How Interactive Design Language Could Manifest Uncertainty

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Abstract

We are no longer living in a three-dimensional linear form. Discourses in cybernetics and quantum mechanics have fundamentally changed our way of social organization. These philosophy, theories, and technologies have enabled globalization and interstellar explorations. It is essential to rethink the definition of the ‘fourth dimension’ in the ever-accelerating modernity that thrusts human beings into deeper space.

The first part of this paper analyzes the development of timekeeping devices in both current day and ancient epoch. Chapter Two discusses the concept, making and references considered in the design of Present Revisited; how it reflects the contemporary theories in space time and the notions of present, ephemeral and eternity. Chapter Three takes a reflexive angle to inspect the diminishing of permanence in contemporary social modes of organization. The last passage emphasizes some underlying theories in regard to performance, observation, system and interaction.

Keywords

Interactive design, timekeeping, working hours, spacetime travel, uncertainty principle

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Chapter One Timekeeping Methods

1.1 Analog Clock, Digital Clock, and Atomic Clock

When looking at time, one cannot circumnavigate space. The fallacy in this discourse is the tautological nature of the language. It is impossible to analyze, confer, negate and reconstruct time without literally utilizing the very word. We have evolved from observing the trajectory of celestial bodies to advancing precision in clock making. We have not yet been able to emancipate ourselves from its bounding of duodecimal notion.

Our current ‘fourth dimensional’ indicators in digital clocks and calendars 60, 24, 7 and 365 form a numerical matrix, a topological mesh in the comprehension of each postmodern individual. Open the map of the earth, you will find geographic meridians and lines of longitude crossing each other and form grids, reinforcing another hypothetical lattice that segregates each of us in ’zone’. While enjoying the convenience and efficiency of such a navigation system, we have in part sacrificed the seamlessness of our collective consciousness.

‘It has been observed, for example, that the clock came along before the Newtonian image of the world as a great clock-like mechanism, a philosophical notion that has had the utmost impact on man’s intellectual development.

...

‘The clock also affected our conception of time so that the idea that a day is divided into twenty-four equal segments of sixty minutes each has become almost literally a part of us.’ (Alvin Tofler 1970, p.29)

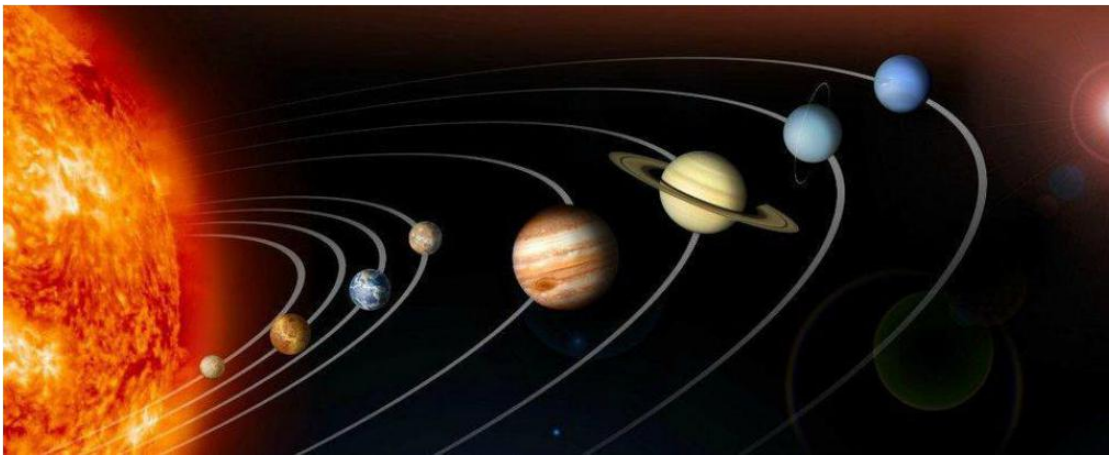

Image 1: Solar System

It is worth pointing out that contemporary timekeeping has departed from Newtonian mechanics as a result of recent propagation of relativity theory, discoveries in micro physics and quantum mechanics. Nowadays, every GPS device and smart phone determines its location via atomic clocks on satellites orbiting Earth (NASA 2019). An atomic clock ticks not by gravity such as a pendulum would do, but with caesium atoms.

Globally, a second is defined as the duration of 9,192,631,770 cycles of radiation corresponding to the transition between two energy levels of the caesium-133 atom, defined by International System of Units in 1967 (The Physics Hypertextbook 1998 - 2020).

Similarly, a metre is defined as the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second (BIPM 1983); the same case goes with other members of metrology: volt, ampere, ohm… A second is defined by an atom, and the rest of the measurement follows.

The difference between an analog clock and atomic clock is that the trajectory of the classic analog clock pin makes up a circle (in the case of a pendulum, a curve) whereas the electrons in play perform irregular leaps between different energy levels and there is no method at our disposal to track its path. As the Heisenberg Uncertainty Principle indicates, one cannot assign exact simultaneous values to the position and momentum of a physical system (Stanford 2001).

Despite the underlying uncertainty as properties of atoms, GMT(Greenwich Mean Time), which is often used as a synonym of UTC (Coordinated Universal Time), has been enabled by atomic clock and clacks on SI (International System of Units) caesium standard. Train networks are a main reason why timekeeping is synchronized globally. Industrial revolution sped up the synchronicity, technology revolution and globalization has somewhat perfected the system. Concurrently on many occasions, digital clocks have replaced classic analog clocks: almost all metro and train systems in major cities have employed digital clock displays, either 12 hour or 24 hours.

For the sake of file writing in digital operating systems, a concept called ‘unix time’ was also introduced. It is the number of seconds that have elapsed since the Unix epoch, namely 00:00:00 UTC on 1 January 1970 (Hausser 2018).

These are great advances compared to archaic recording methods, devices and constructions that are elaborated in the next section. Notwithstanding, these systems have not brought about much solidarity among humankind despite their technological advancements.

