

Influx

Synergies between Colours & Emotions

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the degree of Master of Design in Digital Futures

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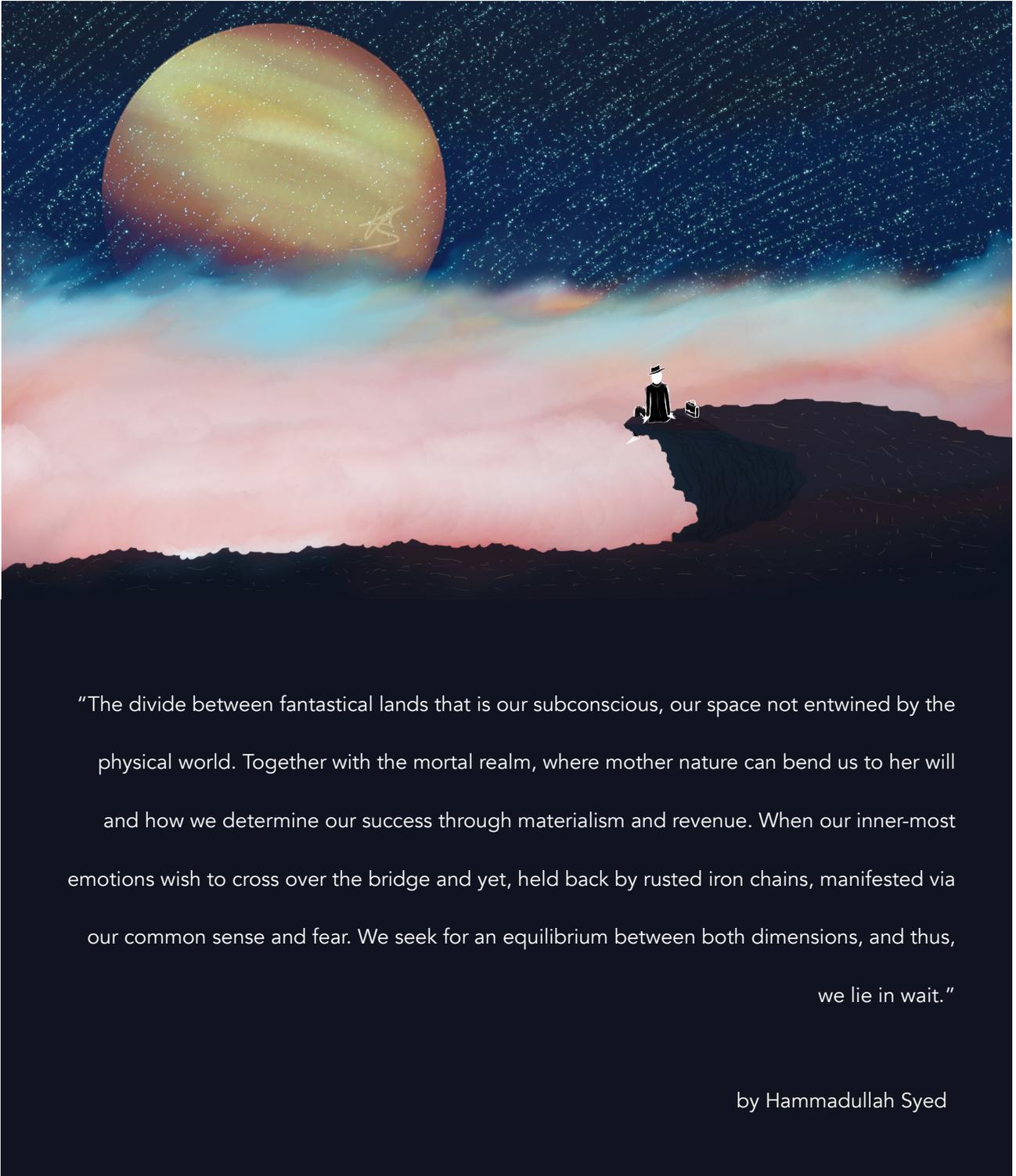
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“The divide between fantastical lands that is our subconscious, our space not entwined by the physical world. Together with the mortal realm, where mother nature can bend us to her will and how we determine our success through materialism and revenue. When our inner-most emotions wish to cross over the bridge and yet, held back by rusted iron chains, manifested via our common sense and fear. We seek for an equilibrium between both dimensions, and thus, we lie in wait.”

by Hammadullah Syed

ABSTRACT

Influx: Synergies between Colours & Emotions

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Master of Design in Digital Futures, 2018

OCAD University

The purpose of this research is to help people understand the limits that languages currently exhibit when trying to convey emotions. I explore Leland Wilkinson's Grammar of Graphics and Robert Plutchik's Psychoevolutionary Theory of Emotion to understand a user's expressional experience and how these experiences can be understood as data. The goal is to deconstruct the relationships between emotions and colour, suggesting that this partnership can become an additive to language. Taking an auto-ethnographic and a research through design approach, I created Influx, a tool for this language to take place and help people reconstruct their emotions in the form of colours.

Keywords: language, emotions, colours, communication, Leland Wilkinson Grammar of Graphics, Robert Plutchik Psychoevolutionary Theory of Emotion, deconstruction, reconstruction, subjectivity, visualisation.

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DEDICATION

This is to all those who have had trouble expressing themselves, troubled by the fact that no one would understand you or your intentions. Yet always looking to someone to express your feelings towards and would hope that they would just 'get you' (for the most part anyway).

May this research be a stepping stone for the bridge we wish to cross.

Influx

CONTENTS

1 BACKGROUND & MOTIVATION	1
2 INTRODUCTION	2
2.1 RESEARCH QUESTIONS	3
3 LITERATURE REVIEW	5
3.1 COMPLEX EMOTIONS	5
3.2 COLOUR THEORY	7
3.3 THE LIMITS OF LANGUAGES	8
4 CONTEXTUAL REVIEW & CONNECTIONS	11
5 THEORETICAL FRAMEWORK	16
5.1 DISTRIBUTED & CONCENTRATED SPACES	16
5.2 MAPPING DATA	17
6 RESEARCH METHODS	19
7 INFLUX	21
7.1 PROCESS	21
7.1.1 <i>Plurosphere</i>	21
7.1.2 <i>Stringularity</i>	24
7.2 DETERMINISTIC TABLES	25
7.3 DESIGN DEVELOPMENT	29
7.4 USER TESTING, OBSERVATIONS & IMPLEMENTATIONS	35
8 CONCLUSIONS	40
9 FUTURE DIRECTIONS	43
10 REFERENCES	45

LIST OF FIGURES

All images were created by Hammadullah Syed, except where indicated.

Figure 1. Plutchik's Circumplex Model	6
Figure 2. Johannes Itten's 12 hue colour wheel (Itten, Birren & Hagen, 1970)	8
Figure 3. Krista Kim's Digital Consciousness NO. 1004 V.5 (Krista Kim Studio)	11
Figure 4. Nick Verstand's Aura 1 (Verstand, 2017)	13
Figure 5. Nick Verstand's Aura 2 (Verstand, 2017)	14
Figure 6. Carlos Cruz Diez's Chromosaturatation rooms (Diez, 2018)	14
Figure 8. Brainstorm example of final output	17
Figure 9. Mapping the data into a bar chart	18
Figure 10. Plurosphere's homepage	22
Figure 11. stringularity's website interface	25
Figure 12. Deterministic Tables: Aesthetics example	26
Figure 13. Deterministic Tables: Build example	27
Figure 14. RGB value (241, 56, 92)	29
Figure 15. Emotions and Colour as an infinity loop	30
Figure 16. Prototype Score	30
Figure 17. Initial prototype sketch	31
Figure 18. Detailed prototype sketch	32
Figure 19. UX map of initial stage one touchscreen interface	33
Figure 20. Current stage one touchscreen interface	35
Figure 21. User's emotional representations	37
Figure 22. User's Colour Representation	39
Figure 23. User's Emotional Representation	39

1 BACKGROUND & MOTIVATION

I have always been fascinated by the ideology of identity and self-expression since childhood, however I always had difficulties in expressing my emotions and feelings to others, including my family and friends. As a remedy, I would write letters to myself about my situations as I knew my other 'me' would understand. However, this would later lead to complications such as other people finding out, not understanding what the letter's intentions were and thus dealing with the consequences. I then stopped doing this and kept my emotions bottled up; this was not healthy either. I became cold, shut everyone out and only stuck to myself.

I discarded my previous ways and transitioned to illustrations, here I was most fascinated by the ways that I could play with colour to convey complex emotions. The majority of the time I would use conventional Western nuances, for example, red would be associated with anger and love, and blue with calmness and mystery. However, at other times, I would use these colours in different ways, where the colours themselves would speak to me, to the emotions I would be feeling at the time. In either case, at the end of every illustration, I would be left feeling like my life was on track again. My ability to dive into fantastical worlds far beyond our reality was my form of personal escapism. After many years I started noticing others' who were experiencing this conflict without their own personal escapism. It was due to this realisation that I wanted to help people develop their own forms of escapism, in much the same way I found mine.

2 INTRODUCTION

This thesis investigates how complex human emotions can be represented and communicated through colour. I investigate the interconnectivity between colour and emotion and formulate a method for helping people create alternate representations of their emotions with colour, followed with reconstructing them through playful colour mixing. The result of this process is the display of abstract visualisations that is recognised perceptually as colours but understood conceptually as emotions.

This builds primarily on two areas: the first is understanding the relationships between colours and emotions, and how this should be interpreted on a per individual basis. The second, that this understanding can help users themselves and researchers to deconstruct their colours to emotions via Concentrated and Distributed colour spaces for mapping.

People can often describe their emotional state at any given time using simple words such as "happy", "sad", "angry", etc., but this is a gross oversimplification of the actual multifaceted state that they are in. In reality humans hardly ever experience any one emotion at a given time (Plutchik, 2011). Humans therefore, experience multiple emotions all the time in various combinations, but for simplicity's sake are often summarised into single words or phrases.

