AI Art and Design Perceptions:

A Sociological, Philosophical, Economics and Technical Study

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Abstract

Over the years, there has been an increase in Artificial Intelligence Based Art and an increase in the intervention of AI in the Generative Design industry. A market research has shown that the Generative Design industry is expected to accelerate at rates of 16 percent due to an increasing intervention of Artificial Intelligence (Technavio, 2019). There have been rising debates on whether AI can be creative and whether AI can produce Art. This study aims to highlight the background to the 'brain' of AI – Creativity, Computational Creativity, Genetic Algorithms, Generative Art, Mathematics of AI, and a history of AI based art. In section 2, this study aims to discuss societal, philosophical and economics-based implications of AI based Art, and whether AI based Art could be the next 'Dada' Movement.

Based on a review of the Art collector market and an AI market survey with AI artists and Artists in the industry, an online survey was distributed to people across age brackets in the university and artist community, and were asked to respond as per their preferences towards certain art pieces. Analysis of the responses demonstrated that the respondents generally prefer when a human paint than if it were painted via an AI based system. And also ascertained that human reactions were different when art pieces were displayed without being told that AI or Humans produced the pieces. However, the research has been performed with a midsize sample of respondents. Further research and surveys across communities is needed to re-ascertain the conclusions.

In addition, based on review of the AI market and the market survey, an economic analysis has been built on the basis of the interviews with AI artists and a broad market evaluation. An analysis of the market brought forward the changes in the job market, art collector market and other evaluations of the generative design industry.

Keywords: generative art, artificial intelligence, art, economics, philosophy, psychology, creativity, computational art, market

Section 1: The ‘Brain’ of AI based Art and Generative Art

Psychology, Creativity, Science and Mathematics

This section revolves around what goes in to making of Artificial Intelligence based Art and generative design, and a brief history of AI and computational art.

Section 1.1: Creativity

What is creativity?

"I saw the angel in the marble and carved until I set him free". This quote by Michael Angelo captures the duality of what it means to be creative (King, 2020).

Being a creative individual means thinking, exploring, understanding, discovering new ideas and most importantly taking risks while ignoring doubts and facing fears. It means doing something for the sake of doing something totally different, the ability of thinking independently of any one direction of thought to look for opportunities for knowledge and to manoeuvre one's inner cacophony and riot of perceptions and neurological transmissions into a meaningful form of expression to which other people are able to relate.

It comes with experimentation and hurdles, such that there are possibilities of inspiration found even in the most mundane places with a capability of influencing your perspectives. Inspirations can at times be derived from places, ideas, things and people alike.

Thus, in one sense, creativity allows us to grow better, connect with other beings, and in one sense make the world a better place, where individuals can express their creativity, in order to achieve deeper understanding of one's purpose in life.

It's often said "we create by perceiving, and 'perception' itself is an act of imagination, and an outcome of creativity". In the world out there, there is no benchmark set to conclude if someone is creative or not. Creativity means different things to different people depending on the

muse, niche or medium of expression, because we interact with, process, and produce creativity differently. And likewise what might be creative for one person might not be for another. Thus, E.H Gombrich in the Story of art often puts forward the thought that there is no likes and dislikes in art but it is the object or subject in the frame of art that might be liked or disliked (p. 16). A set of notes played on a piano is 'music' to some ears while it's noise to some. In other words, it can also be interpreted as quietness in chaos and chaos in quietness, which is the reason creativity of often denoted as being a 'matter of perception'.

Steve Jobs once said,

> *"Creativity is just the ability to look at things in a new way. When you ask creative people how they did something, they feel a little guilty because they didn't really do it, they just saw something. It seemed obvious to them after a while. That's because they were able to connect experiences they've had and synthesize new things. And the reason they were able to do that was that they've had more experiences or they have thought more about their experiences than other people."*

Essentially creativity is about making connections and taking actions. Taking action is a really important factor for doing something creative as it drives new ideas, theories and technologies from insights into reality. This is because if one has a bunch of ideas but doesn't act on them, that person is called imaginative and not creative.

It can also be said that the entire process of creating something is more important rather than just the final polished outcome, and most of the people struggle with this process, and questions often arise like, if their work is good enough? Will they be able to salvage something from the train wreck they imagine they have created? Does the interaction with their work provoke something? (Clear). In one sense, thus it is said that the journey of creating art is more important than the art piece.

In the current time, creativity is as perplexing as it was in the ancients, who cast creative ingeniousness in the realm of the supernatural and declare it the work of the muses. To understand the creative process, we can think of it as a four step process as mentioned in the book “The Art of Thought” by the British psychologist Graham Wallis where he outlined the theory of the creative process based on many years of observing and studying the inventors and creatives. This creative process entails four essential steps:

1. Preparation: The first step (discover and listen) the creative process, is to gather new information and materials, and acquire knowledge about anything and everything that one’s brain can handle around the project.

2. Incubation: In this step (design and create), the information and ideas collected in step 1 are brought together to slowly create tiny, million connections in mind. During this process of growth of ideas, the thinker takes their focus off the problems and allows it to rest. Though their conscious mind is not thinking about it, the unconscious thought process is busy in creative thinking, something that Einstein called “Combinatory Play” which is an act of opening up one mental channel by dabbling in another.

3. Illumination: In this step (develop and implement), following the period of incubation, insights began to arise from the deeper layers of the mind, and this is where the jolt in the consciousness awareness which tells that you have got the idea. This sudden flash of solution is known as illumination and is similar to a lot of our

"aha" (Eureka feeling) moments and it happens when we are least expecting it to happen.

4. Verification: In this step (deploy and deliver), the ideas are refined. You know that you have the solution, but it becomes necessary to verify whether those solutions are correct or not and make minor changes as these solutions would be used to make foundation structures of the project. If the results don't come to be true, the thinker goes back to the creative process from the beginning and gathers more resources and knowledge to find the missing elements.

The process mentioned above doesn't always move in a similar order, and it tends to look more like a spiral than a straight line. Another important factor that adds to the creative process is how thinkers inspire, and thrill us with numerous possibilities. Creative thinkers are those who have the courage to do something differently against all the odds. It then doesn't matter how many people you inspire, one or one million, they have the ability to continue to learn and evolve (Gregoire, 2019).

Science and Psychology of Creativity

Science says that creative people are complex and contradictory. The brain has different lobes present across it that handles different tasks. For normal thoughts, specific parts of the brain are responsible for making decisions but in case of creative thoughts there is no specific dedicated area from which innovative ideas come from. These creative thoughts and processes tend to be chaotic and non-linear in nature, which means we cannot predict them anyways. Inside

the human brain, creativity doesn't involve one specific part of it, it uses the entire portion of it (Grigonis, 2018).

Research has exemplified that inside the brain, there are various different processes, including processes like, working memory(memory system in the brain responsible for short term processing and manipulation of information), abstraction(thought process characterised by adaptability and flexibility), planning(set of brain functions necessary for control of behaviour), and cognitive flexibility(function that allows to switch between different concepts), which are crucial for creative thinking. Neuroscientists have also been studying towards making a connection between creative processes and different parts of the brain involved in processing creative thoughts, and have defined creativity as mixing and remixing of hypothetical symbols inside the brain that represents the external reality, to create new ideas and ways of thinking. If we look back to Steve Jobs' quote above, he also thought of creativity in a similar manner (*Connecting the Dots: Your Brain and Creativity*, 2017).

Combinational, exploratory and transformational creativity are three ways through which people can think of creative or unique ideas; as suggested by scientific psychology. A parallel has been drawn between the concepts of artificial intelligence (AI) and the information processes for creative thinking. Let's delve into each way in detail to understand the concept better. A fact that should be cleared here is that creativity is not just confined to so called creative industries, science as a subject is creative too. The art of coding, making new chemicals in the lab, biotechnology, blueprint design etc. all entail some sort of creativity.

Combinational creativity can be thought of a practice adopted by artists when they use familiar ideas to arrive at unfamiliar combinations. Examples for this type of creativity would

include scientific analogies, computer generated animations, poems, musical notes, and collage in visual arts.

The second type, exploratory creativity, comes from a culturally accepted style of thinking. New structures are created within an existing style by following some basic rule of that particular style, while exploring new things. In Exploratory Creativity, a person moves through the space, exploring it to find out what's present over there which also includes previously unvisited positions, and in most interesting cases to discover both the potential and the limits of the space. Examples of this type of creativity would include culinary recipes, and impressionist paintings.

The final way is transformational creativity. This is used to overcome certain limitations of exploratory creativity. Because in exploratory creativity, already prescribed rules have to be followed, certain structures cannot be created. The developer alters the previously accepted rules, which makes it possible to create previously impossible results. One drawback for this method is that it is not easily accepted because of the simple fact that some commonly accepted conventions, which have been in force, are broken and new ways are approached.

Creative Computation

Above discussed three types of creativity have been modelled by computers and have contributed greatly to the aesthetic of computer art. Their performance would certainly be tagged as 'creative' if it were done by a human being. However, there is a likelihood of objection to tag the computer 'creative' as shall be explored through various parts of this study.

It's not surprising that AI and computers can be creative when creativity is evaluated via 'combinatorial creativity' discussed above. After all, nothing could be simpler than to provide some simple commands along with images, improvising music notes and let the machine combine it using some sort of randomness, eventually most of the outcomes would be quite novel, surprising and unfamiliar.

Computers are capable of doing creative things like, making music and songs, writing stories (GPT-3), scientific reasoning, generate cooking recipes, draw and paint pictures, innovative ideas in literature and architecture and other visual effects. This brings us to Computational Creativity which is a multidisciplinary endeavour that is located at the intersection of the fields of artificial intelligence, cognitive psychology, philosophy and the arts (*Can Computers Be Programmed to Think Creatively?*, 2016).

Upon evaluation of Computational Creativity and study of the so called 'brain' of the computer, it can be very easily concluded that computers are more than feature tools, and instead are more like autonomous creators and co-creators in their own right.

According to the Computational Creativity Conference Steering Committee (the group behind many computational creativity research events), the goal of computational creativity is to model, simulate or replicate creativity using a computer, to achieve one or more of the following several ends: (*Association for Computational Creativity*, 2019)

- To construct a program or computer capable of human-level creativity
- To better understand human creativity and to formulate an algorithmic perspective on creative behaviour in humans
- To design programs that can enhance human creativity without necessarily being creative themselves

Computational Creativity is often applied to Artificial Intelligence, in order to produce innovative outcomes which are imagined as impossible for computers such as sculptures, written work of fiction and music, art pieces, pop art etc.

While computers have been known for using complex algorithms, and mathematical logic, creativity once again is thought to be an exclusive domain of conscious beings. The question over the possibility of computational creativity and can machines be creative is quite popular and many creatives are vocally against it. The questions arise as "how should computational creativity be evaluated?", or "can systems programmed by humans be considered as creative?". Further evaluation of creativity and the philosophy of creativity is covered in *section 2*.

In the computational field, when scientific research is performed, the evaluation of how efficient the results are and how well the scientific process was carried out are quintessential. Thus, some sort of system to evaluate against the process is important as a procedural testing method. However, in the case of creativity and the general fuzziness in the definition of the term, such an evaluation made by human beings tends to be subjective. Object A might seem to be creative to person B, while not creative for Person C. Therefore, to facilitate better evaluations, the Turing test and the Lovelace test offer a determinant if a machine is creative or not.

Turing Test

The Turing Test was a thought experiment which was used to determine whether or not a computer could fool a person into thinking that a computer was an actual human being, such that one cannot differentiate between a human and a computer when communicating with them. The test was crafted according to the following criteria- If the computer could imitate the human, then it should be considered 'intelligent'. This was based on the party game at the time of the "Imitation Game", where two people would go into separate rooms with typewriters and people would ask them questions through the doors and they would reply typing on the typewriters pretending to be the other person and the guest would figure out which person was which.