1.2 Archaic Tools, Devices and Constructions

While living in small groups of tribal communities as humanity evolved, we look at the sun and moon to keep track of our daily activities. Changes in rivers and trees signalled when seasons were starting and when to conduct rituals.

Over time humanity developed agriculture, fixed settlements and an increasing variety of work and leisure activities. As communities grew and became more closely interlinked, there emerged a need for precise meeting points in both space and time. This need for meeting points drove the invention of ancient methods and devices of time keeping.

Calendars were developed to guide farming routines that were subject to seasonal transitions. Most notably, elements such as water, sand, shadow and stone were used in various kinds of mechanisms. Burning of candles and incense was respectively utilised in the ‘West’ and the ‘East’ for measuring the length of nights.

The phonic circadian alarm clock of the chicken is the most obvious reminder of the beginning of day in most agricultural households. Moreover, in vernacular and somewhat superstitious texts, cat eyes are surprisingly mentioned in carefully woven rhymes, as their pupils change shape according to the shift of sunlight throughout the day.

Water clocks are said to have been invented in ancient Egypt, while in Babylon, in India and in China they were having their own version of devices that monitor the flow of liquid into (inflow type) and out of (outflow type) a container, usually by means of graduations inscribed on the container.

Some water tanks have an engraved arrow or ruler standing inside that serves the same purpose. The downside is that most liquid freezes when the temperature drops below zero. As the dripping continues, liquid pressure decreases and therefore affects the dripping speed. That is why the water clock is not very precise and requires calibrations.

The later variation is to add supporting vessels that constantly fill up the main vessel so as to maintain the velocity of the flow. The clocks are subsequently advanced by feedback system, gearing, and escapement mechanism; and further, with deepened complexity of the gears and introduction of water wheels. They are widely used until the

appearance and spread of pendulum clocks. The modern water clock designs are essentially pendulum clocks, some of them apply Pythagorean cup principle to different size and shape of water containers as escapement mechanism.

Unlike water clocks, antique hourglass design could still be seen around as artefacts. The scale of measurement is of shorter length compared to water clocks. It consists of two glass bulbs through which fine sand pours through a tiny hole, also called the neck, that connects the two bulbs and regulates the fall through rate. Gravity plays a main role in both water clock mechanism and hourglasses.

Sundial, on the other hand, is a geometric construction that works in accordance with sunlight. By setting up a stick in the sand or a nail on a board which acts as a gnomon, the sun will cast different shadows during different phases of the day and people can start to place marks at the edges of the shadow or outline the shadows at intervals.

A refined version includes a flat plate (the dial) onto which the gnomon stands and later on the dial was tilted so as to receive uniformed shadow. The geometrical calculation is therefore simplified and the marks on the tilted dial become easier to read. On the basis of planar sundials, a number of other shapes and constructs evolved such as spherical, cylindrical, bow-shaped, conical etc.

The disadvantages of sundials are that the way sun moves changes with season and depends on whether it is in the northern or the southern hemisphere. Sundials also cease to work on cloudy days and at night.

Finally, this episode finishes with an icon of English heritage - a ring of standing stones - Stonehenge. The arrangement of the five central monoliths, the heel stone, and the embanked avenue, are aligned to the sunset of the winter solstice, as well as the sunrise of the summer solstice. Its design might have allowed predictions of eclipse, solstice, equinox and other celestial events. These events were crucial to liturgical exercises and are not solely limited to the ancient epoch.

Chapter Two Present Revisit: the Design Work

2.1 The Concept: Spacetime Traveller

The initial idea of Present Revisit is to build, either mechanical or digital, representation of planetary orbits that allow the audience to navigate space time travel via hand movements. The environment this interactive piece is situated in should be rather dark or with dimmed light, quiet with no sound, to imitate the space outside of the terrestrial atmosphere.

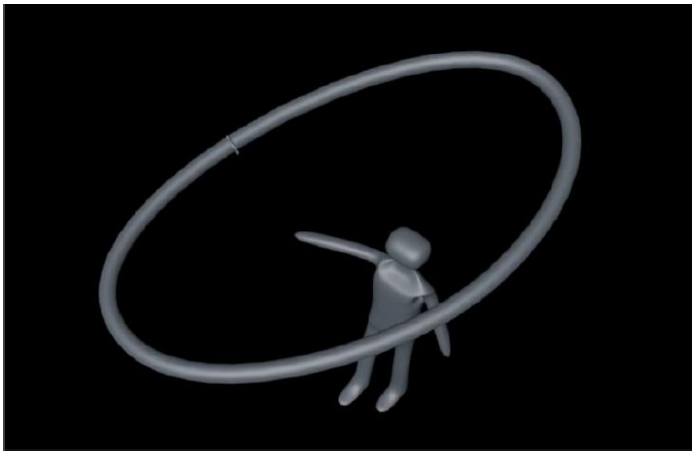

Image 2: Excerpt of concept animation in Cinema 4D

It is a metaphor for our postmodern situation. We live in darkness without knowing where the future goes, or if there is a future after all. The future is unpredictable, and the past memory renders blurry. What happens now is mere experience. It is interesting to point out, however, that being positive about humanity is a decision made through reasonable thinking, rather than emotional judgment.

Ever since the first astronaut was sent to outer space and completed one orbit of earth, human kind has never stopped the explorations in outer space. There are a crew of six people who live and work on the international space station that orbits near the earth planet. The space station might soon be open for commercial use as civic rockets and spaceships are being developed.

The installation aims to facilitate imaginations about how we could live in outer space, an environment that does not follow what we have known as day and night. For example, on the space station, one day equals a 16th of a day on earth. On each other planets in the solar system, the length of day varies, and none of them is the same as the earth planet.

At the beginning of the design process, the goals have been set up as follows: a. allow the audience to manipulate objects in the environment they situate; b. non-contact, nonverbal communication and spatial interaction; c. the feedback loop should be recursive, meaning the audience input would influence the system output; d. provide opportunity of thought experiment on the notions of present, ephemera and eternity; e. to facilitate understanding of the situation humankind would face in extraterrestrial space.