The result of this thesis project is ultimately a digital visual experience whereby a touchscreen surface allows users to convert their colours into digital paint and have them represented as emotions. The colours and their respective emotions will be understood by the users themselves, allowing complete freedom of choice for the user. This prototype is a two-step process where users will be first initially greeted with an input command interface where they will be allowed to pick any colour up to eight times. Each colour has their saturation and

luminosity scales ranging from zero to one hundred percent to provide users with a greater ability to choose their specific colours. After their given colours have been chosen, users then upload their colours into the next step of the prototype. Here users will witness their selected colours spill onto a black canvas as digital paint. Users will then be able to mix these colours as they mingle intimately with one another. I refer to these created colour/emotion representation components as new 'emotional pocket' (EP). Until the user stops playing with their digital paint, new EPs will constantly be made. Once they finish, the outcome will then display their entire 'emotional spectrum' (ES) which is an amalgamation of all their EPs at any given time. This once empty canvas beautified into a flurry of colour mixes is how we will be able to grasp, almost in its entirety, emotions visually. The result is a deep self-representation of emotions.

2.1 Research Questions

Due to their profoundly subjective nature, emotions are very difficult to represent and communicate. This thesis therefore asks:

Is it possible of developing a digital tool that would allow colour to be manipulated as a medium to express and understand one's emotions?

Our understanding of colour is solely based on the cultures that we have been brought up in and therefore might lead to cultural bias, if we were to predefine particular colours to particular emotions. Emotions and colours go hand in hand with respect that an individual would have their own interpretations of what these mean to them as oppose to another. Therefore, this tool is not meant to pre-define emotions through colours, rather re-define instead.

As the relationship between specific emotions and colour representations are subjective to the individual, communicating these visuals to another individual may not communicate the same

meaning. This issue of repeatability, where users may or may not translate between emotions and colours in the same way, is of concern for the goal of this thesis. Therefore the second major research question concerns the reliability of users' subjective results, such that:

How might colour and mixes of different colours convey similar or different meanings to different users?

The theoretical framework that has been used to explore this issue has been adapted from Robert Plutchik's Psychoevolutionary Theory of Emotion and Leland Wilkinson's Grammar of Graphics. This framework serves as a guideline and encourages participants and researchers to interpret a user's visual experience output. The individuals themselves determine the goals and duration of their process. In turn providing themselves with self-reflections and the ability to deeply understand their rationales for manipulating the colours the way did.

3 LITERATURE REVIEW

3.1 Complex Emotions

According to Dr. Robert Plutchik, a psychologist focused on understanding human emotions, "more than 90 definitions of "emotion" were proposed" over the course of the twentieth century (Plutchik, 2001), thus implying that the study of emotions has proven to be a difficult subject in terms of developing a unified model for conceptualising emotions. Our common use of language adds to this difficulty in that Plutchik claims "language itself introduces ambiguity and does not make it easier to describe mixed emotions in an unequivocal way". He goes on to say that "The internal experience of emotion is highly personal and often confusing, particularly because several emotions may be experienced at the same time".

To further illustrate the issue that humans experience multiple emotions clustered together as emotional spaces Plutchik provides an example. Plutchik asks his reader to imagine "if someone loses a parent, crying and grieving tend to elicit supportive and helpful contacts from members of the grieving person's social group and at last in a symbolic way, provide a sort of reattachment with the lost parent and thus a change in the feeling state". This example helps us to understand that an emotional space (ES) can combine to create greater ESs. This clarifies that one is never at a specific point in time, ever experiencing one ES, but rather multiple at a time. Thus if multiple ESs relate to each other, it can be safe to say that they mould together to create a greater matrix of ESs. This process of expansion can be both conscious and subconscious.

Robert Plutchik devised his theoretical model for a spectrum of emotional events that is referred to as the psychoevolutionary theory of emotion (Plutchik, 2001). This theory of emotion, suggests that emotions are analogous to colours in the sense that emotions can include primary, secondary and tertiary components. This describes emotions in both two-

dimensional and three-dimensional models, where dimensions describe certain emotional spaces and other dimensions describe their relative intensity.

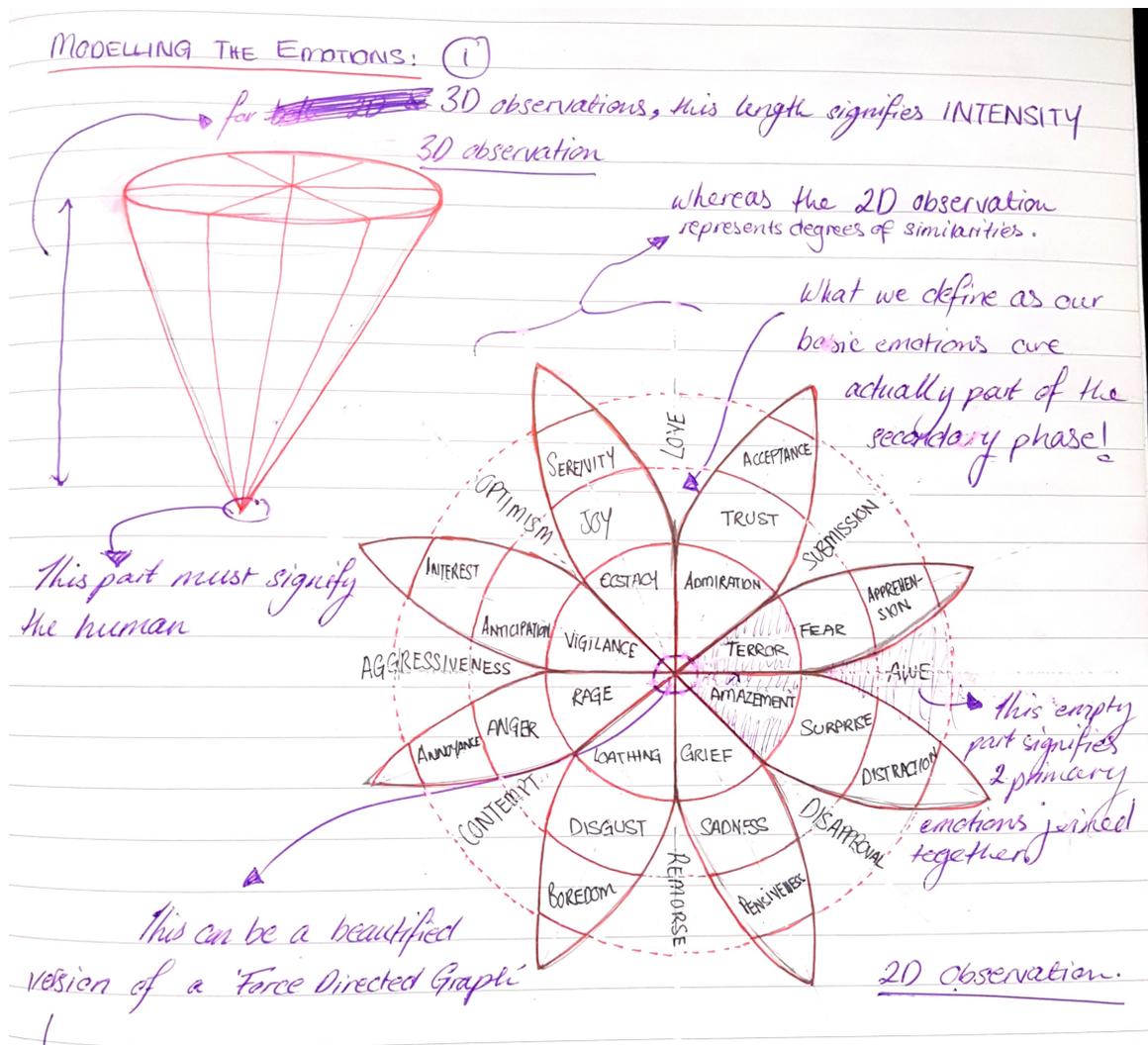


Figure 1. Plutchik's Circumplex Model

Referring to figure 1, the most inner circle represents the 'substrate' emotions and are considered the strongest. The middle circle represents what are commonly known as basic emotions (e.g, sad, happy, angry, etc.). These commonly understood emotions are expansions and subparts of the emotions before it. The gaps in-between the 'petals' are emotions that consist of two primary emotions. Plutchik evaluates that there are eight primary emotion factors that are designed to indicate the substrate emotional dimensions from which all other emotions are developed.

3.2 Colour Theory

Before I delve into the theoretical understanding of colour, I must define what colour is; colour is our perception of the world. It is how we identify our surroundings by describing further adjectives affiliated with them. Such that if I look up at the sky, rather than understanding its properties, (vastness, spacious, and composed of many particles) I identify it as 'blue'.

However, without meaning or precise ideas, colours prove to hold no useful discourse. (Itten, Birren & Hagen, 1970) Almost how language used as a means of communication yet doing so without meaning.

Johannes Itten was a colour specialist and teacher at the Bauhaus School of Design and he was also known for being the creator of some of the most iconic colour wheels in the modern era. Itten speaks to the construction of the 12 hue colour wheel, mentioning how each colour in the primary, secondary, and tertiary phases are exact representations of the said colour, best signified as the distinct colours of a rainbow. These colour values are critical in synthesising a neutral colour wheel such as cold and warm colours. Itten went on to say this colour wheel also offers multiple colour categorisations like complementary and analogous colours. Itten suggested his colour wheel laid the foundations for interpreting more complex colours and understanding their properties. To quote Itten, "I think it is a waste of time for the colorist to practice making 24 hue, or 100 hue, color circles. Can any painter unaided, visualize Color No.83 of a 100-hue circle?" (Itten, Birren & Hagen, 1970)



Figure 2. Johannes Itten's 12 hue colour wheel (Itten, Birren & Hagen, 1970)

Itten also elaborated on the unique expressive abilities colours hold, as colours are not bound to realistic properties, therefore can be used in describing subjective topics, in this case, emotions. I like to interpret this as Salvador Dali's surreal painting of animate and inanimate objects, where fantasy and reality mould, much like the discombobulations in attempting to narrow one emotion from the many we are experiencing.