Alan Turing proposed that in the "Imitation Game", a person should be replaced with a machine or Artificial Intelligence and then conduct the same experiment and see if the Artificial Intelligent could pass the test just like humans or not. In 1950, when Turing wrote his seminal paper on this topic, he was not proposing that this test should be used to determine whether a computer is intelligent or not. He was trying to convince people that it might be possible for computers to have a tendency to imitate human intelligence to help us understand how the brain works (*The Turing Test (Stanford Encyclopedia of Philosophy)*, 2016).

After the test was released, other arguments relevant to the topic came up such as The Chinese Room argument, which proved that the Turing's test is inadequate as it is more a matter of appearance vs. reality. Searle's put the argument forward that the computer only appears to be intelligent but in reality it is false intelligence, which Searle's defines as simply "simulating the behaviour" (*The Chinese Room Argument (Stanford Encyclopedia of Philosophy)*, 2020).

The above two criticisms reflect on the debate around AI and creativity. And could be said that the Turing's school of thought are supporters of AI and Searle's school of thought are thought provokers.

Lovelace Test

Ada Lovelace, the first computer programmer said that, "Computers can't create anything. For creation requires, in the minimum requires originating something. But, computers can be said to have very minimal originality. "They merely do that which we order them, via programs, to do". She was suggesting that a computer cannot have human-like intelligence till the time it's only doing what we humans have programmed it to do. For a machine to be creative, a machine should be able to generate new original ideas (O'Neill, 2014).

This brings the idea of the Lovelace test in 2001, which is a thought experiment that specifies a machine to be intelligent if they are able to surpass the original 'thought' and its outcome, that can't be differentiated by humans based on the original code. So, creativity became a proxy for intelligence and the researchers who developed the test proposed that Artificial Intelligence could be asked to produce something creative, like a piece of painting, a poem, music lyrics and more, and the Lovelace Test would be passed only if the AI programmer could not explain how the machine came up with its answer.

Can AI/Machines be creative?

When creating art and music, random mathematical functions can be used , or some extremely complex algorithms using chaotic functions, pseudo random numbers to generate random shapes and structures on a canvas (cartesian plane) or a sequence of music notes. Though most of these art and music produced would be something that is never seen before but a large part of it would be chaos and not so aesthetic in appearance. This is because computers are unable to differentiate what is beautiful for humans and what is not on their own.

But, if we look into the things around us, and model natural processes which allows creativity to form, our mind sort of experiences 'The process of Evolution', which mirrors the way we and animals alike establish a knowledge base on the basis of all what is around. As it is known we learn from experiences, events, education and interactions around. And then, we tend to reproduce, mutate, mimic and establish our own 'thought process'.

Similarly, the Evolutionary algorithms or more commonly the genetic algorithms which mimics the Darwinian laws of nature via the Darwinian laws of natural selection. These biological evolution through the means of reproduction, mutation, recombination and selection, forms a parallel, exploratory search for solutions. This technology of mimicking the natural laws of nature is based on a population of solutions, rather than one single solution. These solutions are continuously refined over generations and generations and it can afford to try out novel ideas and discover solutions that are quite surprisingly creative.

Evolutionary algorithms have made it possible to come upon new designs and behaviours through ebullient, but guided explorations. Another area of Artificial Intelligence entails Deep Learning which works with supervised training on existing datasets and takes advantage of

massive amounts of labelled data and computational power to develop statistical models through regress training processes. This has been well proven in the field of automating behaviours but when it comes to extending past them where Artificial Intelligence can think ‘out of the box’, evolutionary algorithms come into play advancing the creative approach of AI (and machine creativity), finding and working towards solutions which do not exist yet. For example, a few applications of evolutionary computation could include creating musical melodies, coming up with trading strategies for foreign exchange, gene network reconstruction by analysing microarray data, generating new design forms which are more complex and effective than human designs (Miikkulainen, 2018).

Section 1.2: Genetic Algorithms

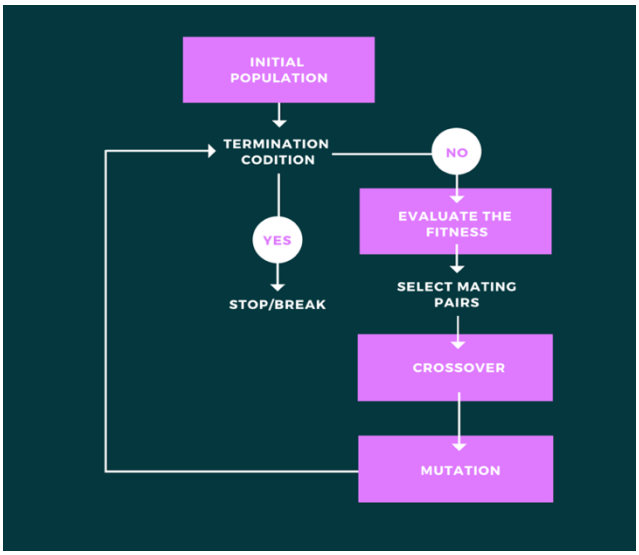


Figure 1
Genetic Algorithms

Nature is incredibly smart. Through millions and billions of years, it has found ways to optimise just about everything it does. All aspects of our life are driven by computation and algorithms, how we learn, play, work. Given the situation, we can say Generative Art best

reflects our present time - work created at least in part with autonomous systems, where artists use heavy use of mathematical functions, geometry algorithms to create aesthetically appealing art pieces. To reflect this, artists have also been using evolutionary algorithms, or more generally 'Genetic algorithms' in their artworks, which in simpler words is an optimization technique that mimics the Darwinian laws of natural selection, the 'survival of the fittest', and depending on what type of problem we are working on these algorithms could be tailored accordingly.

There are three types of genetic operations that can then be performed:

1. Crossover: It represents the reproduction and crossover, similar to what is seen in Biology, where an offspring takes on certain characteristics from its parents.
2. Mutation: It represents the biological mutation and helps to maintain genetic diversity from one generation to the other generation by introducing small changes.
3. Selection: It's a stage where offspring genomes are chosen from the population for crossover.

Here we can cross-think of working with images and art, so the fitness value will be calculated on the basis of how different colour pixels are present. There are a lot of different selection methods out there, and one such method is the *Tournament selection*, which could be used for this purpose. In Tournament selection, we choose individuals (chromosomes) from the population and force them to find a tournament. We choose the winner based on each participant's fitness, which goes further to mate and propagate genes.

Once we have our new generation, we can also check for some mutation by applying it to the selected parents and generate new offspring with altered genes. This way, we would get the best optimized solution and in this case, the initial set of random shapes would eventually replicate the original image.

This process indeed has immense amount of ‘randomness’ and ‘complexity’ built in, that the result might pass the Lovelace test. Perhaps the creativity here is coming from the artist or the programmer who is writing the code, even though most of it includes some sort of randomness. But, when we consider the final output, it can ascertained that the final outcome is something that has the capability of surprising the viewer and let them have this “aha” eureka moment. And when such a thing happens, then it doesn’t matter who created the piece of art because surprise in the outcome is a sort of satisfaction. And thus, it can be said that machines could be considered creative because of the satisfaction is giving to the viewer. Several AI artists feel that this is one of the most cherished moments of their work (Live and Mail Interviews).

One thing is certain, that we are now able to co create narratives with these machines in numerous different ways. And these lays the foundations of AI art and creativity.

Section 1.3: Generative Techniques and Generative Art

Creativity is also what we call discordance, which is moving away from the path of one tradition, and so when we understand it from that perspective, how can a ‘system’ that is algorithmic, based on what we tell it to do be called creative? And how can it do something beyond what we are telling it to do? If a machine or a computer can only do whatever it is programmed to do, then how can it exhibit something we term as creative behaviour if creativity were analysed in terms of ‘Discordance’.

There has been an evolution of art and mathematics if we think about the evolution of human knowledge. So, we could leverage the mathematics behind the chaotic systems, fractals and other functions to be the seed for Generative Techniques in the creative realm.

Generative Art

The first technique is Generative Art, which is art created through the use of autonomous systems, such as algorithms, mathematical functions, natural language rules, genetic sequences or procedural interventions.

Generative art uses iterative commands to draw vector based shapes on the screen. Most of the art created draws inspiration from modern art, especially pop art which makes heavy use of geometric patterns.

Wide variety of artworks that depicts mathematical principles, systems, use them as a point of departure and these areas of exploration includes numerical sequences, L-system, geometric structures and algorithmic based compositional strategies. But examples come from throughout the history, from structured geometry of tiling to minimalist and conceptual artists who constructed works based on a number of systems and formal rules.

The implementation of these "generative" processes yield a range of results, from works that are rigidly ordered to those that rely largely on elements of chance and randomization. An autonomous system is required in the making of generative art, otherwise the art would be classified as more on the lines of a digital art piece, and randomness is one type of autonomous system such that the art/design generated each time is unique in some sort.

Here, the role of an artist is to design the process that includes some sort of autonomy like the artist controls the randomness and the order in the art. So, we can say that elements of the art are provided by the system and the principles on which the art will be created is provided by the artist.

Before we create any kind of artwork, it is important to understand the principles and elements which are the building blocks of art. Similarly, we use the same principles when working on generative art. Together, principles and elements are combined to create art pieces.

Figure 2
Substrate, Jared Tarbell

When we talk about 'elements' of an art piece, these are the things that are used to create an art piece and these can be used individually and in combination for any art making endeavour (Jordan, 2019). These are some of the elements that go into a work of art:

1) Colour (Hue, Value & Intensity):
    i) Hue is the colours used in the art piece.
    ii) Value is the lightness or darkness of the hue.
    iii) Intensity is the aspect of the brightness of the colours used.
2) Form: It's the element of art that renders a 3D art form in 2D, has some volume and could be geometric or organic.
3) Texture: It's the perceived surface quality of a work of art and it defines the way an art object feels.
4) Shape: These are the elements of art that are 2D, flat and enclosed.

Elements are the tools that are provided by a system, and the principles are applied on to the elements, where are essentially the instructions on how these elements are put to work. These principles are provided by the artist. These are some of the principles following the creation of an artwork:

1) Rhythm: This principle of art describes the movement in or of an artwork on a canvas. It's created by the repetition of elements in a piece of art.
2) Contrast: It is the difference between art elements, like colour, value, size and texture.
3) Movement: It's about how viewers' eyes move through an art piece.
4) Proportion: It's the relationship of elements in an artwork, like some elements are smaller and larger than the others.
5) Balance: It refers to the artistic elements and their symmetry and stability to work in an art piece.

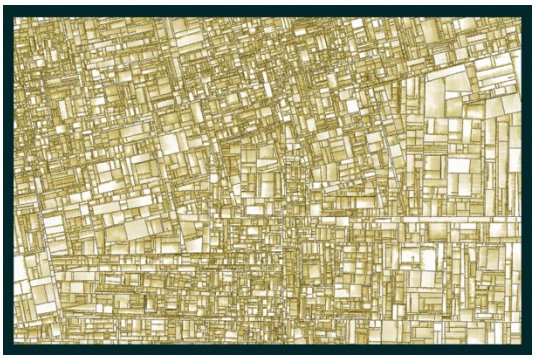
To proceed into creating something, we usually have two types of approaches in generative art. One is that we initially have no results in mind, and we see what computer generates as we play around and the second is that we have a very finalised idea in mind and by adding randomness, we try to slightly change the final outcome.

The exciting aspect about this is, the emergence of the art comes to be really different each time the program is run, and sometimes, both approaches are used together to create artworks. As generative artist Matt DesLauriers said (Email Interview, July, 2020),

> *"It's a bit of both — I typically sketch my ideas out first, but I try to keep my mind blank as I code, letting the program and generative process guide me. For example, sometimes a surprising bug or glitch ends up creating a new direction for me to work from"*.

Three building blocks in generative art could be described as:

- **Randomness**: This helps to add uniqueness to art pieces.
- **Algorithms**: Implementing an algorithm visually often generate aesthetic art pieces.
- **Geometry**: Most of the generative art incorporates shapes, and mathematics, even the high school geometry.



Once, we have everything ready, one can use the building blocks of generative art, elements and principles to create something similar to the "Substrate" art piece by Jared Tarbell.

