lenses, and GOBOs.

By combining the ellipsoidal light with an Orosi stained-glass pattern, I created a kaleidoscope light that was inspired by Olafur Eliasson's *Breathing Earth Sphere*. I painted the traditional Iranian geometric patterns on an acrylic board, then put a light behind it. The stained glass functions as both a gel —by altering the colour of the light—and a Gobo by creating ornamental shadows.

This installation prototype was non-interactive at this stage becasue the primary focus was how contained light can affect space. My observations from this prototype revealed that interactivity should be an integral part of the installation going forward. However, the spotlight being used did not have a streamlined way of being controlled through a sensor so I moved on to working with a different light source (a par light).

Spotlight Fixture and Stained glass pane



Installation version with light shun into the corner of the room

Installation version with light pointed to the ground

Figure 36. Three photos displaying Prototype 1. In order from top left to bottom: Gobo and light, light illuminating the wall, light illuminating the ground. (Photography by Author, Toronto, September 2026)

Appendix B: Prototype 2, October 2025, Toronto, 12ftx20ft

The second prototype moved into an interactive mode. To do this, I used a sensor and an Arduino Uno R3 paired with a DMX Master Shield to send DMX-512 signals to the light. The DMX512 controller is standard in the lighting industry, and is a very reliable method of controlling lights. This system is often used in theatre, concert venues and on television productions. However, it does not inherently connect to any micro-chip controllers such as Arduino or Raspberry Pi. A DMX Master Shield is a reliable method of sending DMX512 signals from Arduino to light fixtures. This process omits the needs of a DMX board and directly connects to the Arduino to control light. In order to achieve this, I had to briefly divert from using an ellipsoidal light to standard LED fresnel lights by the brand name Fiilex P3 as these lights offered built-in DMX compatibility and have a complete RGBW spectrum. This light would not create a spotlight effect however and required shaping to create a diffused circle.

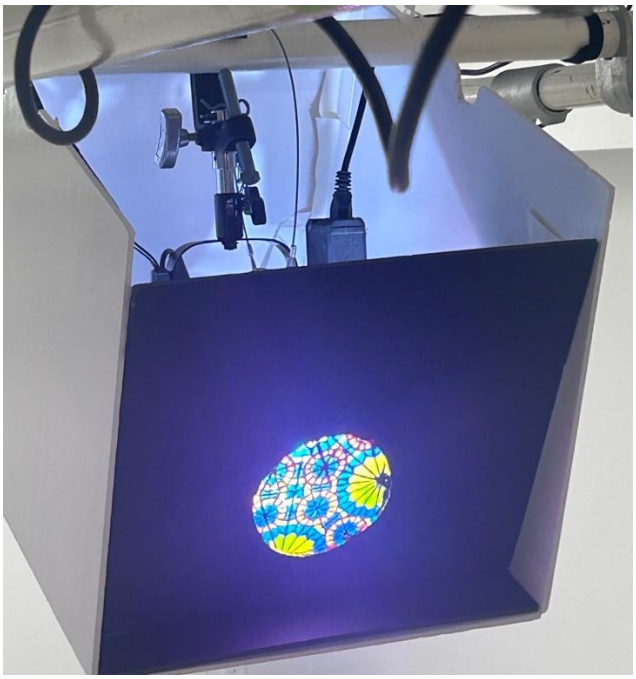


Figure 37. Stained Glass Shaped into a circular shape, (Figure by Author, Toronto, October 2025)

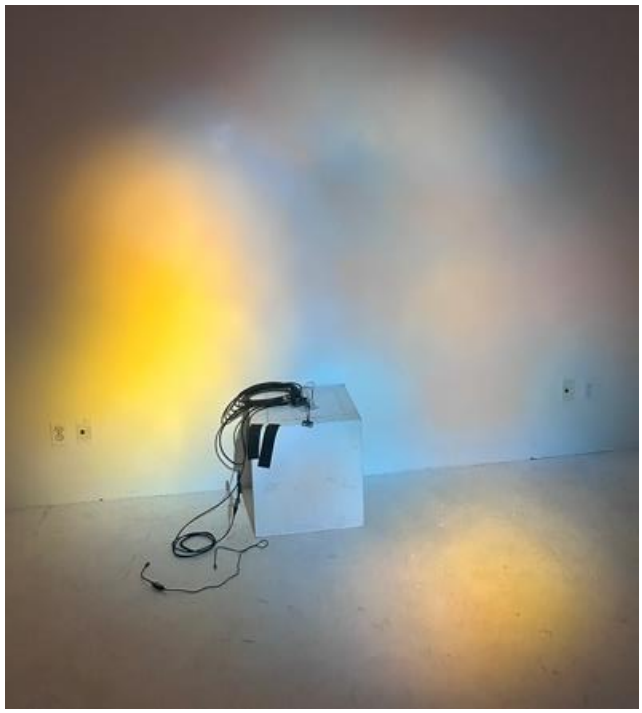


Figure 38. The effects of shaping the light manually, the circle has blurred edges and the lines of the stained glass are not visible, (Figure by Author, Toronto, October 2025)

I tested a few sensors during the prototyping process beginning with the HC-SR04 ultrasonic sensor. This is quite a simple sensor that uses ultrasonic technology to estimate the distance of objects within a 4-meter radius. This sensor did work but posed many questions about what form the installation could take. Given its short range and low accuracy, it limited the interactivity of installation to be rather binary. For example, as a participant gets closer to the line directly in front of the sensor, the light dims up and respectively dims down when the distance is increased. Another question I needed to answer was whether I wanted participants to know where the sensor was placed. This type of sensor cannot be covered or disguised, meaning that participants could locate it with minimal effort. This would lead to a different type of interaction with the installation as it reduces the illusion of the light being an agent on its own.