3.3 The Limits of Languages

In tangent with the previous topic, Complex Emotions, our current notion on language, (those that are spoken, written or gesturally said), are not bad in expressing emotions. As it is through these types of languages that gives names to colours, rather, it is their misconceptions that make it incredibly difficult to get across. Tiffany Watt Smith, a historian at the Centre for the

History of Emotions, at Queen Mary University of London, explains in her TED Talk, *The history of human emotions*, that these types of languages, especially those that are spoken and written make it incredibly difficult to translate emotions coherently. In the beginning of her talk, she asks the audience to close their eyes for ten seconds and identify what emotions they were experiencing, after which she mentions, "there are some emotions which are so peculiar, you might not even know what to call them." (Watt Smith, 2015) It is because of this factor that, no matter the language, it is very hard to pin point some emotions, as some emotions are simply bundles of multiple emotions at any given time. In trying to pin point one, we are often led to try and address many at a time. Due to this amalgamation of emotions, we are often confused in how to express what we feel. Tiffany mentions that perhaps in attempting to understand our emotions, we might need to branch out to other languages just to express them; in Dutch there is an expression called 'gezelligheid', which directly translates to, "being cozy and warm inside with friends when its cold and damp outside." Or in French, the word 'dépaysement' meaning, "evok[ing] the giddy disorientation that you feel in an unfamiliar place."

In the movie *Arrival* (2016), directed by Denis Villeneuve, what seemed to be an alien invasion at first turned out to be an alien civilization's effort to save planet Earth. Their way of communication was through a highly developed non-linear orthographical language. In the film the alien language functioned differently than human languages in that there was no sequential syntax that we are familiar with. Rather with the aliens' language, all the information was present at a single glance and should simply be understood instead of 'read'. With this notion in mind, what I intend to present is a visual colour-based representation of emotions that is similarly not meant to be read but simply 'understood'.

Given all these factors these that go into the rationales for exhibiting colour and emotions as one cohesive form of expression, the next main chapter, 'Theoretical Framework', will address the theories I form to allow for such an experience to take place.

The next chapter, Contextual Review and Connections, speaks to individuals who and have executed works in relation to this literature review, and the connections that tie them to this research.

4 CONTEXTUAL REVIEW & CONNECTIONS



Figure 3. Krista Kim's Digital Consciousness NO. 1004 V.5 (Krista Kim Studio)

As per our daily lives, we rely on our digital screens for most of our needs. Our laptops, tablets, phones and televisions are all incorporated into our everyday lives. Kim acknowledges, "the ever increasing influence that LED devices are having on society [and] pushes the boundaries of the digital art-making process," (Ibid.). As she explores the revolutionary effects that technology has impacted us, our perceptions and messages given by the media and social structures, does she aim to allow artists and engineers alike to work in each other's platforms.

Krista Kim, creates surreal, abstract representations of emotions through colours. As the initiator of a new art movement, 'Techism', she claims it to be the reconciliation between,

“technological innovation with the creation of art.” (Kim 2017) Despite how it may sound, technology is not the forefront medium, rather the companionship between art and technology as one; the birth of digital humanism. The understanding that through art and technology can we create hyper forms of expressionism that become the norm for this century. “We are the masters of technology, and creating art is the expression of digital humanism.” (Ibid.) As this is not a movement which stands in itself, rather an adaptation for past movements. Here Kim claims that in no way should it oppress or devour previous movements, but become an additional resource for abiding by them, that is to say, artists can choose to adopt or discard with each phase of creation. She beautifully breaks down the companionship between art and technology for use via societal disciplines as follows, “Tech + Art is in the creative platform. Art is no longer limited to a frame on a wall. Art is becoming ever more an interactive practice. Collaboration has always enabled art’s creation. Collaboration materializes consciousness. Art is consciousness. Techism is an appeal and return to that consciousness, the consciousness of art as shared, as thing, as idea and as experience.” (Ibid.) Much to the realisation of mixed realities, the hybrid combination of virtual and augmented realities, Techism in essence, is ruling the evident crossings of the virtual world into our concrete jungle.

“Nick Verstand is a contemporary artist exploring human behaviour and perception through spatial audiovisual compositions. His autonomous installations and live performances investigate subjects as material-immaterial and internal-external and are created through collaborative design processes, aimed at breaking down social boundaries.” (Verstand, 2018) His installation, Aura, reconstructs human emotions via beams of lights projected onto the ground. Allowing the audience to experience, and almost ‘feel’ the rays of light. His understanding of ‘light as a material’ translates these emotions from gathering data by “register[ing] brainwaves, heart-rate variability, and galvanic skin response[s]” When users are laid down, this data is then metamorphosed into multiple forms of

silky rays of light and colour. (Morris, 2017) There are multiple 'light shows' taking place in a room, allowing users to see one another's emotional rays of light.

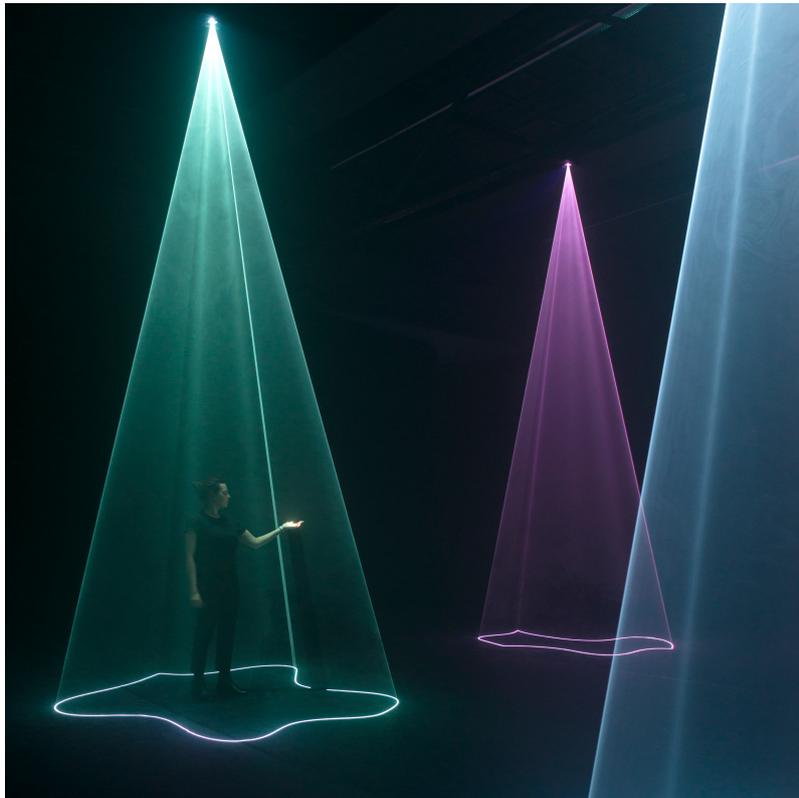


Figure 4. Nick Verstand's Aura 1 (Verstand, 2017)

While this display of emotions is truly breathtaking, this does not leave much room for discussing the audience's emotions between one another. However, I do not feel that this installation was for this matter, yet, more for the individual themselves. The ability to connect with one's emotions and almost have them reflected in a physical form to which one can touch. Such that light having mass far less significant than a gentle breeze, and powerful enough to make us believe that our emotions have taken a physical form in which we can interact with, is nothing less than genius.



Figure 5. Nick Verstand's *Aura 2* (Verstand, 2017)



Figure 6. Carlos Cruz Diez's *Chromosaturations rooms* (Diez, 2018)

The disassociation of one's understanding of colours in a space, where shadows can disappear and rooms transform, is what artist, Carlos Cruz Diez, creates in his installation

Chromosaturation. A series of chambers composed of three colours, one red, one green, and one blue that immerses audiences to experience colours in a monochromatic form. Diez does not rely on any perplexing technologies to create his illusions, rather relies entirely on the human retina to autonomously trick the brain into a reconfiguration of the surrounding environment; in essence, experiencing something outside of the realms of reality. Between chambers, the colours blend into one another producing a surreal experience of misinterpreted spatial joy, in turn "creating an aesthetic universe that submerges the observer in the artist's autonomous reality of colour, time and space." (Diez, 2018)

All three examples can be seen as a creator's, user outcomes, and user experience perspectives. For user outcome, Krista Kim's 'Techisim' speaks about using technology to re-engineer characteristics of traditional mediums to create new forms of experiential projects, and how this frame of thinking can be used to birth new means of experiential expression. The technical basis of Influx follows this frame of thought, the re-engineering of traditional mediums like paint, to be exploited as 'digital' paint, yet not leaving a permanent presence. For user experience, Carlos Cruz Dies, almost as a flip-side to Krista's 'Techisim', he tries to re-imagine a space using only colours as the medium. The fact that the architecture of the space is being conformed to the colours. This speaks largely to the criteria that emotions and colours can conform each other. Lastly the creator, Nick Verstand ways of interpreting features that do not have a physical presence and understanding these interpretations. In his example, Aura, using light as a medium, understanding that its mass is almost nil and the comparison to emotions, again as something that holds no mass, is an almost direct relation to each other.

5 THEORETICAL FRAMEWORK

5.1 Distributed & Concentrated Spaces

The foundation of my theoretical framework is Robert Plutchik's Psychoevolutionary Theory of Emotion. As discussed in section 3.1 Plutchik embraces the notion that emotions, similar to colour, progresses through primary, secondary and tertiary-plus stages. Moreover, can be further understood through both the two-dimensional and three-dimensional models. In the two-dimensional model the degree of similarity of emotions is represented as the distance from the core, and in the three-dimensional model the intensity of these emotions is represented.

However, the colours used in Plutchik's circumplex model (Plutchik, 2001) should not be defined as concrete representations of how emotions and colours mingle. As we research about the interconnectivity of emotions with colours we often notice that there are a few variations on this topic. This implies that colours and emotions should not be defined identically for everyone, and that individual differences play an important role. Our interpretations of these two attributes are strictly for us; we should be given the freedom of interpreting how we want to. Because of this, instead of blindly accepting that our emotions relate to colours directly, we open the table for discourse allowing audiences to understand why we feel this way.