Figure 3
Substrate, Jared Tarbell

The idea behind this is pretty simple. We start with some random points on the canvas, and start drawing random lines to random directions. But, as soon as these lines collide with each other, it starts creating new lines at an angle of 90 degrees

History of Generative Art

In analog art; the art which is manipulated by hand, complexity and scale require exponentially more effort and time, and computers excel at repeating processes near endlessly without exhaustion. The ease at which computers can generate complex images contributes greatly to the aesthetics of generative art.

One major challenge faced by early generative artists was the limitation of an output device. The primary source at those times was a punch card and a plotter - a mechanical device holding a pen whose movements were controlled by the instructions programmed in a computer. Plotter drawings were typically black on white paper and as such most of the early works produced were black and white, even after printers began to be used.

Generative art has received criticism from decades for its perceived artificiality. Most theorists and practitioners are not interested in the history of generative art, and believe that the idea of generative art has an expansive history predating computational experiments. Critiques even argue that generative artists give away the physical control of the art works and rely on machines to finish it for them, and the finished outcome is far from the perception of art. Contrary to that, today generative art, paintings, poems, music is used in art installations, personal collections and museums around the globe.

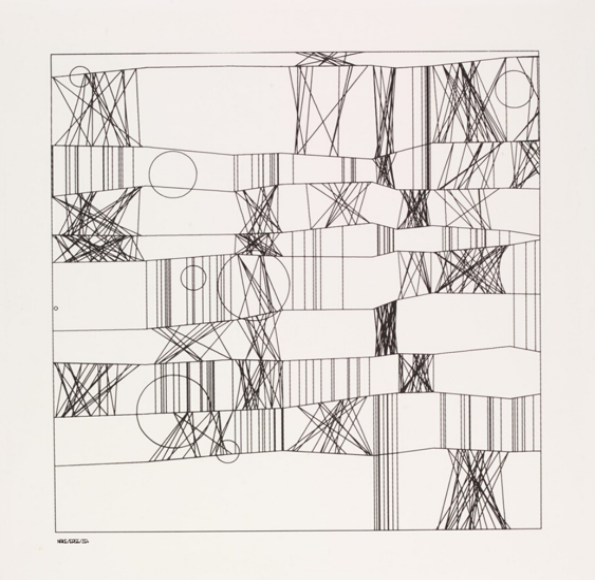


Figure 4
Hommage à Paul Klee, Nake

One of the fist artists to produce plotter drawings was Frieder Nake, and this is his famous art piece named “Hommage à Paul Klee” which Klee made in 1965. This artwork is based on a painting by Paul Klee, entitled “High Roads and Byroads”. Frieder Nake took Klee’s exploration of proportion and the relationship between the horizontal-vertical lines and ellipses as the backbone of the

artwork. He adds a lot of randomness to the size, scale and proportion of lines and ellipses on a pen plotter.

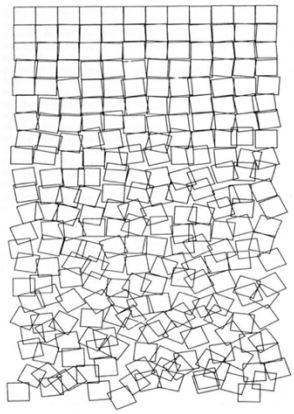


Figure 5
Schotter, Nees 1968

One of the earliest and best-known pieces of generative art is a piece named “Schotter” by Georg Nees. Schotter starts with a standard row of 12 squares and gradually increases the magnitude of randomness in the rotation and location of the squares as we move down the rows.

Generative art is one of the best options to create such art pieces because imagine for a second, you wanted to create something like the “Schotter” on a piece of paper using a pen. It might take hours to create one. On the other hand, add a few instructions to the computer, and we can produce thousands of such artworks in a couple of minutes.

Female Generative Artists

Vera Molnar is a French media artist and one of the first women pioneers in the field of Generative art. She invented a "machine imaginaire" that allowed her to create an image series of preordained compositional rules. Using endless variations in geometry and lines, generative art became one of the best mediums for her artworks.

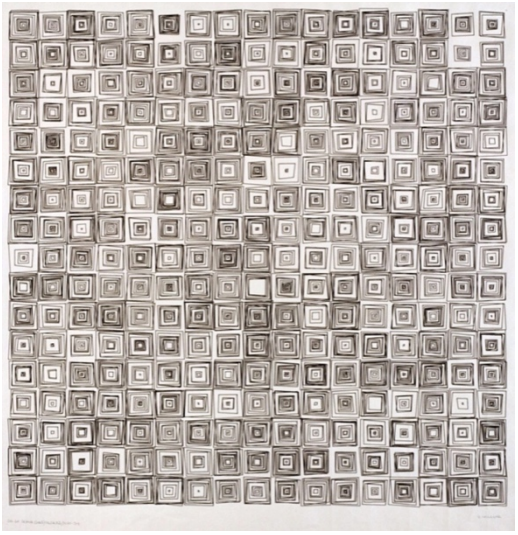


Figure 6
Dés Ordres, Molnar

Her art piece named Dés Ordres, which she made in 1974, received significant criticism bringing up the debate around whether art made with computers is artificial or real art. The majority of people in those early decades of computing had little to no contact with computers or frame of reference outside of science fiction. Against this backdrop and in a time where women faced tremendous sexism in the workplace, a large number of female generative artists emerged, making key contributions to the craft and the community (Bailey, 2018).

Digital designer and researcher, Muriel Cooper too made quite an influence in the establishment of the aesthetics in the computing revolution. She co-founded the MIT's Visual Language Workshop in 1975, which moved to MIT Media Lab in 1985 as "one of its funding sources". She believed that the shift from mechanical to an information society demands new communication processes, new visual and verbal languages, and new relationships of education, practice, and production. (Bailey, 2018).

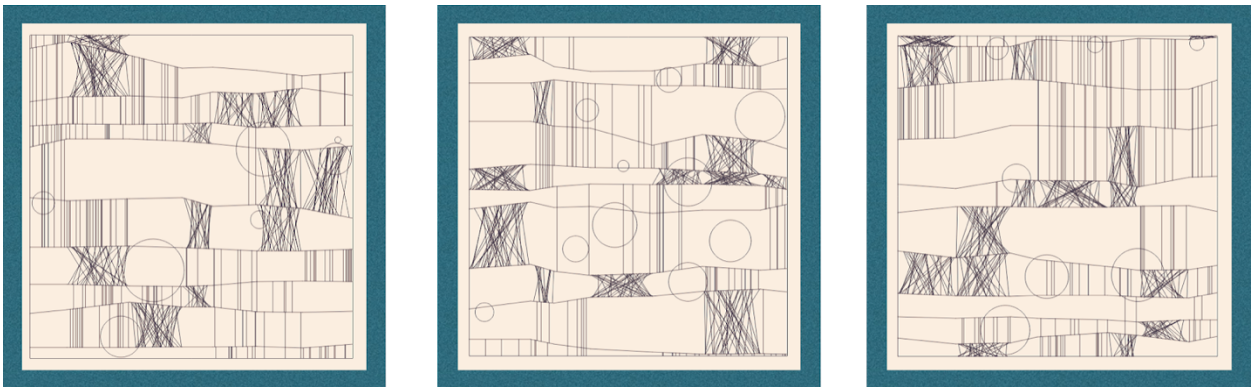


Figure 7
Our approach to the artwork "Hommage à Paul Klee" by Frider Nake.

Section 1.5: Using Mathematics, Algorithms & Geometry

In generative techniques, mathematical systems play a vital role for creating different shapes, adding randomness and noise, chaotic systems, fractals and so forth.

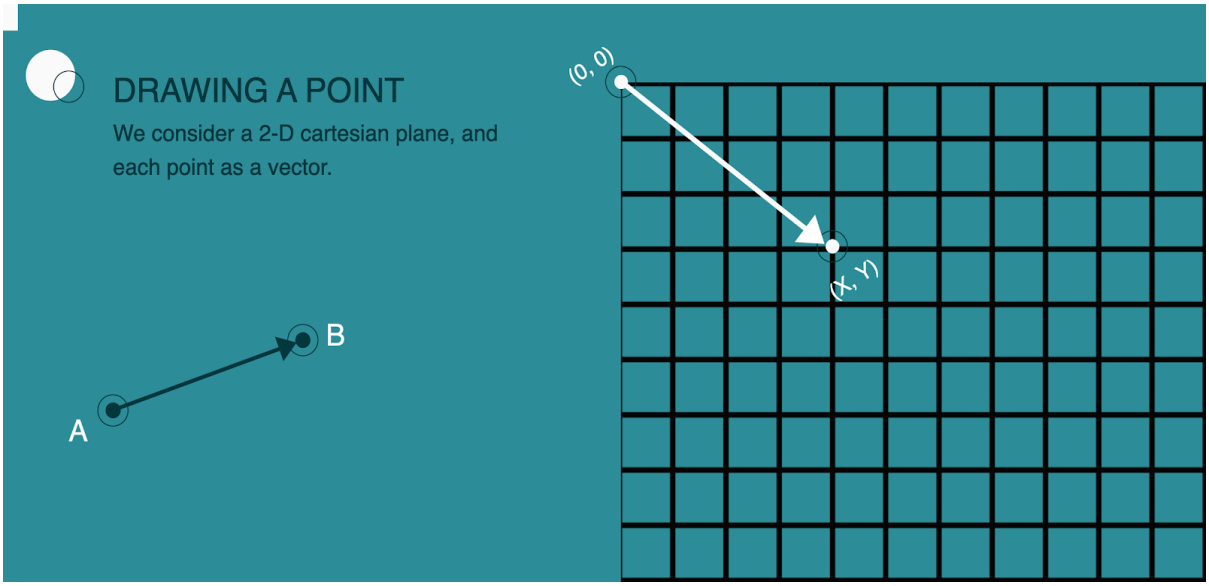


Figure 8
Two-Dimensional Cartesian Plane

Before we use any mathematical function, chaotic systems, geometric patterns, vector operations we need to understand how exactly a ‘canvas’ looks like when we are working on a generative art piece.

The canvas is like a two dimensional cartesian plane where each point can be considered as a vector. Here, we are talking about a vector in two dimensional cartesian coordinates which is the distance between the two points. As shown above, there is a cartesian plane on the right side, and a point is denoted by (X, Y) and the point (X, Y) stores instructions on how to get to that position point from the previous point or the origin. Further, linear algebra operations like linear transformations, scaling, rotations could be applied to draw lines, create shapes and more.

Once, we are familiar with the 2D cartesian coordinate system, which is on how to measure x and y position on the canvas, the scope of experimentation begins by utilising a wide array of operations as reflected upon in the previous paragraph. Similarly, if we add an extra position by adding a z-value, we would be able to measure how far we are above or below the 2D cartesian plane and eventually we will be able to draw in three dimensional coordinates.

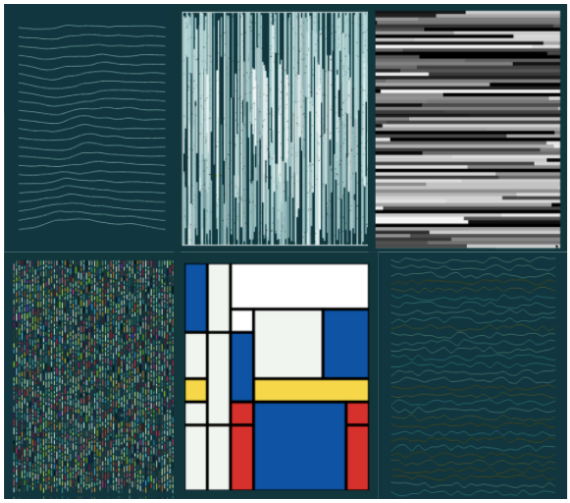


Figure 9
Examples created using simple lines, rectangles and vector operations

Random and Noise

As discussed earlier, randomization is a major part of creating generative art. Random methods differ in different programming languages. But the main objective is to provide us with a random floating-point number between 0, 1. These random numbers generated have no relationship with each other, such that if we place a set of random numbers generated on a graph, it will form a zig zag line.