Later on, the first goal ‘manipulating objects’ have changed into ‘manipulating lights’, which I’ll elaborate in the section 2.3 Making Of. The interaction mechanism being noncontact and non-haptic is an analog of our circumstances in space: wearing a heavy, airtight suit whenever outside of the capsule; objects tend to float inside the cabin without being attached or ‘placed’ on a table, shelf or ground. By employing these methods of living and communication while enabling audience to manipulate lights that are around them on the orbit, I have, on one hand, placed the audience in the place of the sun in the solar system, for the reflection of our position in space; and on the other hand, created an analog of spacetime travel console, for the imagination of navigating through universes.

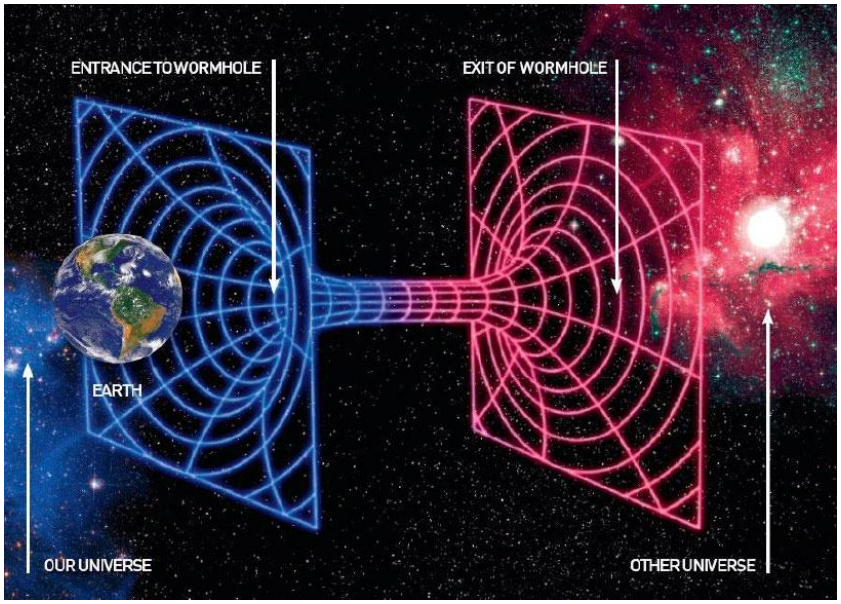

Figure 1: Wormhole Theory in graphic

The theory of wormholes is a great prospect for rupturing spacetime. A wormhole is an alternate route that leads from point A to point B in space, often shown as inter-universal shortcuts in science fiction novels and movies. They work by bending spacetime around and making tunnels from one side to the other. Wormholes are often expressed in the shape of a tunnel. And as a convenient tool, ideas such as spacetime continuum and wormholes are often explained with the assistance of mesh. Mesh is also a frequently used space-forming element in spatial design, either in two or three dimensions. It is often used to construe a plane and the warping of planes. This resembles our current status of living in a mesh, as described in section 1.1. Present Revisit plays around these ideas in the interest of re-imagination.

2.2 Case Studies

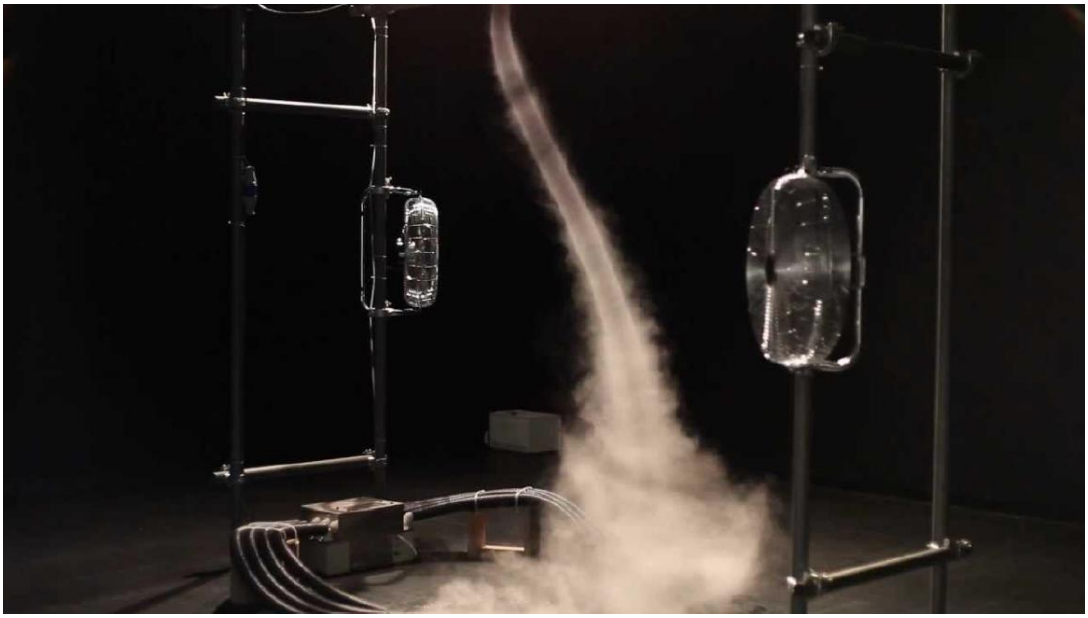

Image 3: The Limitations of Logic and Absence of Absolute Certainty

The Limitations of Logic and Absence of Absolute Certainty is an experiment. The water vapor is created and actuated by pumps and fans. One would not know where the drops of water are going. The vortex resembles the clouds and atmosphere that surround us. It is an intriguing metaphor of utmost simplicity.