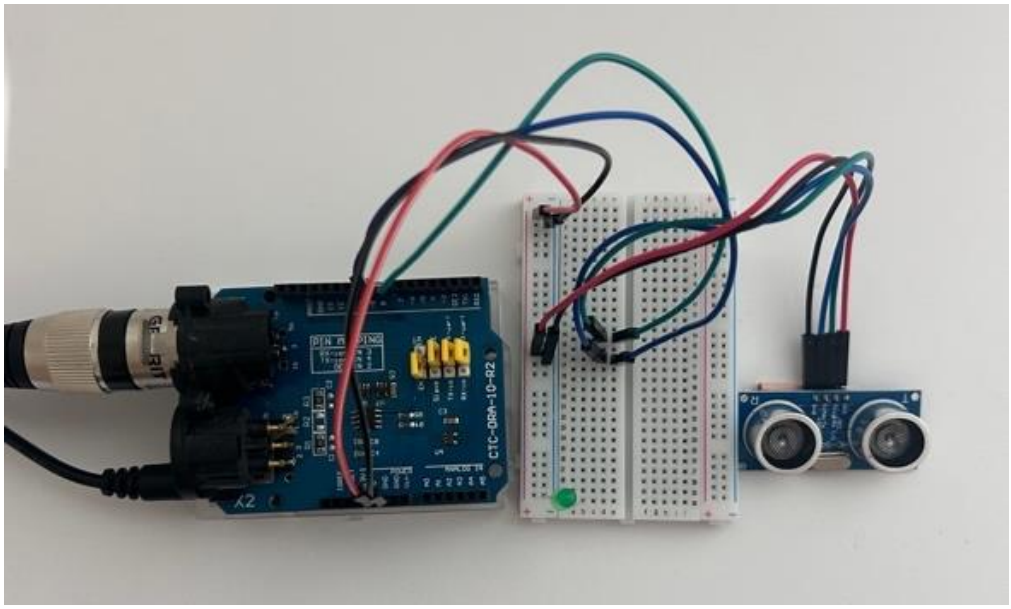


Figure 39. Circuit for HC-SR02, (Figure by Author, Toronto, October 2025)

The second sensor tested was the mmWave sensor, which can detect a drastically wider range of motion than the ultrasonic. The mmWave sensor uses more complex technology than the ultrasonic sensor. While it can detect human presence, it also can disregard non-human and non-metal objects. This technology would allow the sensor to be completely hidden behind other materials (a feature I desired because I wanted the sensor to be hidden from view). Lastly, the mmWave sensor is far more accurate in its measurements and with some additional coding can compile near-exact measurements down to the centimeter. This was the sensor that was tested during a gallery show for Spark, a collective exhibition for Digital Futures graduate students that was held in November 2025.

Figure 40. Gallery Installation of Spark Prototype, Sensor is hidden behind a white board. (Figure by Author, Toronto, October 2025)

Based upon the results of this prototype, I realized that the installation could inspire social interactions among multiple participants. In addition, I observed that viewers were seeking to gamify the installation. Going forward, I made the decision to focus on creating a protype for multiple participants with interactions that were staged and more complex.

Appendix C: Prototype 3, December 2025, Toronto, 12ftx20ft

The third prototype took a large leap both in interaction and aesthetics compared to the previous iterations. To accommodate multiple participants, I changed the sensor to an RD03D mmWave sensor which is capable of tracking three targets at once while extracting exact positional data in real-time. The lights too, evolved into two DJ DMX-controlled lights that allow for a full RGBW control and have a softer light beam than the Fiilex. This softness allowed these lights to easily cover the installation space in an even wash of colour.

Figure 41 Prototype 3, DMX-Controlled Par lights allow for the installation space to be completely immersed in colourful light, (Figure by author, Toronto, December 2025).

Aesthetically, this prototype began by diffusing these lights through fabric to both hide the fixtures, and to further blend the colours. A large piece of cotton fabric was hung from the ceiling of the room, where upon approaching it, the lights would react based upon a participant's position. This prototype was exhibited in OCAD's Open Show in December 2025.

Figure 42. Participant looking up at the installation and interacting with the fabric. The lights change from yellow to blue accordingly. (Figure by Author, Toronto, December 2025), Dimensions 12ftx20ft.

Diffusing the lights behind the fabric, greatly shifted how I felt the lights were reacting in relation to my actions. The softness of the lights behind the fabric created a desire to reach out and touch the hanging fabric, which inspired me to explore using draped textiles in the next prototype.

Appendix D: Prototype 4, February 2026, Toronto, 8ftx12ft.

With prototype 4, I chose to cover the entire room in fabric and add cushions that invited participants to sit and linger in the space. This prototype was used for REB user testing.

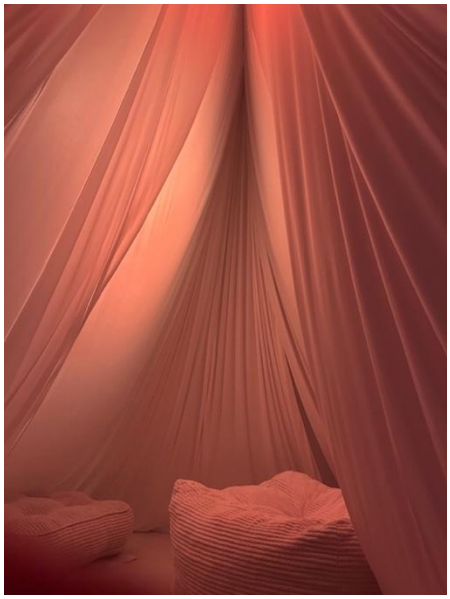


Figure 43. fourth iteration of the installation, (Figure by author, February 2026).