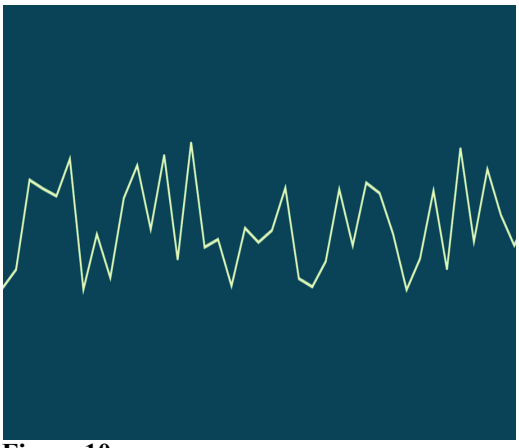


Figure 10
Random Noise

There is another method named “Perlin Noise”, developed by Ken Perlin while he was working on the original Tron movie in the early 1980’s. He used it to create procedural textures for computer-generated effects. Unlike random numbers, which has no relationship with the last number generated and shows no discernible pattern, in Perlin noise, the numbers generated at a specific point has a relationship with the last number generated. Thus, it could said to be more organic in appearance and predictable because these numbers are naturally ordered sequences of pseudo random numbers, and is useful for ‘add’ movement to an artwork. For example, if we have two points on a cartesian plane, and those points are pretty close to each other than the

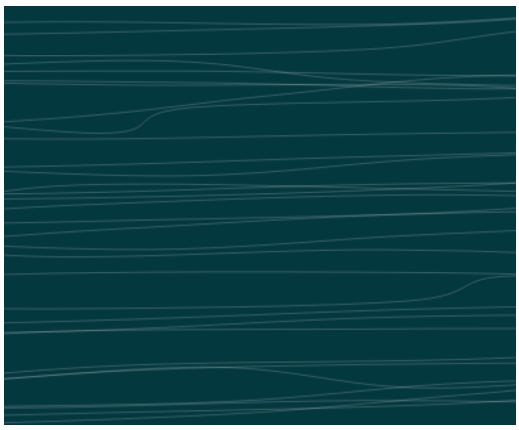


Figure 11
Perlin Noise

Perlin noise numbers generated on those two points would be quite close to each other, and if we place a graph on a set of Perlin noise, the graph would be much smoother and more predictable.

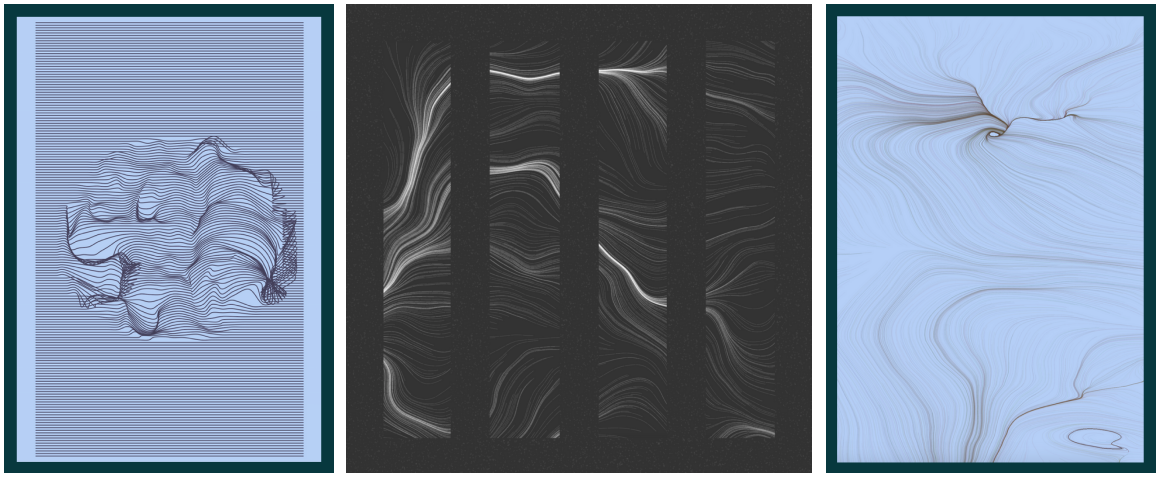


Figure 12
Altered Graphs

These are 2D fields of vectors, each pointing in a similar but different direction as its neighboring vector, and their velocities are affected by the vectors itself. Depending on how we draw the particles during animations, use mathematical functions like trigonometry, one can generates some cool stuff!

Similarly, *simplex* noise can be constructed for n-dimensional noise functions comparable to Perlin Noise in higher dimensions. An implementation typically involves four steps: coordinate skewing, simplicial subdivision, gradient selection, and kernel summation.

Geometry, Fractals and Chaotic Systems

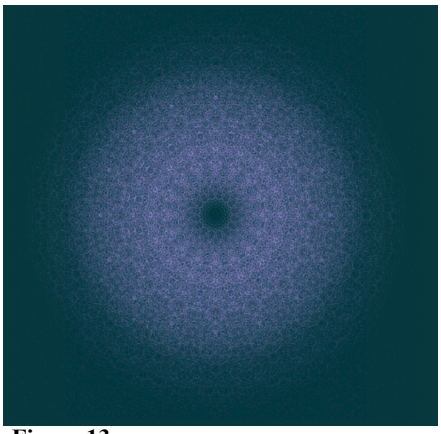


Figure 13
Geometry

Geometry plays an important role in the creation of generative art and algorithms. If we look around the work throughout history, there is evidence of artists using iterative symmetry of geometric figures to generate form. Even geometry is the most important factor for understanding numbers. Greek Mathematicians' ideas about numbers were closely related to geometry - to quantities like length, perimeter and area. As a result, there was no developed concept of negative numbers since such geometric quantities are always positive! This is not only important in generative art, but also in the field of architecture, music, poetry and visual arts.

Generative art is an interpretative field used to redraw tools beginning from Geometry. Using fundamental laws of generative art, it is a medium to build parallel, multiple, and progressive paths of dynamic transformations using interpretative logic. The key lies in its ability to represent the interpretation of a creator performing the artworks in an endless multiplicity of the possible variation. One of the main fields, geometry, owes to the construction of these generative algorithms and is the main tool for managing dynamic modification processes.

Geometry is one of the main fields involved also in the construction of the generative algorithms. Not only for architecture, design and visual art, but also for music and Poetry. Since Generative Art moves from static forms to progressive transformations, Generative Geometry should be considered as the main tool for managing dynamic processes of transformation.

Generative Geometry moves from geometric figures to the representation of dynamic logic processes, from measures to dynamic proportions, from measurable figures to measures related to a point of view, from representations of limited spaces to representations of infinity (Soddu, 2014).

When we look back at ancient architecture, we see numerous examples where symmetry (golden ratio, musical ratio, square) is being used in the creation of architectural sites, and there have been critics who oppose the concept of symmetry being an autonomous system. Upon analysis and deeper study of symmetry in various objects, it can be said that use of symmetry is more of an autonomous system than a piece of art and is more primitive when symmetry and geometry is used in textiles, repeating shapes and more. Generative art also draws inspiration from the use of tiling in the architecture, more particularly with the abstract systems to decorate specific surfaces especially from the Islamic and Roman architecture where lies the roots of algorithms and bassinet of mathematical innovations.

Fractals

Fractals are unique and complicated mathematical forms of art. These are the never-ending patterns, which means no matter how much we zoom in we will see the similar pattern over and over again on any scale. Fractals are everywhere from the snowflakes, galaxies, cloud formations, broccoli, and flowers in nature. The term fractal was coined by Benoit Mandelbrot, who worked at IBM in New York.

He was inspired by the works of mathematicians to understand the curve and experiments like a single line could be divided forever, and he noticed a strange pattern out there, and put a

lot of numbers in the IBM machines, and came up with an interesting design. He found that the patterns keep on repeating again and again, and the process led him to a breakthrough equation, resulting in his own numbers and the creation of the ‘Mandelbrot’ set. For him, it was a pragmatic desire to model nature in a way that actually captures roughness such that these self-similar shapes could give a basis for modelling the regularity in some sort of roughness.

One of the most amazing facts about the Mandelbrot fractal is that the more you zoom in the newer patterns you see forming inside of it. This also led to the new era of math called the ‘Fractal geometry’, and has been used in fields like climate change, trajectories of meteoroids and more. Fractals are quite popular among programmers and generative artists, because a small set of code can produce images that are way more intricate than any human hand could ever hope to draw.

The Mandelbrot fractal is represented on a complex plane where there is a coordinate that has complex numbers. The X-Y axis represents the real axions and the Z-axis represents the imaginary part. We pick a number C, any number in the complex plane and start with z = 0, and then iterate the equation over and over again. If it blows up to infinity, then the number C is not part of the set, and if the number C remains finite after infinite iterations, it's a part of the Mandelbrot set.

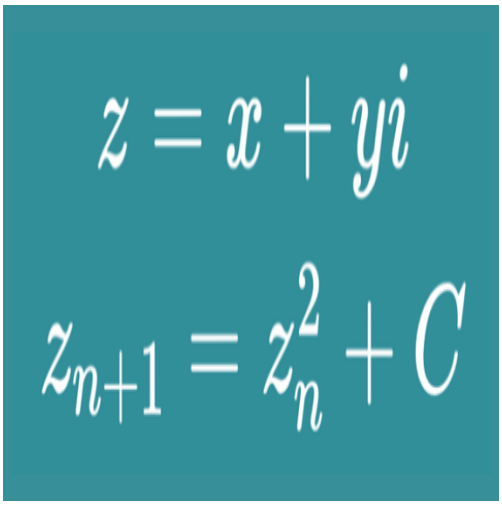


Figure 14
Equation

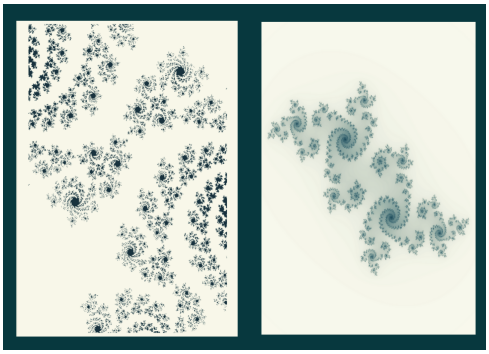


Figure 15
Julia Set example

If C is held constant and the initial value of z is variable instead, then one obtains the corresponding Julia set for each point in the parameter space of the simple function.

Inside the Mandelbrot set, there are two parts, main bulb and the main cardioid. All of the numbers in the main cardioid end up stabilizing onto a single constant value but the numbers in this main bulb end up oscillating back and forth between two values, and then hit the Chaotic part. The Chaotic part happens only at the needle, where the Mandelbrot set gets very thin.

Chaotic Systems

When we go deeper and deeper into the Mandelbrot set, we will see the Mandelbrot set extending outwards and is creating this bifurcation diagram. The logistic map or the bifurcation diagram is basically a part of the Mandelbrot set and exists only on the real line because we put only real numbers into our equation. This method was the first method to

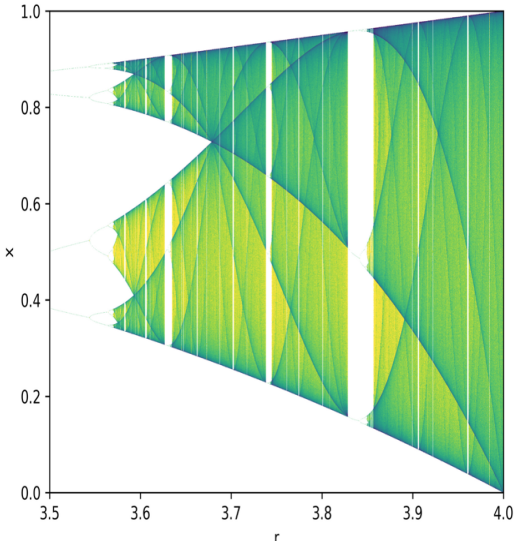


Figure 16
Chaotic Systems

generate random numbers on the computer and gave rise to a topic called *Chaotic behavior*.