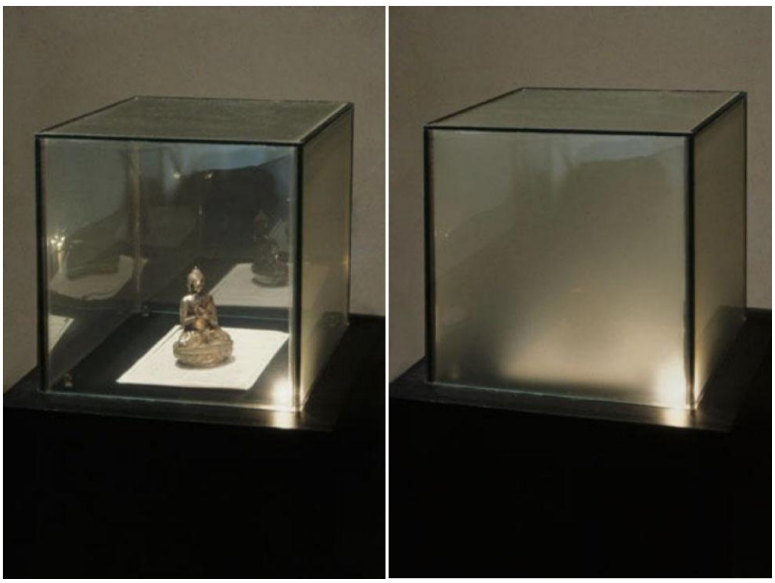

Image 4 & 5: Shadow for Heisenberg

Shadow is an installation created by Jim Campbell in tribute to Werner Heisenberg. The cube is made of glass and LCD material. When a person walks toward the pedestal the glass cube fogs up. The closer the spectator gets the more the glass fogs, and the shadow becomes clearer. It is an allegory of the heisenberg uncertainty principle, which states that the exact position and momentum of an electron cannot be simultaneously determined.

Image 6: Conrad speaks about ‘art not only about art’, but also about philosophies and science, using robot arms to facilitate productions.

In 2013 Conrad Shawcross unveiled his art installation Timepiece. The project was developed in his studio and home in east London. After its conception, it took 15 months to execute, including six months of research and nine months of production. Residing within the newtonian mechanical system is a homage to the geocentric era of human fantasy. Gears and gearboxes, which have been made by an array of companies based all around the world, are central to the clock piece.

The precision requirements are tenths to hundredths of a millimetre, which is a very high industrial standard. The statistical average precision of a normal CNC(computer numerical control) machine is usually 0.020mm for cutting and smoothing. For jig boring machines, the numbers can go up to 0.003mm. ‘The piece is designed to run five years continuously without maintenance, so it is a proper clock.’

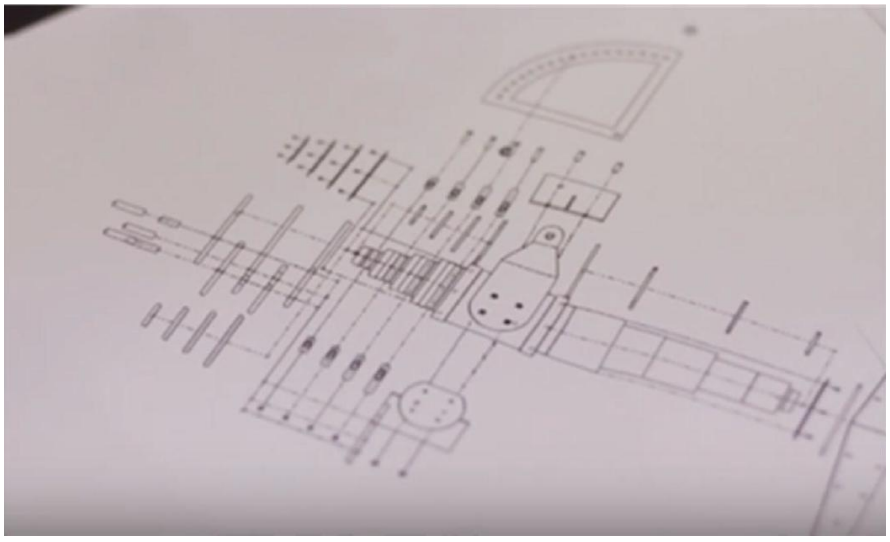

Image 7: Technical drawing, exploded

The project was commissioned by The Roundhouse, an arts and music venue in London. The venue also hosted the sculpture for a month-long exhibition in a circular room with 24 columns around the outside.In this setting, Timepiece deconstructed the ubiquitous clock while maintaining the structural engineering, mechanical precision and smoothness - something that seems concise outside and extremely complex within.

The piece is made of aluminium, steel, mechanical systems and light. In-keeping with the clock-maker's tradition of craftsmanship, the parts are beautifully chamfered on the edges and filed on the surface. Each of the separate second, minute and hour hands are mounted on different parts of the shaft, driven by motors and supported by steel structures.

The scale of the piece is large with the second hand of the clock measuring at 8 metres in length. The whole building is suspended 4 metres above the floor.

To make the familiar clock peculiar, the artist also designed each hour, minute and second arms in segmented sections that bear semblance to industrial robots' arms. To the end of each arm, incandescent lights are installed to add the luminosity. The lights on each arm are independently dimmable from the remote console. This could potentially be programmed and choreographed to synchronise with musical scores, dance performance and aesthetic synesthesia.

The exhibition has welcomed Siobhan Davies Dance performance 'Rotor', where four dancers were aligned with the centre pillar and occasionally run across the field. While walking backwards revolving the centre pillar, the four dancers form an analogue of celestial movement of solar system planets, however in a geocentric manner. It is a historical throw back that expresses a regressive anthropocentric view when human beings were once the centre of the universe.