This prototype used three lights — upgraded to four for the final version — that reacted based upon user's positional data. The intent of this layout was to displace the viewer by creating an immersive space to walk into. The small space guided viewers to whisper, walk around slowly, and approach the fabric gently even though they were not given specific instructions. I observed that by creating a shared experience, participants were more inclined to interact with each other which resulted in new emerging perceptions of the space. This is the last prototype in this series, which most closely resembles the final installation. Minor changes were made to the interaction, which primarily included simplifying the code to make the installation feel more reactive. Finally, the installation at the waterfront (DFX Exhibition space) is larger than any of the spaces used for testing at OCAD's main campus. This allows for more walking space and encourages viewers to roam around freely.

Appendix *E: REB Questionnaire*

m pertains to the installation you had just experienced. Please answer the questions in as much detail as you can. There ar
ns in this survey.
d duration: 5-15 minutes

l

al Information

w information will only be reviewed by me (the student researcher) and thesis advisors.
sonal information is only to verify your participation. They will be separated and discarded from your answers during the rese

is your name? *

4. How long did you stay within the installation? Did your engagement with the work change over time? If so, how? Please elaborate. For example: Did you feel that an evolving relationship was formed between you and the interactive lighting? *

5. How did the dynamic lighting shifts present in the installation affect your interaction with the light and installation? *

8. How long did you stay within the installation? Did your engagement with the work change over time? If so, how? Please elaborate. For example: Did you feel that an evolving relationship was formed between you, the interactive lighting and the other participants? *

9. How did the dynamic lighting shifts present in the installation affect your interaction with the light and other participants? *

10. How did your perception of the space/room evolve (if at all) during your time in the installation? *

Appendix *F: REB Poster*

Appendix *G: REB Consent Form*

Light Paint Consent Form

Date:
Project Title: Light Paint

Student Investigator:
Assal Toudehfallah
OCAD University
assaltoudehfallah@ocadu.ca

Faculty Supervisor
Simone Jones
Faculty of Arts & Science
OCAD University
sjones@ocadu.ca

PURPOSE

Light Paint is an exploration into the mobility and reactivity of light. It is a creative graduate research project that explores how people and light can interact together. The purpose of this study is to learn how these kinds of interactive experiences dynamically affect spatial and emotional perception of immersive environments.

WHAT'S INVOLVED

As a participant, you will be asked to experience the installation in a gallery space, and then complete a short survey and/or interview about your impressions and feelings. Your participation will be videographed for future reviewing purposes.

Participation will take approximately 45-60 minutes hour of your time.

POTENTIAL BENEFITS

Possible benefits of participation include contributing to new knowledge in interactive art and human–computer interaction as well as enjoying a relaxing sensory experience.

POTENTIAL RISKS

There also may be risks associated with participation such as mild eye strain or light sensitivity. To mitigate this, you may leave the installation at any time if you feel discomfort.

CONFIDENTIALITY

The installation and the interview portion will be recorded and only listened to by the student researcher and faculty supervisor for analysis. The data will be stored on a password-protected hard-drive and will be kept for two months after the completion of the thesis project after which time it will be permanently deleted.

☐ I agree to be [audio-/video-recorded] for the purposes of this study. I understand how these recordings will be stored and destroyed.

☐ I do not agree to be recorded for the purposes of this study.

The findings from the video recordings may also be used in the published paper. You may withdraw from the study at any point later in time, refer to "voluntary participation" below. If your video and/or data is to be used in documentation, the used portion cannot be deleted once analyzed, though raw data will be destroyed as mentioned above.

☐ I agree for the above mentioned [audio-/video-] recordings to be used in documentation. I understand how these recordings will be used.

☐ I do not agree for the recordings of me to be used for documentation purposes.

VOLUNTARY PARTICIPATION
Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. You may further decide to withdraw from this study at any time, or request withdrawal of your data prior to data analysis.

To withdraw yourself or your data from this study, let the researcher know by the email provided at the top of this form or inform them verbally during the study.

PUBLICATION OF RESULTS
Results of this study may be published in reports, professional and scholarly journals, students' theses, or presentations to conferences. In any publication, data will be presented in aggregate forms. Quotations from interviews or surveys will not be attributed to you without your permission.

Feedback about this study will be available if you contact the researcher by email provided at the beginning of the consent form. The final report is expected to be available in 2 months.

If you would like to get the final report of the project when it is available, please check the box below and provide your email address accordingly.

☐ *Yes, I would like to get the final report of the project. You may reach me by:*
Email:

CONTACT INFORMATION AND ETHICS CLEARANCE
If you have any questions about this study or require further information, please ask. If you have questions later about the research, you may contact the Principal Investigator Assal Toudehfallah or the Faculty Supervisor Simone Jones using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at OCAD University [insert REB approval #].

If you have questions regarding your rights as a participant in this study, please contact:
Research Ethics Board c/o Office of the Vice President, Research and Innovation
OCAD University
100 McCaul Street
Toronto, M5T1W1
416 977 6000 x4368
research@ocadu.ca

AGREEMENT
I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name: _____

Signature: _____ Date: _____

Thank you for your assistance in this project. Please keep a copy of this form for your records.