Though these are predictable in nature, a small change in the initial state would result in a very large difference in the final outcome.

As discussed earlier, we use randomization quite often when working with generative art pieces. Chaos theory concerns deterministic systems whose behavior can in principle be predicted. Chaotic systems are predictable for a while and then 'appear' to become random. This means that, say we change the initial state by some margin and we assume the final output would also be just slightly different. But the reality is that the output is an outcome of deterministic chaos.

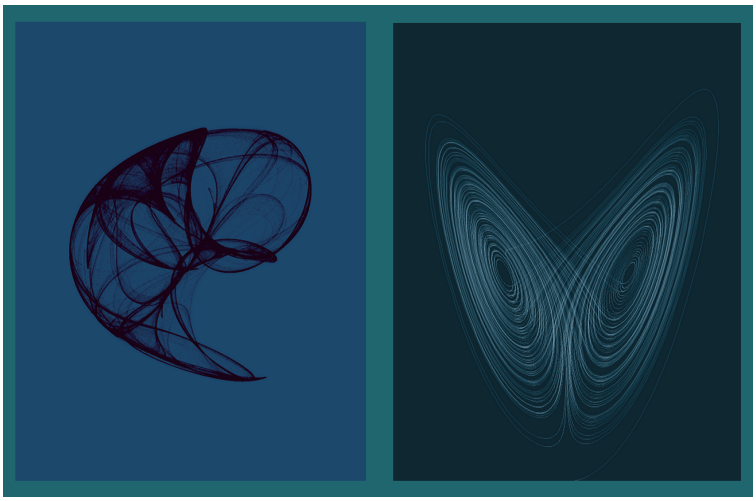


Figure 17
Lorenz Attractor

Figure 18
de-Jong attractor

It's important to keep in mind that the dynamics of these chaotic systems are non-linear and are quite difficult to predict over time, even while the systems themselves are deterministic machines following a strict sequence of cause and effect and the results are drastically different. One thing while working with generative art is that we should not get confused with chaotic systems as random systems. Attractors are the best examples when it comes to chaotic systems, more commonly the Lorenz attractor (Figure 17) and the de-Jong attractor (Figure 18).

Section 1.6: Effective Complexity / Control in Generative Art

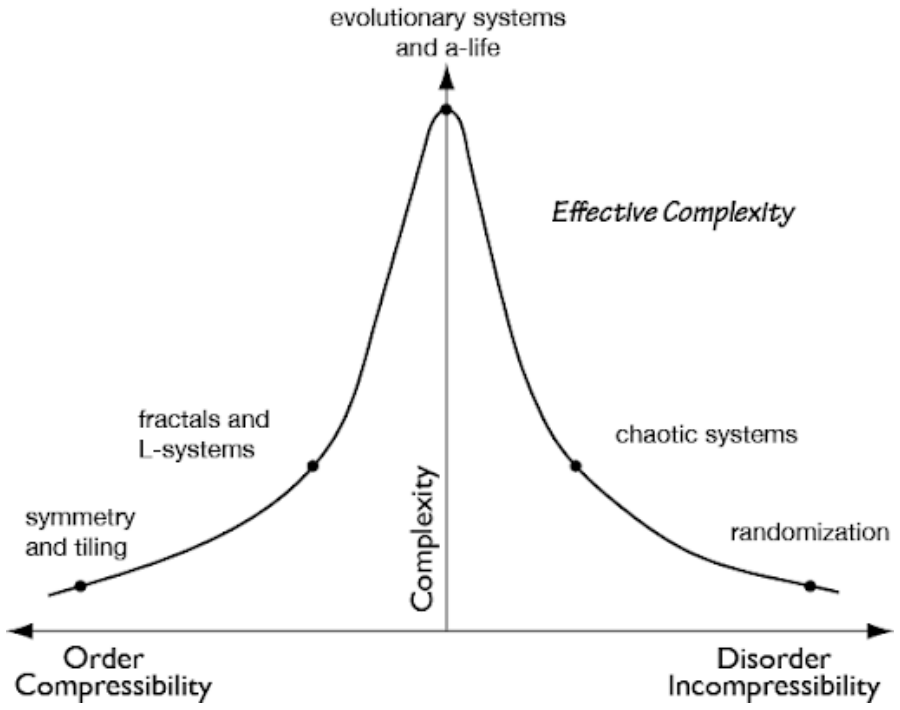


Figure 19
Complexity graphs

In computational creativity, we can leverage the mathematics of randomness, fractals and so forth and can achieve something called Effective complexity. This means that we don't want complete randomization as that would be just white noise, and we don't want order because that would be too predictable. So, we want something in between and if we have a mathematical system that has enough random behavior, so as not to be completely random that could be the basis for creative artifacts.

In the book The Computational Beauty of Nature(1998), Gary Flake has talked about the effective complexity of generative art techniques, and pointed out that the regular and irregular artifacts are simple. Similarly, Philip Galanter in his paper, “What is Generative Art? Complexity Theory as a Context for Art Theory” (Galanter, 2003), described generative art systems in terms of effective complexity, where he mentioned that the art based on symmetry, tiling, and L-systems. Flake has put forward the approach that these systems are going to be more ordered than generative art systems based on randomization, and are highly disordered with low complexity. Generative art systems based on evolutionary computation are found lying in between the order and disorder spectrum including the most effective complexity.

But, if we accept this paradigm that generative art systems are defined by the use of systems, and that systems can best be understood in the context of complexity theory, we can lead to an unusually broad and inclusive understanding of what generative art systems really is.

There are a number of underlying theories about generative art and its definition. We could somehow summarize it as: (Galanter, 2012)

1. It uses evolutionary algorithms to evolve form.
2. It uses randomization in its composition.
3. It's constantly changing over time while on display.
4. It has been automatically creating variations of a central data.

So, we can use chance as a generator to generate different generative techniques, based on (Phon-Amnuaisuk & Panjapornpon, 2012):

1. Stochastic Processes where stochastic processes have been used to create abstract visual artifacts.
2. Grammar, where we instruct the computer what it should be developing and it simply tells the rules through which we can create new sentences and determine if a sentence is a part of the language. So, rules and grammar could be used to gain more control over the dependency and relationship among components, like the position, size, color.
3. Evolutionary Computing and Exosystemic Approach, where we use genetic algorithms and genetic computing to create abstract images.

Section 1.7: Generative/Music Intelligence

Generative music is any music where apart from the compositional process is delegated to an autonomous system of agents other than the composer, which is mostly a computer-composer interaction, in which the composer creates an algorithm, or in other words a set of instructions to carry out a specific part of the compositional process.

The first example of generative music was The Mozart's Musical Dice Game (Musikalisches Wurfelspiel) which uses mathematical patterns and dice to compose music from precomposed options. Similarly, Golan Levin's work involves the use of a stylus and computation to generate music where the program translates what you draw into musical compositions.

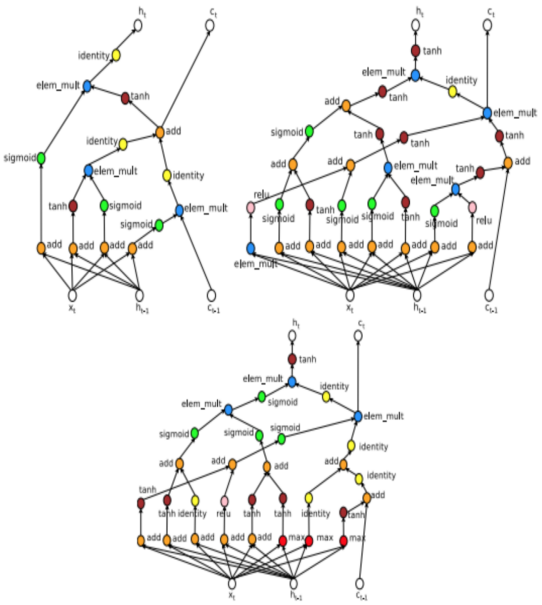
Brian Eno, one of the first generative music artists used real magnetic tapes, and created a sort of loop at the end to a random looping around so that every musical piece which is produced is unique just as the basic starting point. According to Brian Eno, generative music are systems which create “ever-changing music,” that could “produce original music forever,” lamenting the limitations which forced him to simply record the output of these systems as traditional albums rather than “sell the system itself, so that a listener would know that the music was always unique.” (Bainter, 2019).

David Cope, created systems for his own generative music compositions to inject some randomness and chance into the musical compositions he was producing and he extended it by combining musical styles that never existed before. This is one of the best parts of generative music that one can combine different genres and styles all together and effectively create a new genre, which would be quite difficult to do with complete human compositions.

Section 1.8: Generative Design

Generative design is an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints, and a designer that will fine tune the feasible region by changing minimal and maximal values of an interval in which a variable of the program meets the set of constraints, in order to reduce or augment the number of outputs to choose from (Wikipedia contributors, 2020).

Figure 20
Generative Design analysis



It combines the parametric design and uses artificial intelligence and neural networks to make the design suitable to the design objectives. This parameterization of design helps to generate an abstraction of the objects which in turn helps to generate thousands if not millions of alternatives design options which all meet the same criteria, and makes heavy use of genetic algorithms and neural networks.

Generative design exists everywhere both in the physical world, and in the design of neural networks like Long Short Memory Neural Recurrent Neural networks(LSTM). These LSTM's are designed and generated by the use of algorithms, and are shown to be much more

effective than the conventional Long Short Memory. These are generative neural architectures, and thus these can be terms as ‘machines that learn to learn’, more like meta meta-models.

Learning apparently is not uniform and it can be highly suspected that meta-level reasoning is a primary mechanism in learning and something which is reflected by its biological manifestation(Perez, 2016).

The basic working environment for Generative design is as follows:

- **Idea:** In this phase, we identify the problem we are dealing with, and come up an initial concept
- **Create**: In this phase, we create a prototype of the concept and set our goals and constraints.
- **Design**: Here the computer takes a look at what we have constraints we have defined and works through those options from a different number of angles.
- **Validate**: In this stage, the computer shows the solutions it came up with in reference to the initial concept.

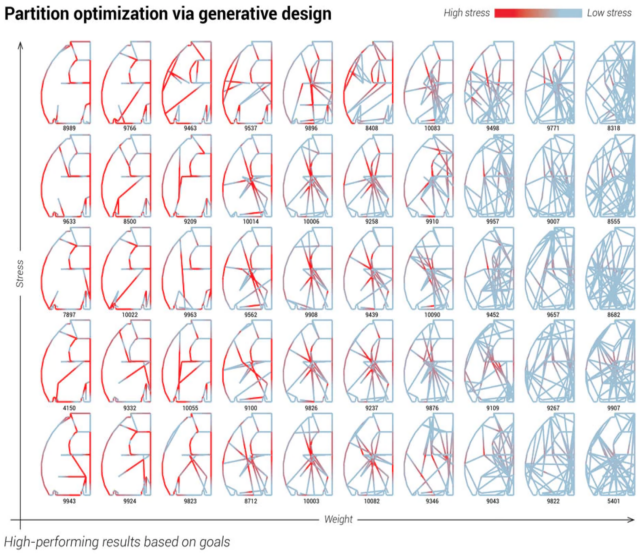


Figure 21
Design Optimization via generative techniques

Generative design has been used in a variety of fields from architecture to creating shoe designs. One such example is that Airbus has been using generative design to create parts for the interior of the Airbus A320 and it resulted in 45% of the weight reduction of that specific part, which reduced fuel usage, costs and CO2.

Section 2: The ‘heart’ of AI based systems – Society, Human Interactions, Economics, Philosophy and Behavior.

Section 2.1. Art, Art in Artificial Intelligence and can a machine actually produce art?

Art is a term which has had very complex definitions. There are people who argue only something that is joyful to the eye has the capability of being called art or perhaps the objects around us are all forms of art - right from the innovation of a laptop to the clothes we are wearing, are all ultimately outputs of an artist's imagination and cultivated from their individual creativity.