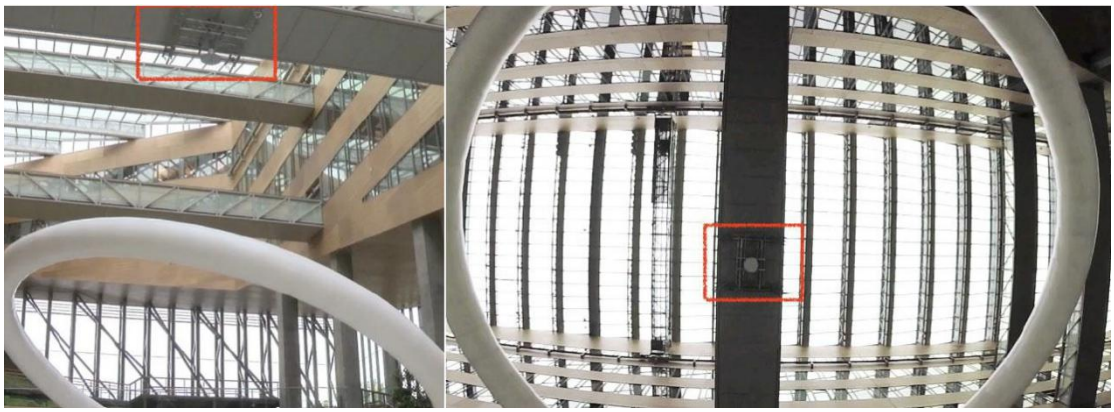

Image 8 & 9: Excerpts from video 'Tetro - Creative Vision #1 - Vincent Leroy'.

Auréole Boréale is a kinect sculpture designed by Vincent Leroy. The sculpture has a minimalistic shape. It brings about freedom of imagination and produces an evolving epistemological process among the audience. From my standpoint, it takes the shape of a torus (plural tori) that looks like a lifebuoy. A coffee cup and a doughnut are both topological tori. This single-holed 'ring' torus is known in older literature as an 'anchor ring' (Weisstein, Eric W., 2020).

A centre anchor plate is used for string suspension. As the plate turns, it brings the torus revolving around a centre axis in the atrium of the building and creates dynamic choreography. The movement bears resemblance to the brinks of sufi dress during its spin. The simplicity of the piece is fascinating.

2.3 Making Of

After looking into different materials and attempting to bend wood and metal sections into curved rails, as well as the study of mechanical build that would involve mounting plate, wheels, belts and motors, decision has been made to work digitally rather than mechanically.

Image 10: Present Revisit prototype exhibition setup

The Kinect camera is set up at a depth of 2 metre. The orbit itself is made of steel stripe of 4 metre length, roller bent and welded into an ellipse. The major axis of the ellipse is roughly 2 metre, and the minor axis is roughly 1.4 metre. This shape is to simulate a planetary orbit that is often not a perfect circle. Due to the relative gravity pull between the star and planets, our planets in the solar system follow a trail of oval.

For exhibition set-up, the oval prototype is suspended in the air at a height where ordinary adults could stand in front of it with their head at the position of the intersection of the major and minor axis. The deficiency of this setting is the lack of consideration of children and people with disabilities.

When static, one of the LED lights would stay lit. The kinect camera would capture human shaped objects that pass by. A ‘skeleton’ library is imported to read human shaped objects and translate them into geometries: hands as ellipses, arms as lines, and the centre point of spine as dots.

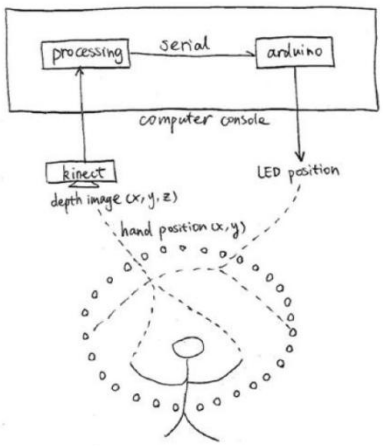

Figure 2: interaction mechanism

When an audience enters the proximity of the installation, they will be detected by the kinect camera. We applied trigonometry in programming and divided the plane - the surface where the audience's hands and spine are positioned - into four quadrants. We set the centre of the spine as (0,0) point of the plane. Based on one hand's (x,y) position in relation to (0,0) point, we could know the angle or radius of the arm in relation to the x or y axis.

In order to address the LED light along the oval and coordinate it to the hand's (x,y) position, we mapped out the angle of the arm in relation to x or y axis to a full circle 360 degree. The result is a percentage. We then apply the percentage onto the total number of LEDs along the strip, to locate the specific LED that should light up. This information is communicated as an integer from processing to arduino via serial plotter. The position of the LED light being lit corresponds to the position of the hand in space (Appendix Code 1).

In the first prototype, only one hand was tracked. As an improvement, in the second iteration both hands are tracked. Meanwhile, to manifest the underlying uncertainty principle, a translucent material is used. The tubes close back to each other via inner sleeves of smaller diameter. The entire piece forms a torus that is inspired by Vincent Leroy's Auréole Boréale. This second iteration used frosted acrylic tubes. Acrylic bends in heat. After it cools down, the bent shape remains. However, acrylic material breaks easily.

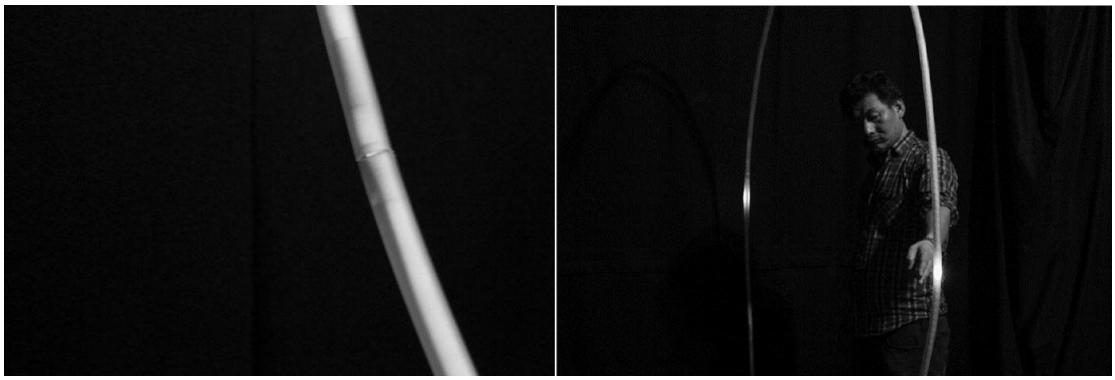

Image 11: Translucent material, both hand tracking and diffused light effect in second iteration

In the second iteration, A train loop light effect is also designed. This light effect came from the tunnel lights flashes in the London tube. It is also to imitate light beams observed at high speed space travel. When the spaceship's moving at near light speed, because of relativity, the stars in the environment, viewed from the spaceship cabin, would render light strokes, instead of dots. This light effect has been shown in many science fiction movies.