Appendix H: Defence Presentation

Figure 44. Slide 1 of Defence Presentation, by Author, April 2026.

Title page

Hi, I'm Assal Toudehfallah. I come from a film production background, where I work primarily as a lighting technician. So I'm always thinking about how lighting shapes narrative—both literally and emotionally.

The more I used light as my primary material, the more I observed that there is an inherent relationship between us and light—but also that this relationship could be made more active, more responsive, and more experiential.

This is where Light Paint was born, to see how light (which is inherently immaterial) can be harnessed as a material that can create an emotional response in the absence of an explicit narrative.

Light Paint, is an interactive installation that investigates the mobility and reactivity of light in relation to human presence.

Figure 45. Slide 2 of Defence Presentation, by Author, April 2026.

What is light paint

On slide: video of installation

Light Paint uses responsive light and colour to shape how participants perceive space and each other. It also draws from my Iranian heritage and the spiritual spaces I grew up with.

Through this project, I explored how variables such as architecture, culture, and even personal biases inform our perception of light and colour.

In addition, rather than treating light as passive, the installation positions it as an active presence—something participants can form a relationship with.

Figure 46. Slide 3 of Defence Presentation, by Author, April 2026.

Cont'd

On slide: showcase various colours of light on the same colour shirt

Now this was important to me as I was initially fascinated with how we all perceive light and colours differently and wanted to explore what I can do with this unreliable perception in an installation setting. As you can see here, the same colour appears visually different under different colours of light.

In tandem, having grown up around traditional Iranian architecture, I have an understanding of how light can be used to create a metaphorical and spiritual feeling to a space. I have also found myself applying similar notions to my lighting design in order create an emotional or occasionally bodily response in the viewers to drive a narrative forward.

As such, Light Paint conjoins these facets to use non-narrative lighting design in an interactive installation to explore the potential of creating an emotional response in viewers. As well as, to see how I can craft an installation that challenges the notions of perception as it relates to light and colour.

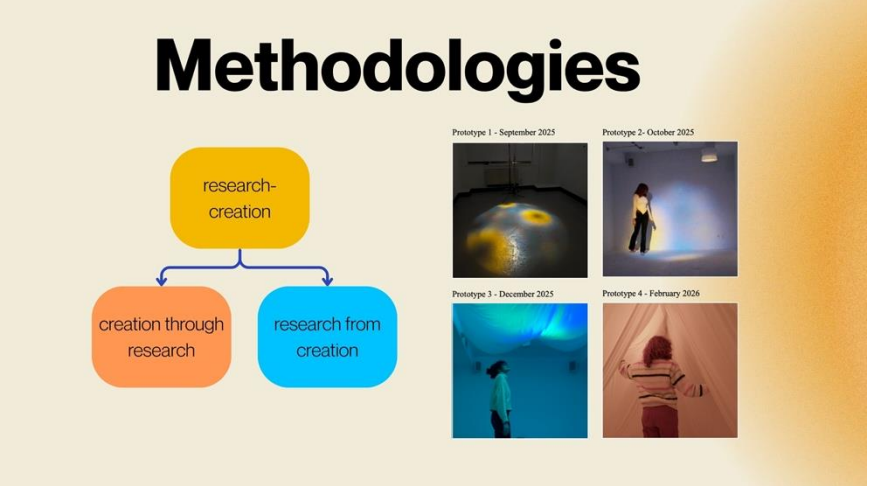


Figure 47. Slide 4 of Defence Presentation, by Author, April 2026.

Methodologies

On slide: research creation graph and iterative prototype photos

To approach this, I began to study light and colour in numerous practices – including theatre, archaeology, architecture, film, painting, and installations – as light seems to bleed everywhere. At the same time, I was experimenting with different light fixtures, sensors, and ways to alter various properties of light such as brightness, softness, and colour. (show photos)

Through this process of research-creation and iterative prototyping, I started to look more deeply at how we have different relations to colours of light, and how interactive lights can alter spatial and durational perception.

Through the research-creation process I reflected on my experiences of the prototype outcomes. And I began to delve into readings that introduced me to thinkers and frameworks that discussed embodiment and its relationship to theories of affect and relationality.

Figure 48. Slide 5 of Defence Presentation, by Author, April 2026.

Light Paint cont'd

On slide: keyword diagram

These frameworks helped me craft Light Paint as a way to conceptualize how light and colours have a deep and emotional effect on humans.

As I became familiar with different aspects of affect theory, I also became fascinated with how agency and interaction can be integral to creating a sense of embodiment. Here, I also began to see how the notion of play was often an integral component of interactive installations, especially installations that incorporate light.

As James Turrell says, we tend to have childlike wonder surrounding light. This childlike wonder could be relevant as to why the notion of play was visible in many participants who explored the space and the interactions.

The research I conducted as I began to create my installation pulls primarily from affect theory (and by extension agency and embodiment). My materials and prototyping has been

informed by interactive and immersive installations, with a particular emphasis on the effects of minimalism, duration, and interaction as a way to deepen embodiment.

For example, I intentionally used a minimalist approach to the design of my installation so that a sense of curiosity and play can emerge in the participants as they explored how the interactive element functioned. In doing so, I aimed to focus the interactive element of the piece to emerge between human presence, movement and gesture and the behaviour of the lights. These constraints allowed the behaviour of the light itself to function as the primary instigator of the interaction.

Figure 49. Slide 6 of Defence Presentation, by Author, April 2026.