Joint with this, Leland Wilkinson's Grammar of Graphics (GoG) generalises that most data, when considering how it is plotted onto a graph or visualisation, can often obscure how we interpret data. In most cases graphs and some visualisations, aside from being pretty graphics, display data that can be difficult to interpret. His logic implies, data plotting, of which the three elements Data, Aesthetics, and Geometries are essential. Data is understood as the variables to be plotted, Aesthetics as the medium to which the data will be plotted, for example, a bar chart or a pie chart, and Geometries as the shapes that will be used to interpret this data. (Wilkinson, 2010)



Figure 7. GoG Essential Layering System

5.2 Mapping Data

Looking at figure.6, there are two main attributes here that we will deconstruct: Distributed and Concentrated colour spaces. If we use Plutchik's Circumplex model (Plutchik, 2001) we can understand that emotions that are closer to the core are assumed as the strongest and clear, whilst as the emotions stem further away they can be seen as weak and abstract. Using this notion, areas that have significantly more activity, as seen inside the small black ring, can be seen as emotions that are stronger as the user had made a conscious effort to mix the colours together. Whereas larger bodies of colour with little to no interaction with another colour, as seen in and around the large black ring, can be seen as abstract and weaker.



Figure 8. Brainstorm example of final output

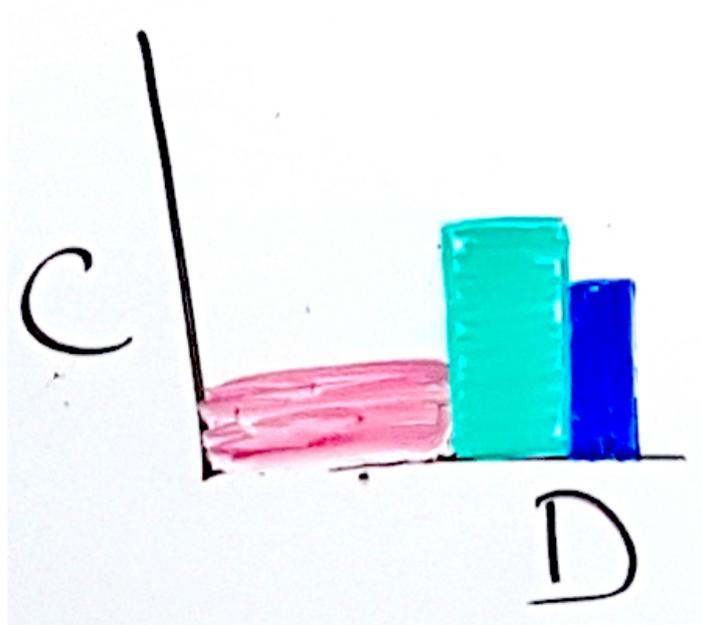


Figure 9. Mapping the data into a bar chart

In figure.7 I have defined the y-axis as the Concentrated colour spaces and the x-axis as the Distributed colour spaces. So when plotting the 'bars' into the chart, we can see a direct relationship between these two interpretations of the data. In doing so, the necessary elements of GoG (Wilkinson, 2010) have taken place. The Data is represented via the colours, the Aesthetics as the bar chart, and the Geometries as the distinct shapes used in the bar chart.

6 RESEARCH METHODS

Influx can be understood as a research project that expands on previous research attempting to unravel emotions that can be experienced and viewed visually while enabling a user to identify the properties of their emotions. The basis of this research is an expansion on Plutchik's Psychoevolutionary Theory of Emotions (2001) as mentioned in previous chapters. As such, the ideations, design work, and building processes seek to allow these experiences to take place and suggest that emotions with colours are personal occurrences defined by the individual, and should not be standardised for a population. By focusing on the process of designing and building this research prototype, the research methods employed in this thesis are research through design and auto-ethnography, which will be useful in helping guide this project as we evaluate the hypothesis.

Auto-ethnography is a research method commonly used in the social sciences where researchers study themselves and their cultures, and societal structures. The auto-ethnographic research method however does not necessarily need to belong to a specific research domain but it must essentially relate to the observation of subjects experiencing some kind of experiential input and sense-making (Genzuk, 2003).

Research through design (RtD) on the other hand, as the name suggests, employs design practices in seeking new knowledge. It "draws on design's strength as a reflective practice of continually reinterpreting and reframing a problematic situation through a process of making and critiquing artefacts that function as proposed solutions." (Zimmerman & Forlizzi, 2014).

Research through design principally follows five steps: (1) selecting an area to research and goal, (2) designing artefacts in order to accomplish the research goal, (3) evaluating the design with further research, (4) gathering design research results through user testing, and evaluating

these results, (5) and lastly, if the previous four steps lacked in any way, then repeat this process.

For what Influx stands as, the purpose of having two methodologies allow for a systemised understanding of how to encompass this research. Auto-ethnography becomes a means to which I can deconstruct how emotions should be understood, allowing myself to undertake a principal under this methodology called Discovery; a perspective where the researcher would suggest a topic to their participants in an attempt to limit their preconceived notions on the subject matter, (this will be covered in the User Testing and Observations sub-chapter later in this paper). This allows for increased focus and sharpening of the research as time progresses. Whence through the course of the study, valuable outcomes become not the preconditions, but new insights. (Genzuk, 2003) Joint with this comes RtD, as this research has undergone multiple theories and prototypes, RtD allows for a more in-depth focus outside of the pre-understood subject matter, prioritising on further developing the hypotheses. This methodology aids in locating the kinks in the research, in a sense, empowering the notion 'to fail is to succeed'.

The next chapter, Influx, walks through these methodologies in each of the prototype iterations.

7 INFLUX

7.1 Process

Emotions have always been the forefront of my endeavours, and as such, this project similarly seek to discover ways that users can express their emotions in a way that the audience on the receiving side would be able to understand them, or for the one expressing them to understand their own emotions better. I wanted this process however, to be simple, so as to avoid misinterpretations, and the prototypes presented here represent the conclusions of this endeavour. It was from these discoveries that, new insights, and experimentations were developed that finally lead me to my most developed research and prototype explorations.

The first prototype, Plurosphere, explored expressing emotions through linguistic notations whereby some of these notations were flexible words having no attachments to emotions. The premise was to allow users to express their emotions as freely as they wanted, resulting in visualisations that would depict these words. The second prototype, Stringularity, considered the approach of integrating colour instead of linguistic notations, having categorised a specific emotion relative to the colour hues.

7.1.1 Plurosphere

The first prototype depended on the individualism between two or more anonymous identities. I was initially trying to establish connectivity between anonymous identities, so that the creator of the artwork, however explicitly their emotions were portrayed, could never be exploited to the public, while the public could view the unique content as they pleased. Anonymity, at the time, was of strong influence in my thinking, as I felt that the process of coming out of one's

shell and openly addressing an audience with their emotions would be quite the feat to overcome. I did not want to put anyone on the spot, or make the user feel uncomfortable, as this would hinder their freedom of expression.

The artwork was intended to produce randomly generated visualisations in real time, but required initial human inputs, emotional typed keywords in this case, to generate the graphical output. To keep the anonymity strong, all visualisations would only be present for a set amount of time, such that audiences and users alike will only be able to view visualisations in the brief period before their complete erasure from the server. This meant that myself, the creator of the website, would not be able to access or salvage any of the information. Besides, I wanted to leave the emotions as open as possible, as certain words and phrases can trigger memories. For example, the term 'cake' may trigger a memory that holds multiple emotions, which in turn makes it easier for the user just to write 'cake'. Unfortunately, this became very ambitious, for I would have had to create complex algorithms to understand what 'cake' could mean to an individual, as the same word could reflect different emotions in another person.

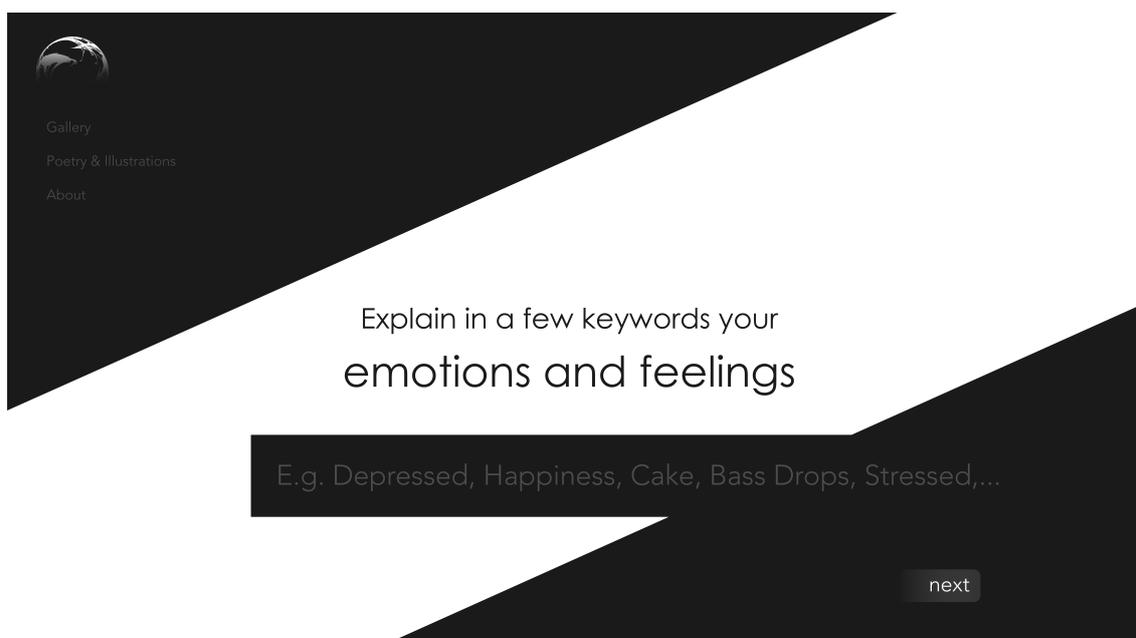


Figure 10. Plurosphere's homepage

Due to the complexity of the algorithms in the previous prototype, I deviated from these directions and started to look for the source of this issue, which I ultimately determined to be language. Language was, and still is what, hinders one's ability to express emotions coherently. The most common complaint by users in the previous approach was that they found it difficult when being forced to write their emotions out. There were two main problems with this. The first problem was that, for the majority of the time users were unable to pinpoint their emotions to a word, and much of the time, users' emotions were in the form of onomatopoeia. Because of this, creating the visualisations became ever more challenging for users. The second problem was that, the method of execution was not enticing enough. Users mentioned that if they were positive, then accessing and proceeding with the website was not an issue. However, when users were feeling negative, their motivation to produce clear responses was low and they would input the bare minimum. There was simply not enough drive for them to characterise their words properly and thus create effective visualisations in that state.