Image 12: train loop light effect

Image 13: Excerpt from movie Space Odyssey 2001, during the narrative of space travel

Image 14: Excerpt from movie Interstellar, when the spaceship is going through wormhole

For the convenience of audience understanding, the shape of the orbit has changed into a slightly warping circle later in the second iteration and the third iteration. The margins of the sun, blackholes, wormholes often presents warping as they absorb or give out a large amount of heat that destabilizes the particles in the area of space around them. Such is how the vision around a boiling kettle warps.

Image 15: Third iteration in display

The installation setup has since been kept in a vertical plane. It is for two reasons: The kinect camera skeleton library would only be able to track humanoid from the front or back, not from bird view above, or below; by placing the viewing plane of the piece the same as the audience's plane of movements, the work bids to ease the discovering

course of the relation between audience's movements and reactions of lights.

In terms of the volume, owing to the restrictions of available tubing materials, we barely managed to source translucent tubes that could cover the 10mm thin strip. The design of LED strip fixations went from metal steel to acrylic then back to metal aluminiu, which holds great ductility when it comes to curving.

'Stochastic galaxy' light effect is designed to resemble a galaxy, as well as the electron cloud in an atom (Appendix Code 2). The position and hue of the LED lights are programmed as random, for in an unknown space, unpredictability prevails. From a macro point of view, each LED light could resemble a start or reflecting planets and their moons. From a micro point of view, each LED light could be considered as electrons that orbit around the nucleus of an atom. In both cases, we do not know simultaneously where the objects are and where they are going. Ensuingly, a 'pulse through' light effect evolved as a further-developed version of stochastic galaxy. The light hues are random,but the lights are connected and they light up one after another.

Chapter Three The Diminishing of Permanence

3.1 The Modular Man, Transience and Adhocracy

We live in a fast moving and modular society. Each day in the early morning, people go to their working desk and try to fill in a position that defines the content of their work. Adam Smith has started off Wealth of Nations with 'the Division of Labor' (1982) and thenceforth put an end to the relaxed foraging and agricultural means of production, pushing mankind into hastened industrialization.

Image 16: Modular rooms being assembled during the construction of Covid-19 virus hospital in Hubei, China

Together with the development of modular architecture, our forming bricks of social skyscrapers - people - changed faces, started to endow modular function.There appeared, a new type of employee, humorously named by Alvin Tofler 'Monday to Friday friends'. They allow themselves to be occupied by productive aspects in a demeanor that tends to seem aloof and distant regarding personal matters and beyond office hours.

Today, in comparison to a singular functioning employee on an industrial assembly line, many self-employed entrepreneurs and freelancers are executing a digitally nomadic work-style. There are more than 53 million freelancers in the US (U.S. Bureau of Labor Statistics), 2 million freelancers in the UK (IPSE 2017).

This prompted the outsourcing economy, growing the number of freelancers worldwide. Concurrently, the format of work in 'permanent' working relationships becomes more and more 'flexible'. Some internet information companies encourage working modes such as working at home or working remotely. Working tasks have been broken down into micro assignments. Outsourcing contractors and freelancers could even find themselves susceptible in a position of acquiescing to the ad-hoc tasks appointed by their employer or client, often requested via immediate mobile phone calls and social media messaging.

Each personality can be imagined as a unique configuration of thousands of such modules. Thus no whole person is interchangeable with any other. But certain modules are. (Alvin Tofler 1970, p.58)

Our social and working relationships are becoming more and more modular, temporary and dynamic. The boundary of social and working facets are crossing-over. The population on the globe is moving through continents. The speed and amount of information exchange within human species is growing exponentially without permanent commitment due to the speed of information exchange. Furthermore, the human kind is looking beyond the earth globe and exploring outer space in a shared effort.

3.2 Progressive Liberation from Working Hours and Work Altogether

The modern way of organisation does not answer the circadian clock built in human beings. We have been savages in the age of industrialisation and globalisation. People have unconsciously and voluntarily signed up for late night shifts or to work in artificial fluorescent lights. To accommodate the needs from the other side of the planet, night shifts first emerged in manufacturing, followed by guards and safety, tech support, customer service and transportation. People who work in those hours may enjoy a quiet working environment, but are also more vulnerable to psychological conditions such as depression and anxiety, resulting from disassociation from their fellow workers, as the majority of night shift laborers work alone for many hours.

The fact that working hours are measured in o'clock numerical values provides the foundation of capitalistic exploitation of surplus value. It was not until the 15th century that the Parlement of Paris definitely tied workers to clock-time and decreed work would end at the last stroke of the seven o'clock ringing (Mondschein and Casey, 2015). Punch cards are one of the most inhumane bureaucracies invented to work against ourselves.

The new goal of the worker's union in the UK, apart from filling the wage gap among different group classifications, could be a four-days work week (Lewis 2019), especially for the urban slaves. This policy is said to elevate the morality and efficiency during the reduced working hours: less and better work production. The basis of this motion are two commonly accepted ideas that came up only in the last several decades. One, the productivity is less linked to the labour hours spent next to the production line or in the office but more attached to the quality of mind work focused on the task; two: the scarcity in the foundation of economics is fading away, we are producing enough for our needs, although not enough for our greed.