Research Questions

This brings me to my research questions (read out questions)

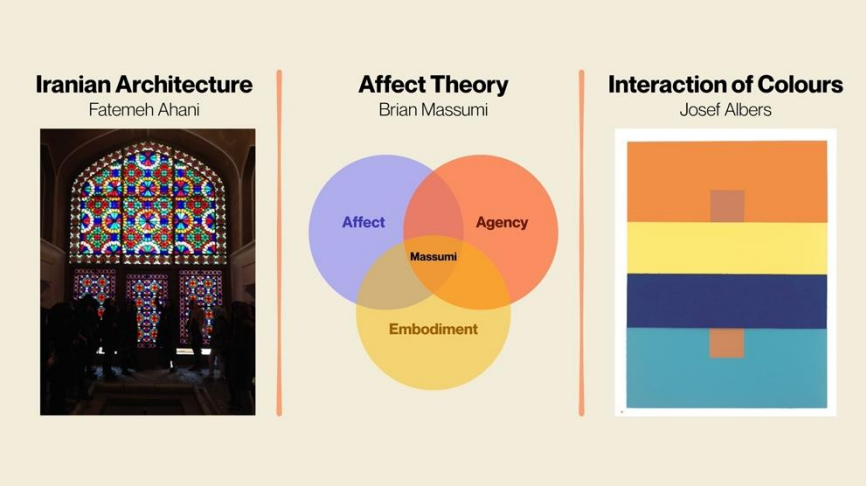


Figure 50. Slide 7 of Defence Presentation, by Author, April 2026.

Thinkers

On slide: three columns showcasing each thinker

The primary research that informed the installation is derived from Fatemeh Ahani's research into light in Iranian architecture, Josef Albers's interaction of colours, and Brian Massumi's affect theory.

Fatemeh Ahani is an architect, interior designer, and independent researcher who focuses on ornaments and light used in Iranian architecture. She explains that there are five primary roles of light in this case: climatic, psychological, aesthetic, spiritual, and symbolic. I chose to focus on the spiritual and symbolic roles for my installation as these most closely resembled the embodied emotions I was seeking to recreate and study through Light Paint.

Ahani emphasizes how light has a strong metaphorical presence in Iranian culture, which is reflected in Iranian architecture. Lights and shadow often form ornamental shapes so that spiritual connotations could be attributed to a space. She also delves into the Iranian colour

palette often visible in traditional architecture. These colours are azure, yellow, teal, and persian red which can be seen in all prototypes of Light Paint.

The architectural element that became my primary source of inspiration was Orosi windows (photo on slide), which allows for light to shine through and create striking light rays.

Josef Albers's book, Interaction of Colours, helped me take these colours and think about how I can place them against each other. He specifically examines how our memory is fickle in regards to colour, which allows for colours to interact in unexpected ways. So, for example, putting two colours next to each other can create them to look different than their assumed 'true' colour. (see photo on slide)

Of course, Albers works with paint and coloured paper, while I work with light. But as we saw a few slides ago, colour is certainly fickle so that changing the colour of the lights can change our assumed perception of the colour of these objects. This interaction of hues, helped me better understand that colour is relational.

Next, is my primary thinker **Brian Massumi** whom I referenced when I discussed affect theory. Affect theory studies how our bodies affect our minds and our dynamic relationship to other bodies. Specifically, he mentions affect to be as pre-personal, relational or even generative. The way this linked to light paint was by observing how affect is present between human and lights, specifically in an interactive environment.

The reason I chose Massumi over other affect theorists that I came across was that not only he discussed affect and embodiment. But specifically, how agency, and voluntary movements are of high importance when it comes to experiencing certain forms of affect.

Massumi frames agency through the presence of reciprocity and voluntary movements. All of which are present in the installation through the movements of the participants as they explore the space. These voluntary movements are a reciprocal action in relation to the dynamically changing lights.

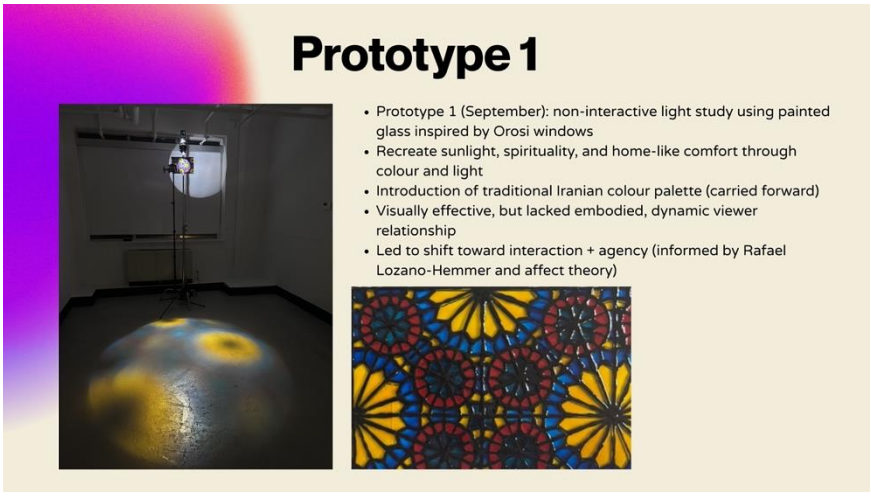


Figure 51. Slide 8 of Defence Presentation, by Author, April 2026.

Prototype 1:

On Slide: Photos of prototype and inspirations

To see how these theories emerged and were made palpable for me, I will review four of my prototypes. This first prototype was completed in September, and involved shining a spotlight through a glass-pane I painted to resemble the Orosi windows. At this point, I was looking to recreate the feeling of seeing sunlight pour through these windows in homes and spiritual spaces. This prototype was not interactive, though it was successful in creating this feeling of spirituality and the comfort of home.