Once I came to understand this flaw, I made an attempt to create a universal language, (as far-fetched as that sounds) where there would be no barriers or misinterpretations. However, this language was not meant to be a means of scripture or symbols. In fact, I tried to eliminate any form of grammar or independent character forms. There would be no use for sentence structure or anything resembling the regulations that constitute linguistic notations. The intention was to adapt the visualisations from Plurosphere into the form of a perceivable 'language'. There would be no speaking involved and the shapes formed would not be predefined. This idea was an attempt to realise the alien language used in the movie *Arrival* (2016), yet, altered to only express emotions. However, despite the beautification of my ideas, it was just as overwhelming, and was soon dropped. This idea was not meant for this thesis.

7.1.2 Stringularity

In an attempt to still engage in forms of communication, I changed my scope from linguistic notations to colours. I understood the subjectivities that pertained to colours, and thus attempted to merge both colours and emotions to form a randomly generated visualisation that mapped these ideals. It was also by this point that I had narrowed my research further by neglecting the possibility of sharing an emotion with someone and stuck firmly with whether the visualisations was an accurate representation of the user's emotions themselves. The option to share the visuals was still present, but this was not the primary focus anymore.

The intended experience for this project was meant to be facilitated via website, and as such, after the experience was completed users could view other people's experiences too. This idea, unfortunately, started to collapse relatively quickly though, due to the connotations it had with audio. Many of the keywords and visual cues represented audio-based mechanisms, suggesting that there should be forms of audible elements throughout the experience. As this was not the case, the interpretation hindered the development of this prototype, in turn causing me to re-design the entire interface, and not long after, the entire prototype.



Figure 11. stringularity's website interface

7.2 Deterministic Tables

I had devised a system that would take all other ideas I had for a potential prototype outcome and limit it, such that I would only proceed with one. I called this system, 'Deterministic Tables'. These tables included the two following categories: The first reflected the aesthetics of the final outcome, and the second reflected the difficulties in the build process along with the time constraints. Each table was given five columns, each with a grading scale between one and ten,

with one representing the worst possible and ten representing the best. The totals would be calculated from both tables, and joined together to give a final score. The highest score would be the final idea that I would progress with.

DETERMINISTIC TABLES: AESTHETICS

DESIGN RESEARCH

The characteristics I'll be using to evaluate each prototype:

Simplicity: Visually, would it be something that's minimalist or something that perceives to be quite complex?
(S)

BUILD: Much like 'simplicity' this part determines whether the BUILD will be simple or complex.
(B)

Accessibility i): Primarily this speaks to the target audiences that can/cannot interact with the prototype.
(A1)

Accessibility ii): Secondly, this speaks to whether I can access the electronics easily or not, without destroying the overall look & feel of the prototype.
(A2)

COST: How expensive are the materials?
(C)

TIME: How long is it going to take?
(T)

All parts will be scored between 1-10 with an overall score of 60!

DIALS & SURFACE:

S	B	A1	A2	C	T	TOTAL
8	8	8	10	9	10	53

Simplicity: I feel this is a rather simple to approach prototype. As well as welcoming interaction.

BUILD: I would have given this a higher score if only the parts wouldn't have been so heavy. Because I intend to create the shell out of wood, I can imagine the much larger pieces becoming harder to transport around. Other than that, the build itself is quite straightforward.

Accessibility i): Aside from the completely blind & ~~perhaps~~ perhaps some wheel chair audiences this prototype should be accessible to all.

Accessibility ii): I intend to have hinges/flaps in all places that require me to access the electronics that when covered looks completely flush with the overall aesthetic.

COST: Looking through prices for different types of wood, I can say that this prototype is going to be a bit cheaper than I thought.

TIME: From the schematics that I have this should be a relatively quick build.

Figure 12. Deterministic Tables: Aesthetics example

TIME				
Development	Usability	Complexity	Cost	Final Perception
7	10	7	10	8
TOTAL				
42 42				

Development: *As the parts that I 'think' I need are quite already accessible, the building can take place right away. Also computationally the build ~~time~~ should be relatively simple as there's plenty of tutorials online for what I need.*

Usability: *Or UX, is really simple. Turning the dials will give instant visual feedback. Like increasing a volume for sound, my dials will spill colour onto a screen. & then users can physically interact with colour splodge as if they were playing with paint.*

Complexity: *Time: Computationally wise this should be relatively simple as there's plenty of examples online for me to follow. Processing wise I'm not too sure. There are tutorials online but tweaking my variables & animation may become problematic.*

Cost: *To my surprise, this build has come out to be exceptionally cheap. Because I already have a lot of the components already accessible or within my possession.*

Final Perception: *As I intend this to look quite minimalistic, the final build quality can be quite high as there won't be many components to polish. This will be very time efficient & allows for more time to make it look nicer.*

Figure 13. Deterministic Tables: Build example

I had initially structured my previous ideas to observe the following parameters before they were analysed by the Deterministic Tables. These parameters included the following: a simple sketch of the prototype and all the physical and or digital components involved, the technologies used to create it, a user scenario of the prototype in use, and to what platforms will they be applied to. The Deterministic Tables itself included its own set of parameters that concluded the scores of each prototype idea.

The Build version had five parameters that the prototypes pertained to: Development, Usability, Time, Cost, and Final Perception. Development related to the literal building process and how this coexisted with my own skill sets in the creation process. Usability was about the user experience with the physical properties that made up the prototype, which was more about how users approached the prototype and how they physically acted towards it. Time was simply based on how long it would take to build the electronics behind it. Cost was relevant to the costs of the electronics behind the build. Lastly, Final Perception focused more on how the electronics would be housed in the final design, suggesting that the inner compartments of the housing was made in a discernible manner.

The Aesthetic version had six parameters: Simplicity, Build, Accessibility 1, Accessibility 2, Time, and Cost. Time and Cost were as relevant as the Build version, but, they spoke to the materials that would affect the final aesthetics of the final prototype designs. Simplicity, as the name suggests, spoke to how minimal the prototype design was in its visual properties. Build would speak to how difficult it would be to create the visual properties, in most cases related to the housing of the prototype. Accessibility 1 would speak to the kinds of target audiences that would literally be able to access that prototype, relating to questions such as what would be the limitations to each prototype design, and who might be inadequate at following through with the prototype? Lastly, Accessibility 2 speaks to myself, the creator, being able to access important parts and components of the final build, like the electronics, of that prototype.

With a maximum score of fifty for the Build version, and sixty for the Aesthetics, for a total of 110 points, I had maximum flexibility in discerning which prototype idea would be best to proceed with.

7.3 Design Development

Since emotions, as described by thinkers like Plutchik, are composed of multidimensional underlying spaces, there is a difficulty in isolating and communicating every possible emotional space with conventional language, as there cannot be a word for every shade and combination. I suggest that this conundrum might be solved, or at least aided, by focusing less on communicating emotions through conventional language and instead focusing on other forms of representation. What visual colour offers that linguistic notations struggle with is their near infinite ability to stand alone as themselves. For example, a word can have multiple meanings attached to it, hence the existence of homographs. The exact value of a colour on the other cannot be manipulated so as to be understood as another. To illustrate, Figure 14 shows that if the RGB value of a digitally produced colour is (241, 56, 92) it will only be understood as (241, 56, 92). Therefore in the same way that there is an infinite number of emotions that exist along the multidimensional spectrum, colours can be used to account for all of these combinations and unified states. Figure 3 shows how I would interpret colours and emotions together.



Figure 14. RGB value (241, 56, 92)

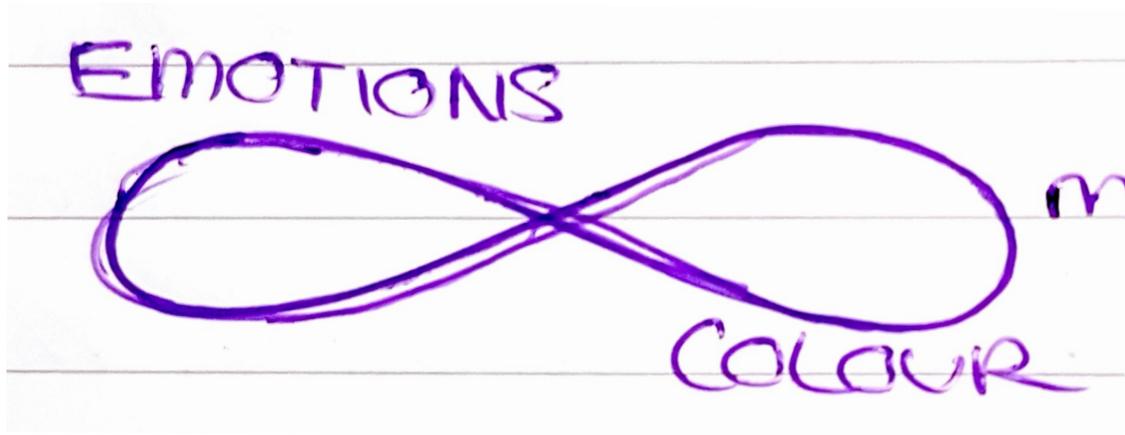


Figure 15. Emotions and Colour as an infinity loop

The earliest stages of this prototype development initiated with sketches illustrating a potential outcome with all the technologies involved and user scenarios, ready for calculations towards the Deterministic Tables. I ideated a total of 4 prototypes, all suggesting different forms of executing this latest research. With the highest score of 95 out of 110 (Figure 16), I proceeded with the idea of creating a touchscreen table that would allow users to play with colours for expressing their emotions.