The Ju/'hoansi people in Botswana, Namibia, and Angola of southern Africa spend 'only fifteen hours a week securing their nutritional requirements and only a further fifteen to twenty hours per week on domestic activities that could be loosely described as work' (Suzman, 2017).

The domestic activities carried out by women in the house includes weaving, sewing, sorting food and clothes through the day into night. The material output of such works are consumed within the household or bartered with goods produced in the community, rather than sold for conceptual currencies, much as the lifestyle our foraging ancestors conducted millions years ago. It is a primitive form of economy in comparison to the scaled industrial approach that is so advanced and dependent on a global financial system. In a sense, the primitivity in foraging areas allows for maximum human freedom as social creatures and intellectual existence.

Auroville in Tamil Nadu, India, is a radical community that advocates utopian view of human union. A number of architectural experiments were carried out in a compactfully planned landscape. Among them, the Golconde Ashram designed by Antonin Rymond, a former disciple of Frank Lloyd Wright, is symptomatic in modernist architecture. The building stands as one of the best examples of climatic comfort through passive cooling (Kundoo 2007). Most habitants in this 'town' carry out planting, spinning and weaving activities to provide food and clothes for use in their lives.

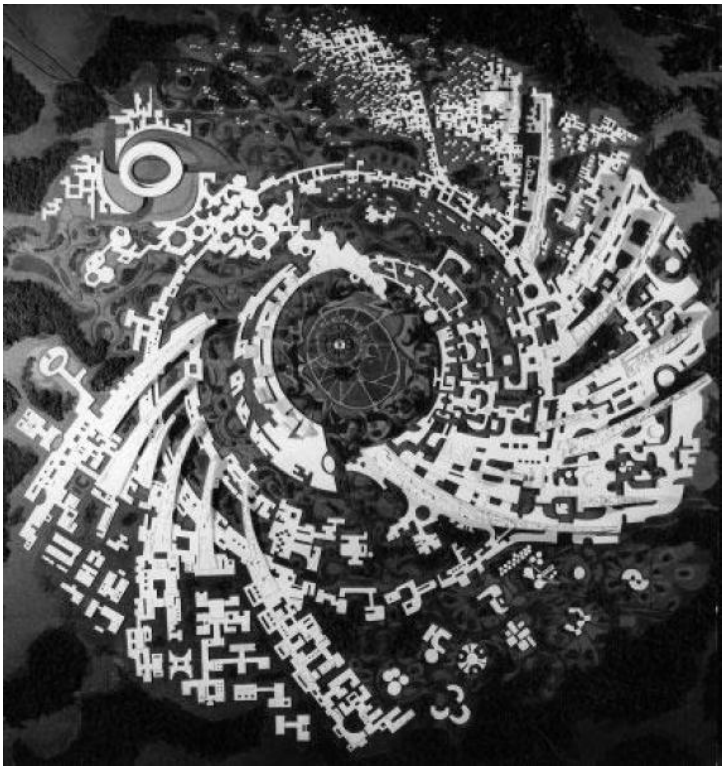

Image 17: Roger Anger, Concept for the city of Auroville, Tamil Nadu, 1968

A profound view in respect to a possible economic arrangement is that, the entire concept of currency would diminish. Ursula Le Guin described in details of an anarchosyndicalism society in her award-winning novel The Dispossessed: An Ambiguous Utopia (Le Guin 1974), in which jobs are allocated by a central board of advice; foods and sheltered are provided regardless of one's working status. Notably, this is only possible in a society without scarcity.

Alternatively on earth planet, universal basic services scheme, after welfare state, and a controversial universal basic income proposal are under discussion and experimentation (Bastani 2020).

In utopian speculations, individuals are temporarily allowed the opportunity to be dismissed at ease with no obligation of working or producing, receiving indiscriminate stimulation from the surrounding natural environment in every form and react out of its own accord. Their core values are gratitude and respect towards the ecological surroundings.

These experimental social organizations could be viewed as being informed by cybernetics, performing decentralized methods of communication, i.e.,each member acts as a processing unit of a network and actively exchanges information between each other.

Hitherto, these social experiments around the globe have provided insights into alternative social modes, without exerting decisive influence over the majority population. Whether these experimental modes would be applied in our moon or mars ‘colonies’, how would our social organization evolve, one could not fathom.

Chapter Four The Interchangeable Role Between Performers and Observers

When designing interactive art installation, one key component is the feed in and feed back loop of the interaction mechanism. For, when an audience enters the proximity of the environment where the interactive art is installed, a response is expected. The response is from the environment in association with interactive art. The audience, performer or observer would receive this response then react to it. Therefore, the response feeds in the audience behaviour, audience behaviour triggers system response, creating a recursive loop. The interactive art itself forms a system. When an audience enters, it adds an element to the system. Because of the homeostasis these systems and the audience usually holds, the interactive system remains stable with or without participants.

Every stable system is assumed to have an internal goal of its own. It is shown that every goal must have a goal of its own. It is also shown that the determination that the goal is a goal is observer dependent (Glanville 1997).

When an observer enters the vicinity of the interactive piece, they do not immediately realise the connection between the response from the environment and their presence. Even when they realise their relation in regard to the environment, one might not choose to engage and become an audience, but to merely observe.

In Present Revisited, the system is stable without audiences. When an audience appears, they might not discover the goals of the system at once. These goals are laid out in section 2.1. When they realise the goal, they could choose not to pursue the goal by engaging in the interaction. During the interaction, the goal is constantly changing as the LED light position follows the hand position and vice versa. The goal of the system is a dynamic goal. No matter if the audience is actively participating or merely observing, the system remains stable.