This is also where I first included a traditional Iranian colour palette, which I kept in future prototypes.

This prototype was visually striking but was failing to create the dynamic relationship that I was looking for. After setting it up, it seemed that there was still space to make it more of an embodied experience. Since I was actively reading Massumi and looking at the works of Light artists such as Rafael Lozano-Hemmer whose work centers on interaction, I took it to mean, interaction and agency would be another way to deepen the affect of the installation and the lights on viewers.

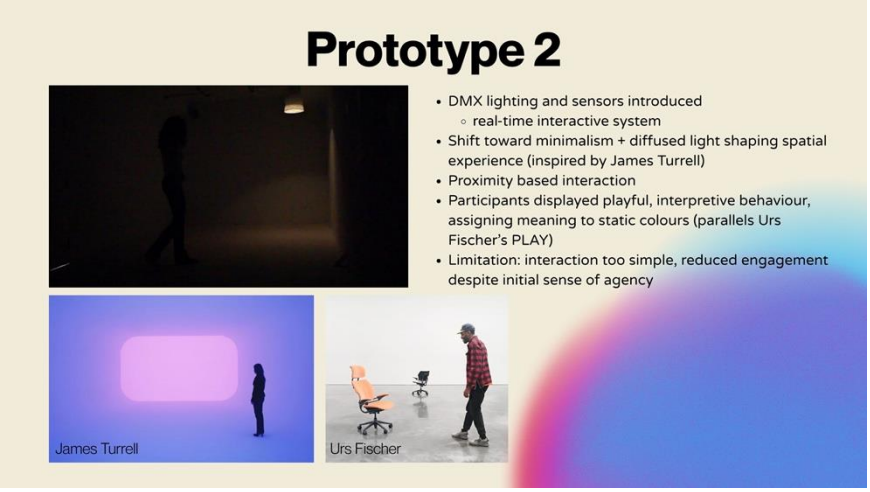


Figure 52. Slide 9 of Defence Presentation, by Author, April 2026.

Prototype 2:

On Slide: Photos of prototype and inspirations

Prototype 2, was a massive overhaul of the previous one. Not only the light changed to allow for DMX control capabilities, but I began exploring various sensors to create dynamic and real-time interactions with participants. As you can see, this is also where I begin to play with minimalism and diffusing the light to engage more broadly with the spatial aspects of the room. At this time I was highly inspired by the large scale installations of James Turell.

The interaction implemented in Prototype 2 was simple, as you approach the play area, the light dims up and down based upon your position. At this time, the notion of play became more visible to me. When I displayed this prototype for the Digital Futures Spark presentations, I observed that participants were trying to decode the interaction by being playful and embracing the space and the light.

Here you can see me re-enact some of the most common mannerisms. Some people were even attributing definition to the colours, jumping from one to the other and expecting a relevant response. This participant behaviour emerged in spite of the colours being static.

This reflects another one of my inspirations, Urs Fischer's PLAY installation where he observed that participants in the installation associated emotions to different coloured chairs as they explored how the chairs moved throughout the space in relation to their own movements. E.g. assuming the red chair is aggressive.

While this prototype achieved my goal of creating an interactive relationship between us, light and colours. I noticed that the interaction was too simple, and needed slightly more complexity to meet the playful expectations of the viewers. While participants were practicing agency through their movements, when the lights don't respond in a fulfilling manner, eventually the viewer would stop employing agential movements.

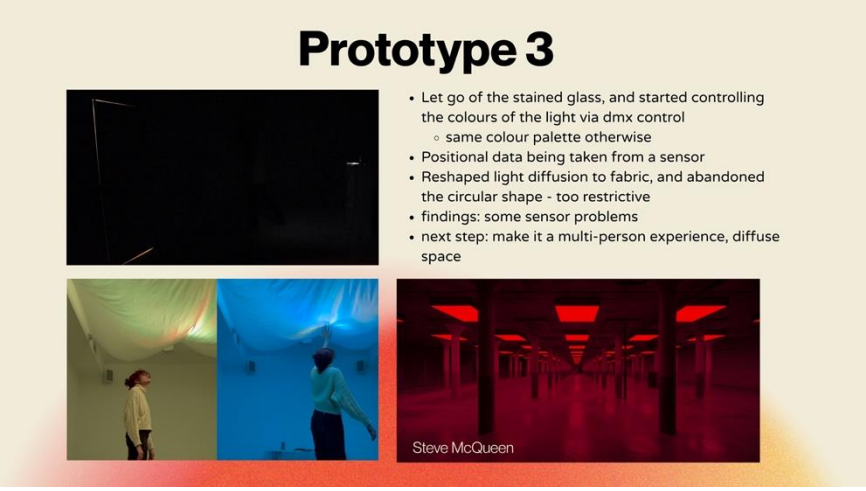


Figure 53. Slide 10 of Defence Presentation, by Author, April 2026.

Prototype 3:

On Slide: Photos of prototype and inspirations

Prototype 3 is when I completely abandoned the stained glass, but rather took those colors and coded them to be controllable through DMX. Now, instead of the interaction –which is still positional data–controlling the brightness, it controls which colour is visible.

I also chose to diffuse the light through fabric so that the light could engulf the entire installation Space. This is where spatial perception became as important as light in the effectiveness of the installation in creating an embodied experience.