This is something the period of Dadaism in 1916 was arguing for. Even toilet seats and pots were being classified as pieces of art. On one hand several critics of art define art as a "journey we take" (Tjeerd Hoek, Email Communication, August 5, 2020), and its true essence lies in the act of doing. While others would argue that art is everything. And in a counter argument to that, there is a belief that anything that is termed to be 'art' is believed to be Art. This is because we start viewing and accepting that piece to be an art piece as soon as the mind is told that this is termed as 'Art' - something that Art historian E.H. Gombrich would classify as "Art with a capital 'A'." This is the psychological aspect of the way we believe (The Story of Art, 1995).

Professor Gilbert from Harvard University has explained this belief mechanism in his paper "How Mental Systems believe". He has often described and evaluated how people find it easy to believe but difficult to doubt (1991), and how this belief mechanism has been embedded into the mind over the years. For instance, to practically understand this concept, we would like to correlate his thesis question with the works of Picasso. Picasso's paintings are simple, in our perspective. They are mostly childlike and his strokes are naive. And Picasso has often accepted

this opinion and has used it as a quality worth appreciating. Today, Picasso's paintings are one of the most expensive pieces of art in the world with prices rising up to 179 million US dollars in the Christie's 2015 auction. There is a sense of belief used in selling such paintings. Firstly, we have been made to believe that his art is beautiful and appealing. Secondly, Picasso is a legendary artist. The name of the artist says it all. As Art historian E.H. Gombrich (The Story of Art, p.5) has put forward, "There is no such thing as Art. There are only artists". Thirdly and most importantly, we have been made to believe that such high prices for art is acceptable. I feel it is less to do about demand and supply for the painting but more to do about the 'name tag' which surrounds the painting. This is something that we shall explore deeper in the context of the AI - Art economy later in the paper.

However, in the case of Art produced by Artificial intelligence, this belief does not exist especially for people who don't understand or have not been made to acknowledge the insides of AI Art - the coding, the algorithm and the deep neural networks that have been involved in the creation of AI based Art. Thus, we cannot 'believe' that AI art can be auctioned at a high price of approx. 400,000 US Dollars (Christie's 2018) and 'Robotic Art at $1 million in 2019' (Ludel). It is not considered acceptable for art produced by computers to be sold off at such high prices. Thus, raising significant criticisms from Artists, Art critics, Art historians and traditional collectors. This is essentially because the hierarchy of power, and cycle is at stake with Artificial intelligence produced creative content. For instance, the question of who gets to use AI, how to prevent misuse and ethics, and the shift of power between who has access to AI vs who doesn't have access to AI. Or to be more precise, who has a greater capability of creating Artificial

Intelligence systems for Art and Design vs who doesn't is a concerning question for several people in not only the art field but across several fields.

Once these algorithms have been trained on a certain dataset, the system can begin to see anonymously. This is what AI Artist and Photographer Trevor Paglen has often questioned "What does it mean that 'seeing' no longer requires a human 'see'er in the loop?". The computer can begin to think beyond imagination and also of creating the unknown and unfamiliar, unlike humans and human artists who are at times bound by creative blocks and limited imagination often resulting from the surrounding environment we are in like the people we meet, the places we visit which are all limited. However, AI art can operate at times beyond limits because it is not restricted by geography or human interactions.

This is how the power dynamics begin to change. AI has the capability of becoming stronger than human beings. Artists who have the capability of harnessing this power of Artificial Intelligence, have data on art, and processes, are likely to have a stronger power to harness this world. This is similar to how nations with coal and oil began to gain strength and become global powers. (Schaare 2018). Similarly, countries and the creative population with greatest access to resources, data on art and periods and skills are likely to have the greatest power in the future and this could pose threat to the traditional forms of art. Cultural heritage might be lost in this process of development but at the same time the culture could be harnessed and exposed at a greater level with Artificial intelligence if the AI were trained on these data sets in a ethical way.

However, excessive exposure might lead to the loss of the tradition in itself as more and more people would be driven to AI based Art. For instance, if there is AI art influenced by Tanjore Art (1600s to 1800s South Indian Art), there are several possibilities built out of AI deep neural networks which produce similar paintings of the time and also bring different periods

together. This has been done by certain freelance artists who have mixed Tanjore and the Vitruvian man together to bring about a new form.

Figure 22
Da Vinci meets Tanjore

(More about this piece : https://www.linkedin.com/pulse/da-vinci-meets-thanjavur-paintings-tryst-deep-swami-chandrasekaran/). This is bringing forward more possibilities and also triggering an intellectual stimulation to think differently. However, such a new form emerging in the first place poses a risk to the tradition.

As people are driven more to such forms of art, the viewership of traditional art forms covering themes of local religion and culture might decrease in the long run.

Section 2.2. The risk to cultural heritage

In order to understand the risk art produced from AI poses, it is important to understand the purpose behind the original handmade paintings in the first place. Tanjore Art was produced during the Chola Dynasty in the 16th Century, a time when the Nayakas (Army leaders) encouraged art and innovation in art forms especially around the fields of classical dance, music, literature and paintings on the themes of traditional heritage temples (Mathur, 2020). This overall spree of innovation and creativity during the time led to the development of the Tanjore (named after the city of Thanjavur in the Indian State of Tamil Nadu).

Another reason for this innovation was due to artists from other states beginning to migrate to Thanjavur, in order to work under the Nayakas since arts were being encouraged. All of these aspects put together created the art form Tanjore.

On the other hand, the Vitruvian Man by Leonardo Da Vinci is a sketch that tries to "depict an idealized nude male" (Abdou, 2018). In particular, the measurements of an ideal body have been mathematically calculated and placed in correlation to the Vitruvian Man.

By putting together, the two periods via Artificial Intelligence, there is a risk of losing both the traditions. As Art Historian E.H. Gombrich has noted that often old art forms like the art and architecture in the Mesopotamia civilization were not made to "decorate" the area but rather to ensure that the "image of the mighty is kept alive" (Page 70). By juxtaposing different art forms via large data sets, there is a risk of losing the authenticity and relevance of the original data as the data is only relevant to that time and period, and irrelevant if mixed. In addition, a painting like the one produced by mixing Tanjore and the Vitruvian man, though innovative, could lead to sending out a wrong incorrect message to the viewer which could negatively affect the history of the periods those paintings belong to.

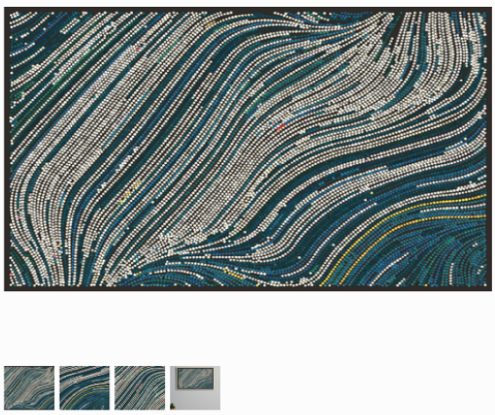


Figure 23
Side Effects, Hobbs 2019

However, making new paintings using Artificial Intelligence without actually picking up arts from periods of the past and developing new periods altogether without harming the tradition is what could be said to be the ethical usage of Artificial intelligence in the art industry. Artists like Tyler Hobbs have been developing arts on the basis of Geographical lines and ship maps like the Art work 'Side Effects' (relevance to

Geographical images and fault lines), which could be said to be an innovative way of experimenting with the arts without causing harm to anyone and creating new appeal across the viewers of art.

Section 2.3. How would have Philosophers seen Art produced from Artificial Intelligence?

Now, to come back to the question of can a machine actually produce art. Art is an aspect of increasingly varying definitions, and one according to our perspective that has changed over the years. Before the Dada Movement in the 1912s, it would have been considered unacceptable to display soup cans (Andy Warhol), fountains (Duchamp) and newspaper articles as art pieces. With the rise in youthful appeal in art, these too became acceptable. This journey of Art would be evaluated in the next section. However, the main point is that philosophers, historians and artists have viewed art differently across time periods. One of the main definitions is that creativity is a bit like ethics. As ethics change over time, creativity also changes and with it its definition. The true essence of creativity lies with the social consensus of what society defines as creative. As earlier there might have been immense amount of hindrance towards Digital Art like 3D videography. Today, 3D videography and immersive art and graphics are considered very creative pieces of Art which tend to be some of the greatest attractions at Art at Art Fairs globally.

However, Russian Soviet Psychologists such as Lev Vygotsky would have perceived Art to be something of a rigid definition. Vygotsky has specified in his Soviet Psychology pieces that ‘Emotions play an important role in creativity” and often contextualizes Leo Tolstoy’s beliefs of Art and Creativity into the operations of the mind. According to Tolstoy, the mind works in the

most efficient and creative way when precision is brought into the thinking. Art according to Tolstoy begins when “scarcity” starts (Vygotsky, 1925). The Russian philosophers, writers and psychologists like Vygotsky and Tolstoy looked at Art as something that required a clinical precision which they described in comparison to the creation of the greatest music that existed during their time. Their evaluations bring forward the need for precision in art in parallel to “pitch, duration and the intensity of sound” in music. As soon as this precision is lost, the true essence is lost. For this matter, AI produced Art might not be considered acceptable in this school of philosophy, as Artificial Intelligence produced Art is confined by certain algorithms but the final outputs can be often beyond the realm of thinking or even imagination at times.

There have been times when the final output set produced by autonomous systems and AI have taken the artists also by deep surprise. Tyler Hobbs, Patrick Borgeat (Generative Music), Roman Lipski and other artists have often felt that the surprise element is what is the true joy of AI produced Art, and there have been times when the unexpected becomes the final art piece to be published. An analysis of this surprise element is present in Section 1.2. This is something which would be contradictory to several traditional schools of art philosophy and psychology.

In contrast, at the same time it is surprising that Philosophers like Plato can have quite a liberal democratic approach of how Art is defined. For Plato, nothing is true art. According to Plato, “Art is always a copy of a copy. Thus, is always an illusion” in the Republic (*Plato’s Aesthetics*). And likewise, AI Art like all the other forms is an illusion because true art doesn’t exist in the first place, because all art that is viewed is a copy. Therefore, even AI Art like the other arts is influenced by what we see around and thus is an illusion. In one sense our mind perceived the illusion, which is a copy in itself. A machine is in a similar way capable of producing art because of the process that is gone into the machine that is instructed to make the

‘copy’, in a particular way and in turn create a new piece of Art, in a similar way to the way we produce art as well. The copy does exist somewhere in the mind. Once the ‘copy’ comes to use, the artist or creator, uses paint, clay or generative algorithms to make another illusion that would appear real. Similar to what Plato reiterates about the concept of Art.

Section 2.4. AI - ART Movement. The new ‘Dada’ Movement.

Is it the 20th Century Dada Movement?

In the early 1900s, Art began to change. There was a general inclination towards abstraction and freedom of opinion, primarily influenced by changing mindsets due to the end of the First World War (1918) and the rising Industrial Revolution taking place. Art alongside began to undergo reforms. From more traditional forms of art like Portraits and the Renaissance that focused more on precision, art began to flow towards “Free experimentation and originality” (Beckett, 1994, p. 353).

And the industrial revolution could be said to have instigated this movement. The meaning of what is art, creativity and innovation began to change as the entrepreneurial spirit began to rise, which also could be due to the capitalist spirit and the changes in the religious system. There was a rise in the inclination towards Protestantism in the West with Calvinism based thinking that led to an increase in freedom and capitalist spirit, which is described in detail by philosopher Max Weber in “The Protestant Ethic and the spirit of Capitalism”. Thus, leading to a rise in creativity and new innovations. E.H Gombrich, art historian has described this as a very transformative experience but one with destruction; (The Story of Art, p. 499)

“The industrial revolution began to destroy the very traditions of solid craftsmanship, handiwork gave way to machine production, the workshop to the factory.”