Another core idea in the realms of interactive art concerns the interchangeable role of an observer and a performer. By engaging and interacting with the interactive work, an observer is giving continuous signals as system input, exerting an influence on the system output, which in turn changes the observer’s behaviours, altering system input recursively. In this process of engagement and interaction, an observer turns themselves part of the system in performance, and becomes a performer that forms part of the interaction. And when one chooses to step down after the interaction and continue to observe, while not leaving the environment, they become an observer. They essentially become the same

observer before their engagement with the interaction. Therefore, the role of an observer and a performer in an interactive system is interchangeable.

The detached observer is as much entangled as the active participant; the only advantage of the former is insight into his entanglement, and the infinitesimal freedom that lie in knowledge (Adorno 2006). The common view is that observation is a passive participation, much as traditional behaviours of theatre audience who conduct acquiescent contemplations; whereas interaction is active participation.

Most of the discussions of interaction, observer and performer touches on the macro scale that follows newtonian mechanism. It is interesting, however, that in quantum mechanic theories, observation is an active participation and a measurement of the system. I suggest that, a look, view, or continuous observation, could exercise as much effects to a system as bodily movements of interference. Though most effective in macro scale, scientists are trying to find the unifying quantum mechanics (micro) and newtonian mechanics (macro). I propose that in the case where an observer is not actively engaging with the interaction but merely performing observation, they are as entangled and participating as a performer who engages with the installation via bodily movements. Due to the limited resources and energy invested in the contemplation of this thread, the design work does not evidently demonstrate such a proposal.

Conclusion

Audiences do not immediately notice the relation of their movement to the reaction of lights. Audiences tend to enjoy interacting with the lights rather than looking at routined light behaviours. Engaging in interaction turns the audience into performers who are then observed as part of the interactive system. Everyone has their own interpretation of the purpose of the work. Some would appreciate the interaction without knowing the theories behind the work.

Uncertainty could be expressed via a number of approaches. In order to achieve a straightforward understanding, simplistic settings and minimal usages of geometry are recommended. Translucent acrylic or polypropylene are suitable materials that symbolize unpredictability. When it comes to addressable led light programming, random command in Arduino C++ could create effects that appear to be stochastic and uncertain.

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Image 10: Wen, W. (2019). Present Revisit prototype. UCL Here East Project Fair

Image 11: Wen, W. (2019). Present Revisit second iteration details

Image 12: Wen, W. (2019). Present Revisit second iteration train loop light effect

Image 13: Stanley Kubrick, (1968), 2001: A Space Odyssey. [Film]. Warner Bros.Pictures.

Image 14: Christopher Nolan, (2014), Interstellar. [Film]. Paramount Pictures.

Image 15: Wen, W. (2019). Present Revisit third iteration in display

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Figure 2: Wen, W. (2019). Present Revisit interaction mechanism drawing

Appendix

Code 1 Mapping hand positions and LED light positions in Processing (exerpt)

```
//for rightHand
        float angleRad = 0;
        int angleDeg = 0;
      if ((HandRight.x-SpineMid.x < 0) && (HandRight.y-SpineMid.y >0)) { //top left quadrant
        angleRad = atan((HandRight.y-SpineMid.y)/(HandRight.x-SpineMid.x));
        angleDeg = int(degrees(angleRad)); }
      if ((HandRight.x-SpineMid.x > 0) && (HandRight.y-SpineMid.y >0)) { //top right quadrant
        angleRad = atan(-(HandRight.y-SpineMid.y)/(HandRight.x-SpineMid.x));
        angleDeg = int(180-degrees(angleRad)); }
      if ((HandRight.x-SpineMid.x > 0) && (HandRight.y-SpineMid.y < 0)) { //bottom right quadrant
        angleRad = atan((HandRight.y-SpineMid.y)/(HandRight.x-SpineMid.x));
        angleDeg = int(180+degrees(angleRad)); }
      if ((HandRight.x-SpineMid.x < 0) && (HandRight.y-SpineMid.y <0)) { //bottom left quadrant
        angleRad = atan(-(HandRight.y-SpineMid.y)/(HandRight.x-SpineMid.x));
        angleDeg = int(360-degrees(angleRad)); }
        int angle = angleDeg%360;
//for leftHand
        float angleRad2 = 0;
        int angleDeg2 = 0;


      if ((HandLeft.x-SpineMid.x < 0) && (HandLeft.y-SpineMid.y >0)) { //top left quadrant
        angleRad2 = atan(-(HandLeft.y-SpineMid.y)/(HandLeft.x-SpineMid.x));
        angleDeg2 = int(degrees(angleRad2)); }
   if ((HandLeft.x-SpineMid.x > 0) && (HandLeft.y-SpineMid.y >0)) { //top right quadrant
        angleRad2 = atan((HandLeft.y-SpineMid.y)/(HandLeft.x-SpineMid.x));
        angleDeg2 = int(180-degrees(angleRad2)); }
      if ((HandLeft.x-SpineMid.x > 0) && (HandLeft.y-SpineMid.y < 0)) { //bottom right quadrant
```

```
    angleRad2 = atan(-(HandLeft.y-SpineMid.y)/(HandLeft.x-SpineMid.x));
    angleDeg2 = int(180+degrees(angleRad2)); }
  if ((HandLeft.x-SpineMid.x < 0) && (HandLeft.y-SpineMid.y <0)) { //bottom left quadrant
    angleRad2 = atan((HandLeft.y-SpineMid.y)/(HandLeft.x-SpineMid.x));
    angleDeg2 = int(360-degrees(angleRad2)); }

    int angle2 = (angleDeg2-90)%360;

    NUM_LEDSR = int(map(angle, 0, 360, 0, totalLEDNum));
    NUM_LEDSF = int(map(angle2, 0, 360, 0, totalLEDNum));
```

Code 2 Stochastic Galaxy in Aruidno (exerpt)

```
    void loop() {
    static uint8_t hue = 0;
    Serial.print("x");
    int i = random(0,353);
    leds[i] = CHSV(hue++, random(0,255), random(0,255));
    FastLED.show();
    delay(20);
    fadeall();
    }
```