Abandoning the circular shape really allowed me to not only include the space in the interaction, but also to better place the participants within the installation space. This is also where I was first successful at showcasing how different colours of light alter our perception, similar to Steve McQueen's installation Bass at Dia Beacon where he completely washed the space in one hue. In this case, McQueen was playing with the notion of time. Similarly, I was

exploring if having a durational aspect to this installation Would change how interaction emerges.

One thing that I noticed here, is that the space needed to be more diffused as I found that seeing the rest of the room took away from the impact of the lights. By creating my own space, I could limit the visual stimuli that distract from the coloured lights.

I also realized that I needed to make this a multi-person installation to mimic the social aspects of light as we experience it usually. Think: campfires

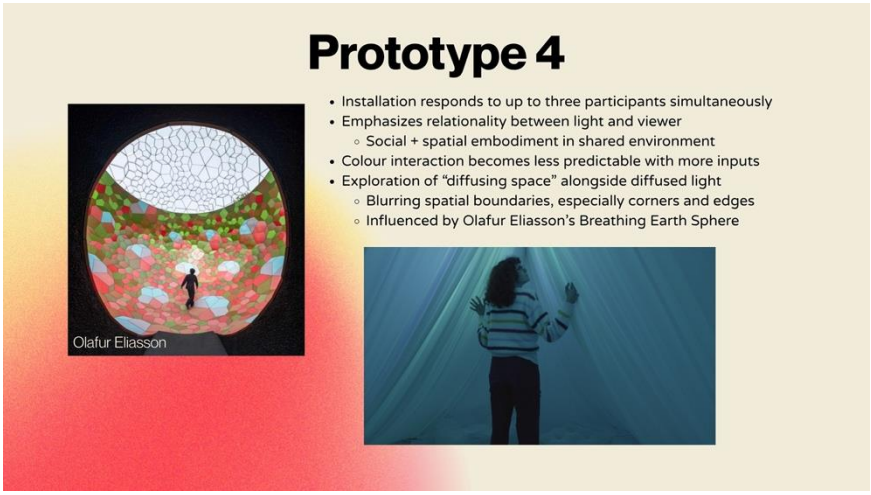


Figure 54. Slide 11 of Defence Presentation, by Author, April 2026.

Final: Prototype 4

On Slide: Photos of prototype and inspirations

This brings me to prototype 4, which is what was showcased at the DFX exhibition at the waterfront. This installation could take in, and react to three participants at once. In fact, the light changes would be different for one person compared to a group of two or three. The more people are present, the more colours can be visible. This was important to me to not only show

relationality and affect between light and the viewer, but also the social and spatial embodiment that came with being in a shared yet minimal environment.

It is also notable that when more colours are introduced, the colours will also interact in new ways. 4 different colours, create less predictable results than two.

Also, this is where I began to see if, in the same manner that I diffused the lights, I can diffuse the space. Especially in regards to blending the corners, similar to how Olafur Eliasson challenges the horizon and spatial boundaries in Breathing Earth Sphere to dislocate his audience.

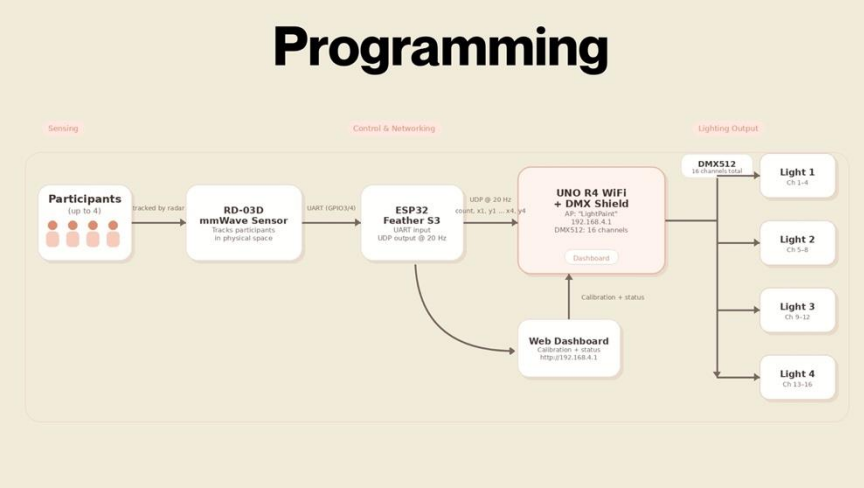


Figure 55. Slide 12 of Defence Presentation, by Author, April 2026.

Prototype 4 programming - system design

On slide: flow chart of the logic

The programming involves an RD03D sensor which, alongside an ESP32 microcontroller, detects human presence, exact positional data, and number of participants (up to three). The ESP32 then processes the data as follows:

- If participant 1,2, or 3, is present.

- If participant 1,2, or 3, is moving or still.

- And where each participant is located.

This is then sent over an AP connection to an Arduino Uno which then sends relevant Colour prompts, via a DMX header, to the lights. THere are two stages of lighting logic:

- Firelight which is not interactive

- And an active stage where the colours shift dynamically based on positional data.