The sold craftsmanship described by Historian Gombrich began to give way to more dynamism, futurist, often mechanical based Art like the art produced by Futurist Artists like Wassily Kandinsky (1923), Boccioni, Robert Dalauney, in the early 1900s.

And from then on, the process of evolution in Art began with increasingly new styles, and a new definition of art. In the 1910s, a new movement began called the Dada Movement which challenged the older definition and framework of art (Also known as the Anti-Art movement for the same reason). The movement can be said to have had a longer lasting effect due to the immense impact it had on the psychology of the general community. The core aim of the movement was to reject traditional forms and values of art and create an "effervescent love for improvisation and curiosity" (Prager, 2013, p. 1)

The spirit of Dada Movement went on to evolve into Video Arts (1960s) and Computational Art in the early 70s and eventually into Generative Art and AI art in the 90s, paving into the 21st century. Without the Dada movement, there would have been a low chance of the arts breaking out of the reforms and driving the spirit of change because the Dada movement brought about a key perspective - It is less about aesthetics but more about meaning and the background. This is the time artworks like Duchamp's Toilet Seat art began catching a rage which was less about the 'Toilet Seat" but more about the revolutionary, radical meanings behind the object.

In a similar context, Artificial Intelligence based Art is less about the final output but more about the "process" that goes into the making of it. As AI Artist Matt Deslauries has explained (Email interview, July, 2020) ;

"Algorithms is the heart of all my work"

AI Art in a similar context is also rejecting the traditional forms of Art. Art was earlier restricted to only a certain set of tools and styles, even within the 'Abstract Art' sphere. Art is capable of going beyond the sphere with Artificial Intelligence based Art. For instance, the creation of 3D portraits, the creation of dream hallucination like portraits (Mario Klingemann), deep abstractions, Human Art interaction systems like an AI based mirror (Kyle McDonalds) etc. These are only a couple of examples but in some form, these are rejecting the traditional meaning of what is art and redefining a new meaning to the field of art and creativity. However, just as the Dada movement was not accepted, the AI movement is still in a very infant stage in terms of its admirers due to the limited technical knowledge and backgrounds within the art collector and viewer population.

This is one of the reasons as per AI Artist Tyler Hobbs, most of his collectors have some sort of tech/science related background. The change in the kind of collectors of AI Art is also in one sense showing hints of radicalization occurring within the AI art market. In addition, it is important to note that most of the AI art is priced at a much lower price compared to traditional art, for a similar reason as above - lack of technical knowledge, lack of understanding around AI, and the lack of brand recognition at this stage. These aspects shall be further evaluated ahead in the paper. Thus, it can be said that AI art is not accepted as Art as such but something that could cave way into something more like a revolution in adjunct to the 'step at a time AI revolution' that is taking place unwittingly across various fields like Healthcare.

AI Art has undoubtedly received immense criticism in the industry and is often characterized as though an outcast in the art circuit, driven often by the common Anti- AI beliefs that exist. And the debate of whether a machine - AI or Robot (Like Aida) can actually paint or not. Secondly, there is always a perception that art is something that humans are possessive about

and are not willing to trust a machine producing Art in one sense. (Kyle Mcdonald, Live Interview, August 5, 2020)

This is in parallel to the Dada movement in the 1912s- it received immense criticism with Art Historians like E.M Gombrich ridiculing the Dada movement art as a "piece of rubbish" (The story of Art, 1995, p. 614), apart from several other harsh criticisms and rejections that it continuously received over the years. And yet the art is admired and criticized even today.

This is the essence of art in one sense- to admire and to criticize, often influenced by our own likes and dislikes of the subject in the art. (The Story of Art, 1995, p. 16). In several of the Art Fairs today globally, there are several Dada inspired art works exhibited throughout the world, without actually being reminded of the Dada movement. For instance, artworks such as David Mach's Gorilla which has been made from trash can be reflected upon the Dada Based Art. According to prior definitions of art, such an art piece would have been considered unacceptable. Today, it's second nature. Similarly, AI art in the long run is likely to become acceptable as it becomes 'second nature' and begins gaining exposure, thereby challenging the true meaning of art in itself. As Artist Ghiora Aharoni in an email interview said (August 5, 2020),

> *"The introduction of a "new" movement or form is often heralded as an innovation that will change the future (think video art in the 1960s."*

Section 2.5. The present-day democratization of AI ART

With the aspect of gaining exposure, comes the aspect of the democratization of AI art in order to make art more accessible and visible to all. This is challenging the previous societal

discrimination that existed with the art audience with art being something that only the upper class can enjoy as Roger Taylor (1972) discussed in the book Art, an enemy of the people.

"The art of ours is not art but what the upper class enjoy"

With AI art, democratization becomes easier. It becomes easier to reflect and propagate opinions, perspectives and thought processes in the form of art due to increased accessibility and also becomes easier to circulate and spread AI art as a form of art especially when it becomes an increasingly acceptable form of art. In addition, due to speed of replicability of AI art, it can be very easily mass produced, in turn making it cheaper and affordable to a wider set of audience. This is something that Tyler Hobbs highlighted that most of his clients and most of the buyers of AI based art are more in the middle-income brackets (Live Interview, 25 July, 2020).

Thus, by making it affordable and many a times enabling free viewership over internet exhibitions and social media platforms, it is becoming easier to cherish the AI art form, in comparison to traditional arts which at times never make it to the eye due to lack of technological interconnections in those fields such as the undiscovered craftsmen around India and the world. However, with an increase in AI art around the internet world, there is a possibility of greater audience attraction towards a new fresher form of art. Over the years, it has often been noticed that the overall attraction of viewers towards arts has decreased. According to a survey conducted by the National Endowment for the Arts in the United States, there has been approximately "33 percent decline over the past decade" (Cohen, 2013) with several museums/art galleries closing their doors and this number is only expected to rise over the years especially with the COVID-19 pandemic situation, there are several predictions of "many art

galleries [going] out of business; and artists [losing] livelihood" (Dickson, 2020). This might lead to a situation where arts might cease to exist. As per a survey conducted across the student, and the local university community, most of the survey respondents are uncertain about the revival of the art market.

Thus, in our perspective, it is quintessential for new forms of Art like AI based Art to attract viewers to the art world online**.** In addition, along with the plausibility of a higher population of Art viewers online, there also comes the increase in the accessibility to art creation with AI art, as long as the technical background and knowledge of AI art and programming skills exist.

With the current COVID-19 pandemic situation and the likelihood of a deep Economic recession, there is a risk of a lack of ability to buy art related goods especially due to a low operating AI art market. However, with AI art, as discussed with several of the AI artists as part of our interviews, the cost of producing art is significantly lower. A basic AI virtual art piece requires a computer and appropriate coding skills. This simplicity to making an art piece along with a creative mindset enables remarkable art pieces to be produced over the computer. And in turn, the final output can be easily spread around the world via social media as a lot of AI artists propagate their art works via Instagram hashtags. This is on the similar lines to Art works produced by the 'Dada' movement which propagated Dadaism via revolution campaigns and street side shows, which attracted more and more young artists and experimenters to Dadaism. It is for a similar reason a lot of the French Artists in the Dadaism campaign began new forms of Art like Surrealism leading to artworks like Salvador Dali's Oblivion.

On a similar level, AI art works have also emerged in its own realm leading to generative design pieces, science fiction digital art and some revolutionary design concepts like Generative

Art used on Shoe designs by companies like Adidas to design new revolutionary shoes for better sport performances.[i] Another example of such a dramatic piece is Japanese AI Artist Nao Takui's Imaginary Landscape installations which create "multilayered environments that don't exist anywhere" [ii] (2018).

However, this field is still left unexplored for many traditional artists who are hesitant to explore and also at times lack the technical exposure for making Artificial Intelligence Art. A solution to increase this exposure of Artificial Intelligence based art and the key to democratize AI Art is via Art Workshops and AI Art interactive exhibitions, as per AI artist Roman Lipski, who uses AI art as a muse to give the artist ideas and propel his thought process in a certain way. This is what artist Roman Lipski believes he is doing through his 'Unfinished' art works and workshops (Live Interview, August 4, 2020). The workshops involve the use of Roman Lipski's AI art muse, workshop students and himself to build a final art piece out of it. This way more people are educated about AI Art and the tools involved around it and at the same time also nudging the mind to think in different ways via AI based art. He believes it sort of triggers the 'imagination'.

In a similar way, AI Art can be posed as an important educational tool to inspire new ideas and solutions to problems. If AI Art can be used to create paintings that resemble Rembrandt's artistic effects, it can also be used to create new designs, new ideas, new innovations and creative activities inspired out of the past art and sketches. This can create a "new ecosystem of teaching and learning with new social and human interactions" (Piech, 2020). In addition, Artificial Intelligence based Art can be used to better understand the concept of Algorithms and predictability analysis. Most AI artists build several algorithms in various ways to create a final output and they put each algorithm to test ultimately.

By experimenting with algorithms, they have a better idea of the final output. And through this experimentation, they are learning something more about Computational Tools. Thus, AI art can be poised as an interactive tool for learning new programming skills and at the same time, harnessing creativity and design thinking. As per most of the interviewed artists in our project, the creation of AI based Art is more of a metamorphosis - Several models, algorithms and tests are created to better understand AI and art in general. This is the reason most of the interviewed artists believe their artworks have evolved over a period of time and often linking one artwork to another has made them better programmers as well.

Section 2.6. History of Computational Art democratization

The goal of democratizing art is believed to have come in to discussion since the beginning of computational art and one of the core techniques to the democratization was to improve the aesthetics mathematically using Birkhoff's Aesthetic equation (as shown below) and thereby increase the reproducibility by improving the Aesthetic value - an idea that was proposed by one of the earliest computer graphic designer and generative artist - Frieder Nake.

M = O/C, where M is the Aesthetic Measure, O is the Order and C is the complexity.

Thus, in order to improve the measure, the order must be increased and complexity decreased, which was contradictory to most of the art that existed as by subjecting some of the world's most abstract works to the equation, there would be surprisingly low aesthetic measures. However, Nake and other scientists at the Stuttgart Experiments were aiming to improve the

information aesthetics without necessarily reducing the meaning of the art piece in itself. Also, another goal to increase the aesthetic measure was to reduce the harsh criticism around artworks during those days and making it more mathematically precise. The main aim behind this was that by increasing the order and lowering the complexity the price of art could be significantly reduced - enabling mass production of art.

And similarly, this idea appears in AI art as well - *"That might be an inevitability of AI art: Wide swaths of art-historical context are abstracted into general, visual patterns."* (Bogust, 2019). Thus, when an AI art piece is sub segmented into smaller pieces a sense of simplicity is visible that enables a wider production of the art.

Section 2.7. The economics and behavioral economics of AI Art

The demand side analysis of the AI art market

It has been embedded into the mindset that prices of 'hand' made art like Picasso are capable of reaching skyrocketing prices of millions of dollars. However, it is still not considered acceptable for computer made /AI produced art to have such prices. When AI-produced portrait 'Edmond de Belamy' was auctioned at Christies in 2018 for a price of about $400,000, there was an immense amount of criticism because it wasn't considered acceptable for an Artificial intelligence art piece to be sold off at such a high price. When a survey was conducted across the Ashoka University community among the undergraduate students, master's students and certain members of the faculty and the undergraduate admissions team, the results were surprising yet expected.

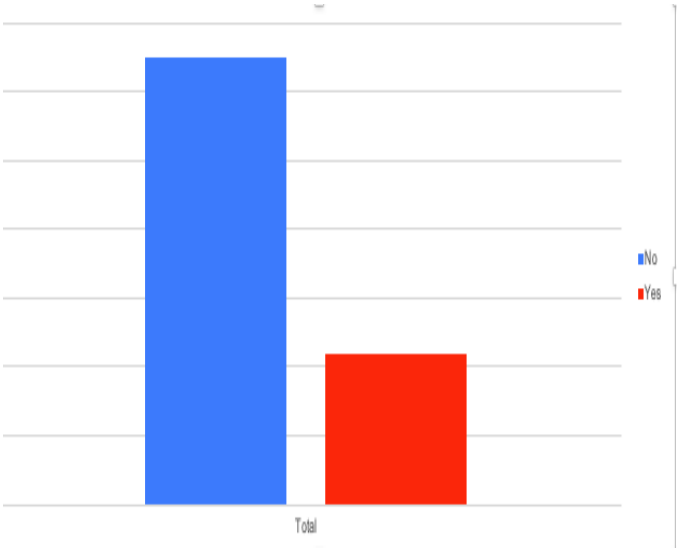


Figure 24
Red = Yes, Blue = No
A large proportion of respondents felt Edmond de Bellamy was not worth the price

When the painting 'Edmond de Ballamy" was presented to the survey participants, there were a large number who did not think it was worth the price (Figure 24) .