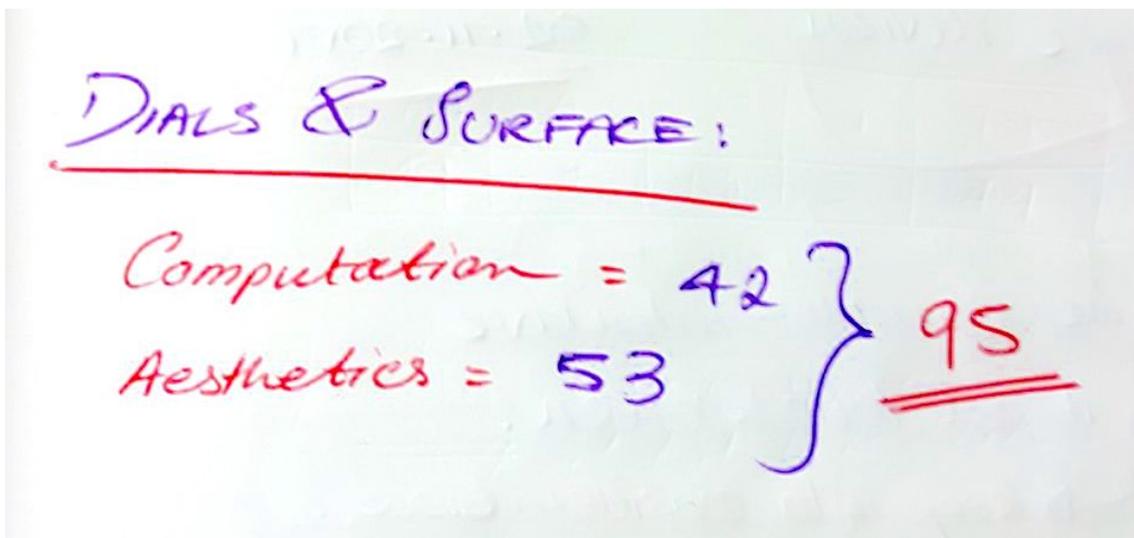


Figure 16. Prototype Score

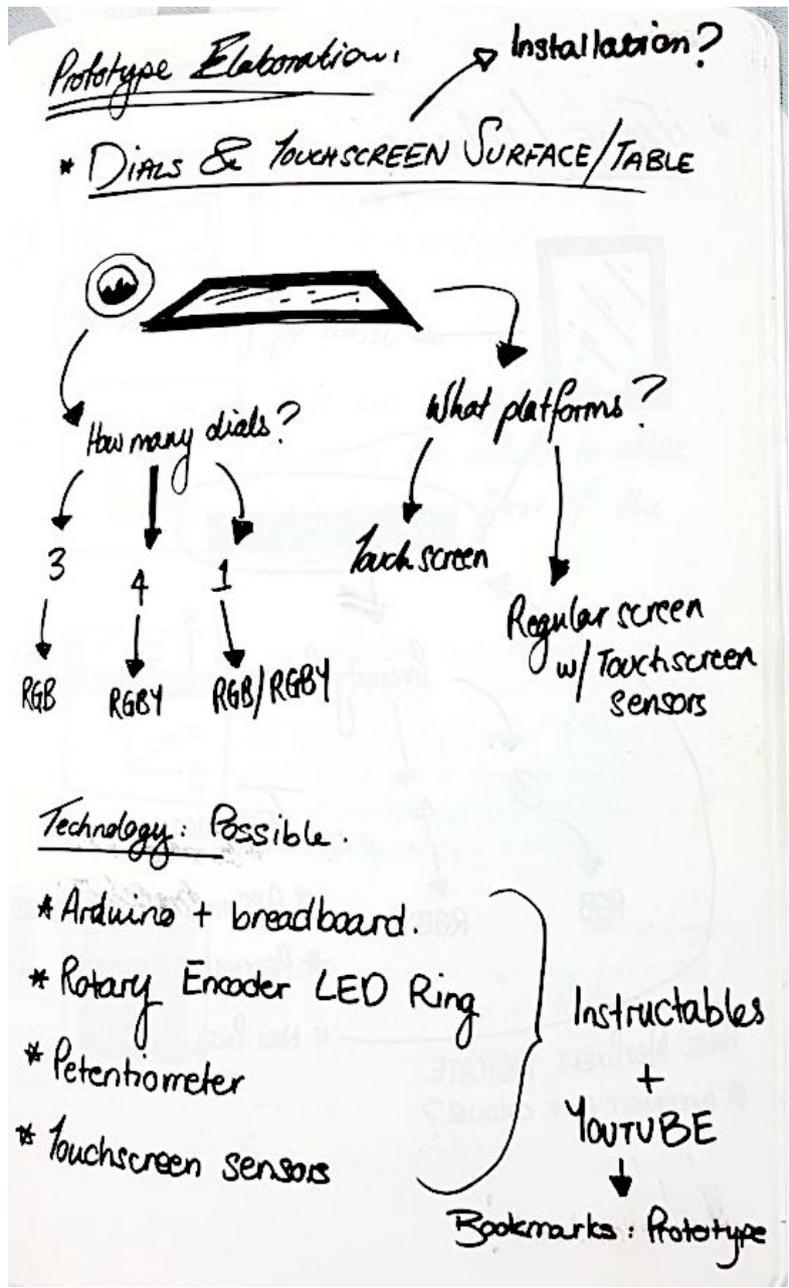


Figure 17. Initial prototype sketch

Immediately after this process, I transitioned into designing detailed sketches of the potential outcome. This iteration revealed the ability to use physical and digital properties in hopes of further engaging the user to be inclined to carry out their expressional experience. The table was composed of a large touchscreen as the base, and four smaller screens adjacent to four physical dials, as shown in Figure 18.

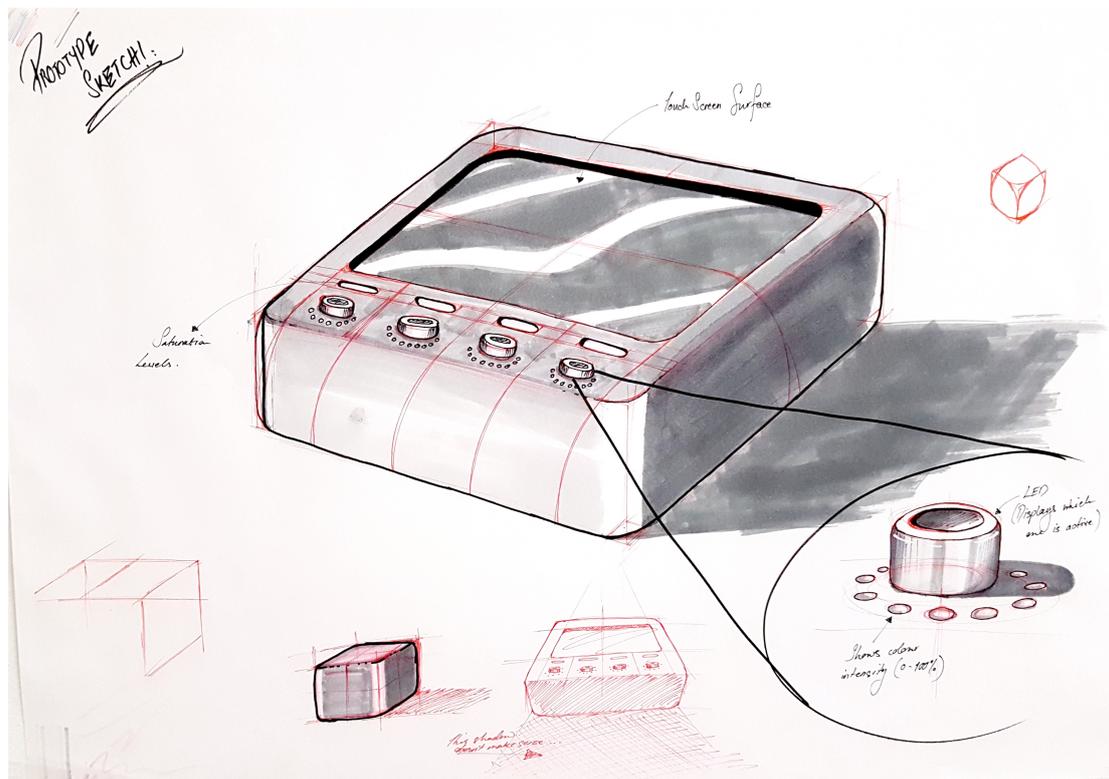


Figure 18. Detailed prototype sketch

This setup was created with the intention of offering a two-stage process. The first stage invited the user to pick a rainbow of colours and control their saturation and luminosity, through a click and dial left and right user experience, and could be carried out four times, hence the four dials and small screens. After choosing the colours, blobs of digital paint would spill onto the large screen, and at this point users would be able to control how much of this paint blobs were present on the screen by controlling their volume through the dials. When the desired amounts of colours were achieved and the user satisfied, the dials would disappear into the table, leaving a flat playing field. The second stage encouraged users to play with the digital paint as a form of digital finger painting, mixing the colours to express their current emotion while creating new colours. This ideation proposed that the new colours formed would further exemplify their emotional spaces and suggest a broader understanding of their emotions.

However, there were some problems with this approach. The first problem was that one, during the first stage, if a user made a mistake in their colour selection, then the only way to go back would be to double click the dial, which was fine only when this was the only correction. Other corrections involved re-doing a colour selection, re-setting the volume of digital paint, and re-setting all functions made. This meant that the user would have to learn multiple gesture controls, and given that this prototype looked sleek, I wanted to make sure the user experience was too.

The next iteration, as shown in Figure 19, looked into making the smaller screens touchscreen instead. This would then eliminate all the extra gestural controls for the dials and the flow of the experience would be maintainable, or so I thought. This iteration revealed another mishap, which was the fact that users would have to continually move back and forth from physically dialling to digitally using the small touchscreen interface for making their necessary adjustments. This now meant having the dials became counter-intuitive. I then resorted to removing the dials and keeping a total of two touchscreens on the table;, a large one and a smaller one too. This Figure 20 show what the small touchscreen interface looked like.