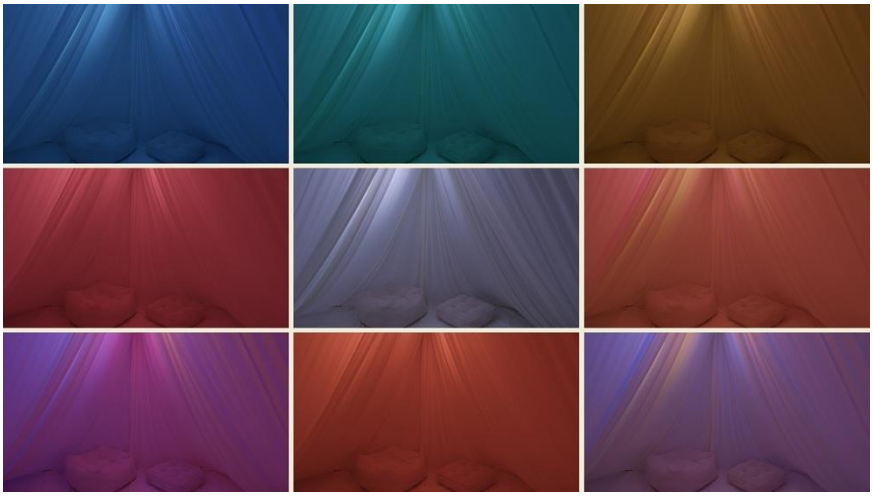


Figure 56. Slide 13 of Defence Presentation, by Author, April 2026.

Prototype 4 colours

On slide: different colours of the installation as made possible through system design

Here you can see some of the colours, and blends of colours that are probable. All of these colours are programmed in the installation, but as interaction is unpredictable, the emergent colours are going to be slightly different for everyone.

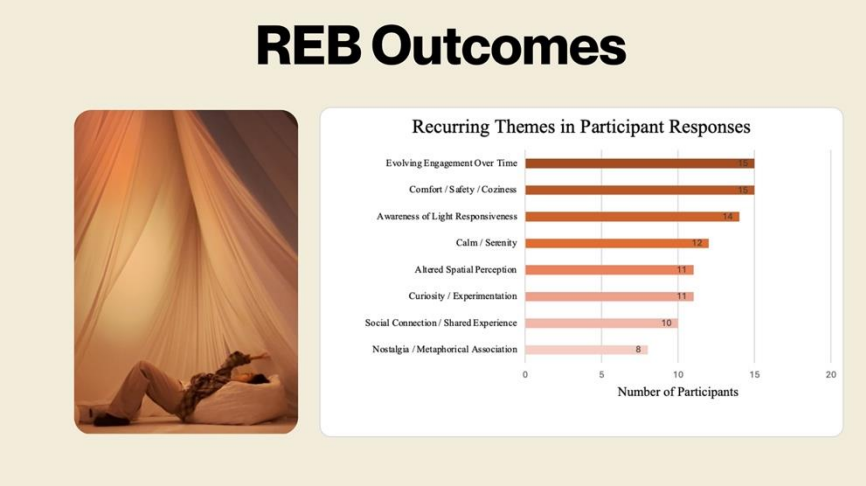


Figure 57. Slide 14 of Defence Presentation, by Author, April 2026.

REB and Research Outcomes

On Slide: Photo of user testing, chart of outcomes

As I am researching and questioning how participants may feel in my installation, a Round of REB testing was necessary to see if Light Paint in fact answers my Research questions, and where I need to diverge.

This was done in February and included my observation notes and survey results from 17 participants.

What was made, incredibly evident to me here was that despite having a wide range of Responses, there were clear categories and specific modes of interacting with the space.

For example, I noted that participants mentioned various different colours as their favourite based on what meanings they attributed to them. I also noticed how some participants chose to not-interact at all, some only wanted to interact with the light changes, while others tried both. This showed that not only colour perception is relational to each individual's personal background, but also that different interaction types revealed different forms of embodiment.

I also observed that the spatial decisions allowed for a sense of dislocation which also altered spatial and time perception. Participants noted that the dimensions of the space seemed to change the longer they stayed.

Another big takeaway was that I noticed how most participants stayed on average for 15-20 minutes. Which I found relevant to my research question on intentional duration.

The final form of this prototype had a countdown of 20 minutes whereupon the lights would turn down.

Figure 58. Slide 15 of Defence Presentation, by Author, April 2026.

DFX Outcomes

On Slide: Video of DFX installation

When I showcased my work at DFX, I first noticed that the notion of play and perception Continued to be of high relevance to the participants. I observed, and talked to many people about how they explored the space, and overwhelmingly, people were playing with the lights, the space, and the fabric to see the extent of the installation. Many people also interacted with complete strangers in a playful manner while in the confines of the installation.

However, time seemed to work differently. I noticed that while some people stayed for the 15-20 minute duration. Most stayed for as long as they wanted whether it was a few minutes, or staying so long that they disregarded when the lights turned off, and instead they waited for the interaction to restart.

This was an unexpected outcome as my REB results showed a unified duration among participants. My takeaway from this observation is that while duration does in fact play a Role in

how interaction evolves throughout the course of the installation, Light Paint doesn't really need a pre-set duration to showcase how participants perceive the passage of time differently while in the installation space.

Figure 59. Slide 16 of Defence Presentation, by Author, April 2026.

Conclusion

On Slide: Photo of installation

To end my presentation, I would like to bring us back to the relevance of light in creating Spiritual atmospheres in Iranian architecture. When I first began this project, I thought the only way for the installation to work was to have only one way it could be interacted with. But, that goes against how light was used in Iranian architecture, and also in modern day light installations.

Through this process I learned to manipulate the space and the aesthetic of my installation to limit interaction outcomes, while allowing it to be an unscripted experience.

In doing so, I shifted my focus from narrative lighting to how the way architecture contains light can lead to spiritual and playful experiences.

Figure 60. Slide 17 of Defence Presentation, by Author, April 2026.

Poem:

I would like to leave us with a poem from Rumi (read poem on slide).