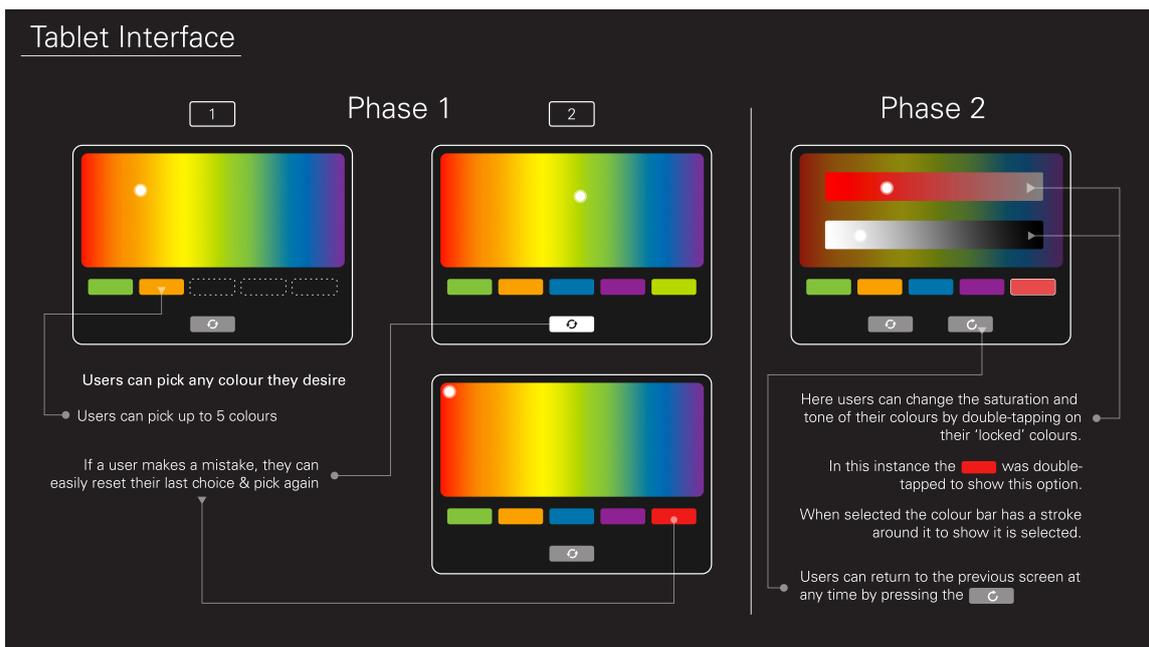


Figure 19. UX map of initial stage one touchscreen interface

The smaller touchscreen was approximately the size of a small tablet, had a large area for the selection of colours, presented in the form of a gradual colour palette, and five empty boxes (the number of colour inputs was still an ongoing thought, and did not define the final amount allowed) that could be selected to pick the intended colours. The new smaller touchscreen and interaction design also afforded the ability to pick the saturation and luminosity of the colour in question, and lastly, it offered options to reset each colour and return from phase two to phase one. Figure 19 describes how this is all executed.

While the interface was mostly acceptable, the need to have two screens however, became counter-intuitive too in a sense. Why would I use two screens if everything could be implemented in one? I thus changed the design to work with only one screen. Aside from the quantity of the screens, there were also issues in the UI/UX of the interface. Not all the buttons I had initially wanted were present in this design. In addition, the icons were misleading and could suggest resetting the entire colour selection instead of just one. Continuing this, in phase two, the back button looks like a redo button, primarily because of how we interpret iconography in relationship with language. As mentioned before, in English we read left to right, therefore using this notion, moving backwards should be affiliated with an arrow towards the left. Taking this stance in understanding the readability of icons, I transitioned to the final design where all the amendments were taken into account.

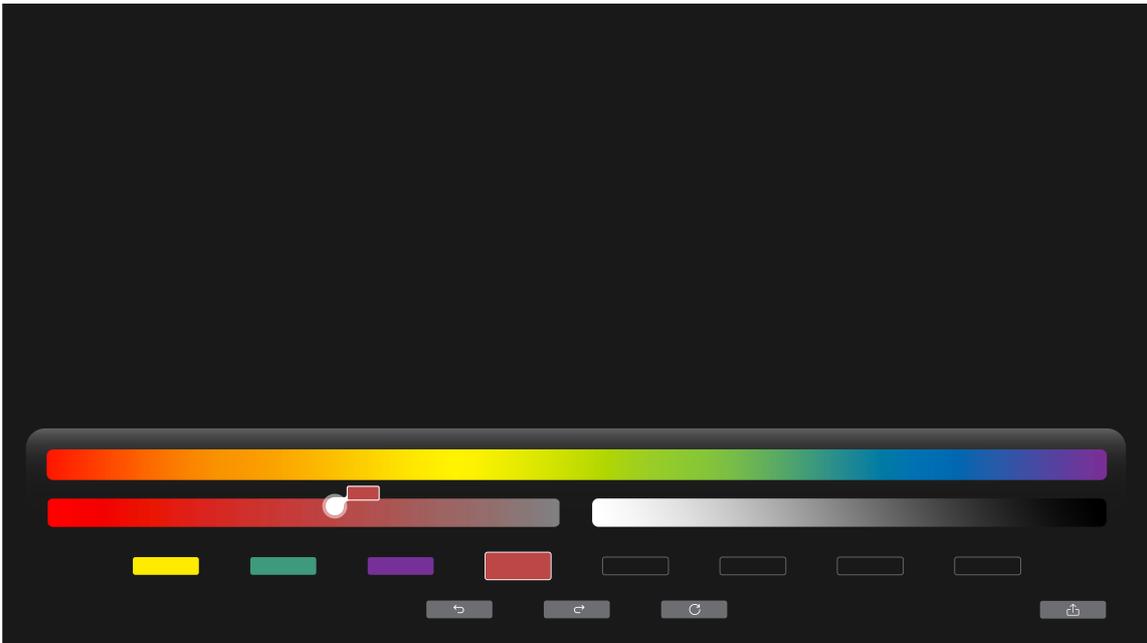


Figure 20. Current stage one touchscreen interface

Aside from a complete revamp of the previous design, I have tried simplifying the entire interface so there would not be a need for a phase one or two, and to allow for all actions to be displayed without hindrances, as shown in Figure 20. I have purposely reduced the size of the interface so that when the colours upload to the second stage, the interface disappears to the bottom of the screen and the digital paint seamlessly spills onto the screen. I added a total of eight colours to interact with so that users are given the freedom to choose their own. Also, the placement of the digital paint allows for the colours to spill from all corners and edges of the screen in relation from the top, bottom, left, and right from the center of the screen.

7.4 User Testing, Observations & Implementations

The user test applied here was directed meant to discern from five participants' understanding responses whether it was easier to express complex emotions through painting with colour as opposed to understanding the word and expressing it through linguistic means. This test,

additionally, was also a way to assess whether my hypothesis about concentrated and distributed areas of colour space was applicable and adaptable.

The participants were all from my cohort, each with a different background and age from one another. No personal identifiers were collected during the testing and their identities were not revealed through the research. They participated willingly as unnamed members of my cohort.

The user test was carried out by presenting to them twelve cards faced down, each with a particular emotion or feeling state that encompassed multiple emotions in each one.

Participants were asked to pick one of the emotions and have that card faced up, and were given a choice of three colours red, blue, and yellow, to depict their notations onto a separate card through painting. This exercise would be carried out twice until the final exercise, which was to fill out a questionnaire of five questions. The questions were arranged where the first three were directed to the paintings, asking participants to describe their processes and explain why their paintings were depicted the way they were. The last two questions were focused on the individuals themselves, asking how participants how they felt about their final outcomes, and whether their depictions were accurate and replicable to them. The questions to participants thus included the following:

1. Why did you use these colours?
2. Why did you make these shapes or gestures?
3. Why did you position the painting on the page the way you did?
4. In hindsight, how accurate is this emotional representation?
5. Would you do this differently if you were given another chance?

The results showed that, from my five participants, there were inherently four almost distinct forms of representations including the following: figurative, abstract, literary, and form with

function (taking abstraction into consideration, however one with a purpose rather than ambiguous depictions). Although, despite my expectations of how they would be perceived, most of the samples were abstract representations with no sense of purpose. This suggested that confusing or hard-to-interpret emotions can be too vague to easily describe them sometimes, and as these sessions were an 'error free environment' users tended to use this ambiguity at their disposals.



Figure 21. User's emotional representations

When asked the final question, 'Would you do this differently if you were given another chance?' seven out of ten samples answered with yes. However, their rationales were as loose as their reasonings and primarily based on the colours used and the form in which they were painted. The results suggested that only small tweaks were needed as there were no answers suggesting large or wholesome improvements and alterations.

A couple of the participants, after the exercise was completed, wanted to share their experiences regarding their experiences during the questionnaire about their thoughts when carrying out the experiment. They felt that when they were thinking of mixing more than one colour at a time, that they were doing so with the intentions that these colours had to mixed to provide the emotions they were trying to represent. One mentioned that because they were only provided with three colours, that they had to use three colours only, and that it did not

occur to them that they could mix the colours. Lastly, little to no prior thoughts went into positioning the painting on the page.

Based on the overall results I have two deductions from this analysis. First, if there are no colours on the canvas, participants are most likely to work from the center, but in doing so, they restrict themselves despite having much freedom of space. The second, I did not feel that most of the participants would be hindered by the fact that I had supplied them with only three colours. Being a graphic designer, I did not assess that everyone would *not* want to mix the three colours. I was under the assumption that I gave them a vast selection of colours as they all could be derived from the primary colours. Therefore, in hindsight, I need to make it clearer to users that there is a large selection of colours to work with, and provide them an easier and more appealing way to use them if they are so inclined.

When implementing these observations into the prototype, I came to the realisation that mixing paint traditionally and digitally are, in fact, two distinct kinds of experiences. When provided a canvas to paint on using traditional means, users generally paint from the centre as they usually have most control of their medium there. However, when provided a canvas with all their colours in place digitally, users sometimes make use of the entire canvas. This can be seen in Figures 22 and 23. In this example, the user had selected the colours red, blue, yellow, and purple. The colours were distributed randomly on the pages (Figure 22), and the user mixed them in ways they felt depicted their emotional state best (Figure 23). I also feel from this analysis, users generally feel this digital experience rekindles the curiosity of mixing colours beyond traditional means.

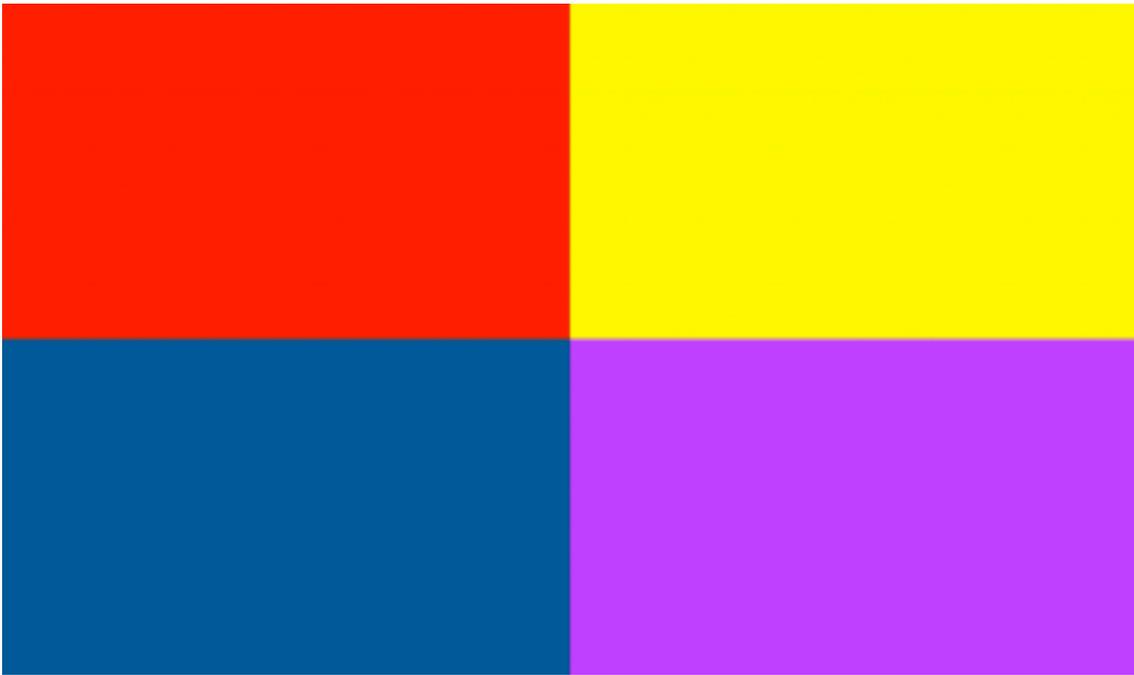


Figure 22. User's Colour Representation

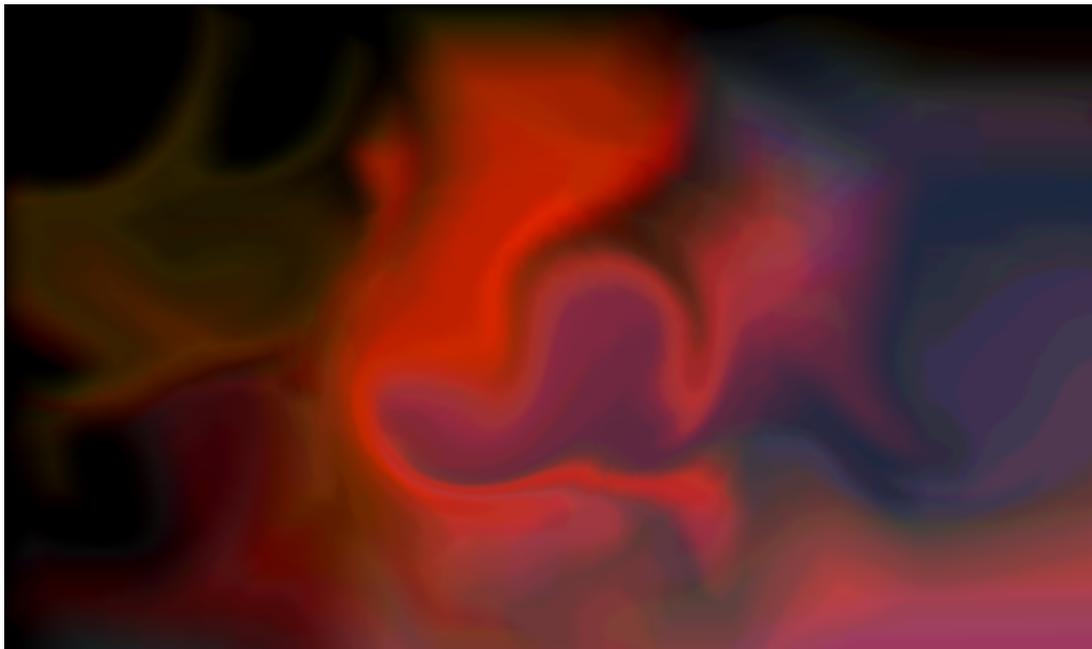


Figure 23. User's Emotional Representation

8 CONCLUSIONS

It is to my satisfaction that I have achieved my goal of giving others the ability to express nuances of emotion through colour and colour mixing. The outcomes become emotions for conversations rather than statements, where users can describe their emotional states through deconstruction and reconstruction.

It is also to my satisfaction that I have answered both my primary and secondary research questions. I have answered the first research question in that, yes, it is possible to develop a digital tool that would allow colour to be manipulated as a medium to express and understand one's emotions. This tool provides the user full expressivity and control over the colours they select without assumptions connected to culture, religion and society.

Also, through the research process of this project, I have come to the conclusion that the secondary research question, i.e., *might colour and mixes of different colours convey similar or different meanings to different users*, is beyond my control. Throughout my time of study I came to the conclusions that users are unlikely to experience the exact same emotions they had experienced in a different moment in time, but they can nonetheless feel similar emotions. Thus, in their attempt to describe to their audiences whether they can convey the similar or different meanings lies entirely with whether the user can literally describe them. This tool is not a solution to a problem but rather an aid, and therefore still requires the user to be *able* to formulate their own discoveries. The tool should allow the user themselves to be satisfied with the representation that they have created using the application. This could be an accurate or inaccurate representation of their emotional state, as represented by the colours they have chosen, and the ways that they have mixed the colours.

As an insight into this research, I have understood that in some way this thesis can be viewed as an extension of Plutchik's research into the Psychoevolutionary Theory of Emotions. He was limited by the fact that his theory was premised on the understanding that the relationship between colour and emotion could be unified and universal for all humans. Yet, emotions and colours, while they do go hand in hand, are personal to individuals, thus revealing that this experience is not in fact uniform. Colours are our ways of interpreting the physical, digital, and fantastical world around us. It is a way for us to further distinguish things we label. Because of this, the meanings of colours should not be bound by cultures, religions, or societies, but rather we should have full control of how we can use them as a medium for expression. This relationship between colours and emotions, therefore, should remain a personal means of interconnectivity.

This tool does not target any specific target audiences, and all are welcome to express their emotions. Some users can benefit greatly from such a tool, for example myself, as I have always had some trouble in orally communicating my emotions. As mentioned in the first chapter, Personal Background & Motivation, it can be extremely difficult to get across what I am experiencing using conventional languages that do not necessarily aid in delivering the message, and surely I am not the only one experiencing this obstacle. Other audiences like those who suffer from aphasia, mutism, other forms of communicative abilities, the elderly, or those suffering from dementia or memory loss, may find aid in conveying these emotions to their receivers.

When this tool was exhibited for the OCAD University Digital Futures Masters' Graduate Exhibition, I was able to observe casual participants' interactions and experiences with this tool first-hand. One of the insights I gained from these observations was that this tool could be

seen as something meditative and therapeutic. This approach does take away from the tool's intentions, but also creates new ones.

9 FUTURE DIRECTIONS

My previous research in this topic had hindered my progress many times in that the underlying focus was to categorise and structure forms of interpreting how one should perceive emotions and soon after, colours. Despite these iterations however, I have gained many insights and figured out ways of expanding this research.

As mentioned in the previous chapter, Conclusion, the feelings of casual participant observers of this tool was meditative and therapeutic, thus suggesting that this tool can be used as another medium for art therapy.

I can see this tool being used potentially as a tool for art therapists in hopes of better understanding their patients. As this tool represents emotions via colours, users can essentially cover up these emotions by surrounding them with other colours. With this depiction therapist can identify these issues, and help in deducing methods to solve them. Additionally, if patients were asked to paint how they felt every time they had a session, the therapists could pick up patterns in their patients expressivity, further understanding their behaviours and possibly their intentions too.

I speak strongly to how colours and emotions should be seen as a personal experience and should not be bound to uniformity and universalism, but, this is based on human input.

Understanding how human populations across the globe perceive colours would be a benefit in post-modern designing for all areas of expertise like graphic design, architecture, and fashion design. I therefore, propose the following idea, which is how does this tool expand upon if machine learning and AI were used to record how colour are seen and used around the world beyond human biases?

There are limitations to this tool, whereby those who are visually impaired cannot fulfil this experience. To this I ask, how can this tool be made more accessible to these types of people? It would be interesting to verify how the blind interpret colours, for both that were born with it and those who lost their sight. And for those who are colour blind, how do they interpret their emotions through colours? How would the colours they choose vary from their vision as opposed someone who is not colour blind?

This tool can be used in big data applications too, such as identifying a location's emotional state based on the population's interactions with this tool. For example, if 100,000 users were active during a span of a month, how might the overall population's emotions be represented through colour? For this to be carried out users would have to be prompted about the relationships between colour and emotions and an algorithm would be needed to identify an average for these relationships. If we could see a representation of colour for a population, what else could we learn?

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