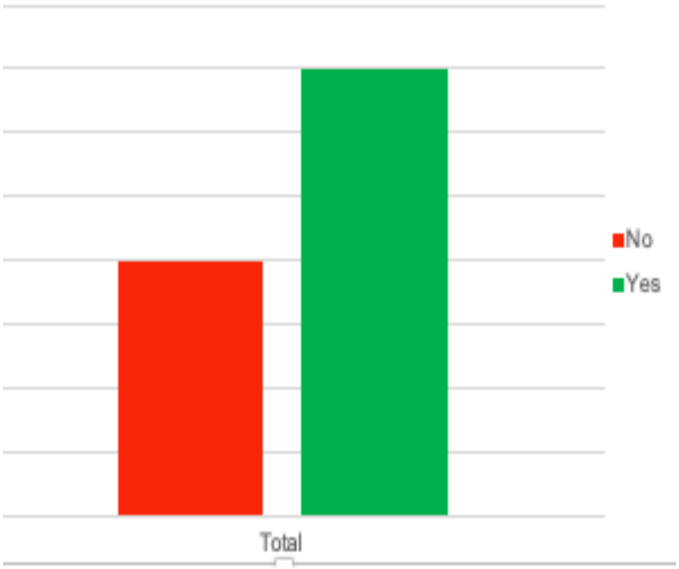


Figure 25
Red = No, Green = Yes
A large proportion of respondents changed their opinion once they were told that the painting is made via AI

And when the participants were told that the painting was made by Artificial Intelligence and via a GAN (Generative Adversarial Network), people's perceptions changed even further and those who had responded as the painting being worth the price, changed their opinion as not being worth the price (Figure 25).

To further ascertain these arguments, there were a couple of other questions asked to prove the audience's general perception of AI based Art. Another question posed to the survey respondents was two sets of paintings - one set with the AI art and another made by normal traditional artists. As a control, both the sets shown were kept to be of a similar aesthetic measure and design (Both the sets were portraits with the AI portraits being influenced by the handmade portrait artist).

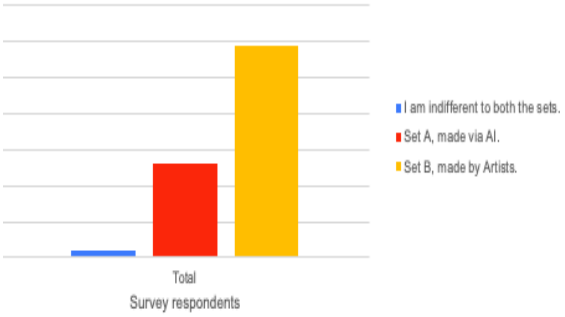


Figure 26
General inclination towards Art produced by Artists

As shown in Figure 26, more observers tended to vote for Set B (made by Artists). There was a general inclination of the audience towards Artist produced paintings.

Before the above scenarios were posed, all the participants were shown the same set of paintings all together without being told whether the paintings were produced by AI or an artist and in that regard, a broad inclination towards AI produced and Artist produced paintings can be seen. This is because the participants were unaware who and what made the painting or art piece.

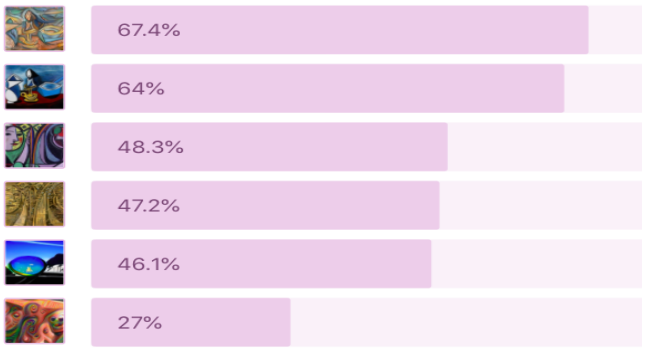


Figure 27
The General perceptions of the audience

As seen in Figure 27, there isn't a wide divergence between AI art and Artist produced art. This is partially because the survey respondents did not know which is which.

However, once the questions are posed in terms of AI vs Artist produced art, the inclination and biases towards Artist produced artworks can be noticed. A couple of other similar set of questions were posed in the survey to ascertain the trend and a similar trend tended to follow with more people inclined towards Artist produced art rather than AI based Art.

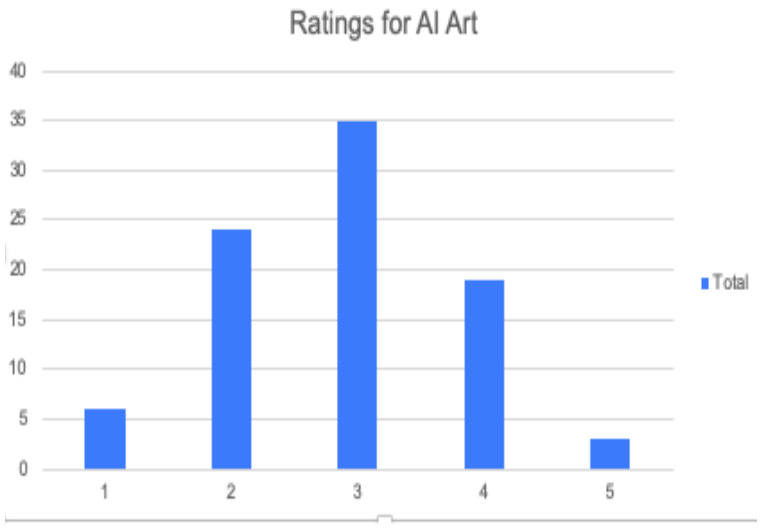


Figure 28
Ratings for AI art

Towards the end of the survey, an AI produced art piece was displayed with the 'Artificial Intelligence tag' on it and the survey participants were asked to rate the work and there was a wide range of responses, as shown in Figure 28.

There is indeed a mixed opinion here but most of the survey respondents voted in the middle range.

One major conclusion drawn out of the survey is that humans tend to prefer human produced art works, even though with a similar aesthetic quality This could be because human beings can associate with the artists background through the art works and also can understand the emotions behind the art piece, a characteristic and feeling that ceases to exist in AI based art as people and viewers begin to look at the art work in a more mechanical manner and thus, stop associating with it. This is again something resulting from the perception of the mind and how we see art in general. As the audience, we would rather find it 'ugly' (Hoek, Interview, August 5 2020), to have a painting like Edmond de Bellamy produced by AI but might look at it in a different way if the same painting was produced by human beings.

This is something that the mind has been made to believe over the years. It has become the part of how we structure our seeing. In John Berger's Book The Ways of Seeing (1972), Berger has presented the idea as a product of capitalism and what is considered to be a standard of the way we are seeing (p. 154);

> *"Capitalism survives by forcing the majority, whom it exploits, to define their own interests as narrowly as possible. This was once achieved by extensive deprivation. Today in the developed countries it is being achieved by imposing a false standard of what is and what is not desirable."*

In a similar context, the standards of seeing art today has been defined by the way we have seen art over the years - on canvas, with paint, or camera, and with the same palette of colors. These are things commonly available in the Art market, produced out of capitalistic gains as art produced by Picasso would appreciate in value.

But art produced by AI is still not likely to appreciate in terms of monetary value. The general viewer is resistant to change this standard as this is what has become comfortable and become recognizable to the eye. We can recognize Picasso style of art but find it difficult to recognize AI based art and thus it is something that is rejected by the mind. In turn, explaining the inclination towards the 'Artist' tag rather than the AI 'tag' in the survey.

The overall drive towards Artist made paintings, is also because of the general perception that art once reproduced by machinery is of a lower value than art produced by hand. This idea has been framed by philosophers and media critics like Walter Benjamin that "A product of mechanical reproduction may not touch the actual work of art, yet the quality is always depreciated" in The Work of Art in the age of mechanical reproduction (1969, p. 2).

This is not necessarily appropriate for art made via AI or autonomous systems because there is a sense of originality that comes from the AI artist and programmer that is reflected upon in the works. The medium is different but the art is original, because if the art is not original, AI artists would not be able to survive in the art world. They are surviving but their names are still relatively unknown to the non-AI art world. One of the major reasons behind such a phenomenon, according to AI Artist Tyler Hobbs is the "Lack of technical knowledge behind the AI art pieces in the market". For this reason, Tyler Hobbs ensures that with every art piece, the 'code' is sent along with the piece, for people and the collectors to understand what has gone into the making of the art piece.

Section 2.8. The behavioral economics of the 'Name Tag' and "Risk"

Art buyers like all consumers tend to be irrational in several ways when determining their purchase. Human beings tend to account various factors when purchasing or doing a particular job often not out of rationality but out of irrationality. For instance, a traditional economist might claim that volunteering is not sustainable because there is no monetary gain in exchange of the work done but still millions of people volunteer each year, because of the altruistic gain they get by doing the work. There is sort of satisfaction they receive by doing the volunteer work. Similarly, companies present flavors and tastes on the front of food packaging and the health hazards on the side, in order to nudge buyers towards making a particular choice (Cummings, 2018).

In a similar way, the operation of the art market today can be explained by the principle of irrationality. There are several factors that go into a purchase of an art piece: The mere-exposure principle, The signaling function, The Bandwagon Effect, and The Snob effect. The traditional art market already has an established name among art collectors with regular auctions being held at Sotheby's and Christies with art pieces fetching up to millions of dollars. This market has a well-known name and is considered a 'safer' investment to make. Such a market is characterized by the Mere Exposure Principle because its establishment is made by the exposure to such a market over the years. There are more people who would have heard of traditional abstract artists or contemporary artists or muralists compared to AI artists. Also, this could be explained by perhaps the smaller population of AI artists that exist today compared to the number of traditional artists in the art market.

Another reason for a lower dominance of AI art in the art market is because of the lack of socially linked trademarks in the AI art field. AI art is not linked with social status or identity as much as how traditional art works are. By traditional, we mean 'non-AI' artworks. For instance, owning an artwork by M.F Hussain or a Padma Shri artist Jatin Das comes with the opportunity to create flaunt the names of the artist in the social circle, a bit like how owning a Mercedes or a BMW is considered to be a symbol of someone's social status. This is something which behavioral economists would classify as "The Signalling function" - "Trademarks and names establish Social Identity". The trademark and 'name' around AI art is still limited.

And with the trademark of "The name of the artist" around non-AI art creates a situation of more people chasing the same 'good' or art piece, also known as the 'Bandwagon' Principle. With more people chasing the same art piece, there would also be a general increase in the demand for the product or similar products. Thus, often leading to a copy and forfeits market of art. However, such a phenomenon is still rare in the AI art market as the market is relatively smaller.

A principle that fits perfectly with the AI art market is the "Snob effect". The snob effect derives out of the desire to be unique and different and along with being different comes the 'risk' of being different. According to AI artist Mario Klingemann, the AI art market is more based on risk taking collectors, in turn making the AI art market more niche in nature. This is another reason why most of the AI art collectors tend to be of a younger age bracket and often belong to technical backgrounds, as per our market research and interviews with AI Artists.

Moreover, reports and research by Artwork archive, show that “Millennial collectors, on the other hand, are more likely to take risks, go above and beyond when it comes to networking in the industry and use social media to buy art” (*Who Is Buying Art Right Now?*, 2017).

However, the number of risk takers in the art market is still low.

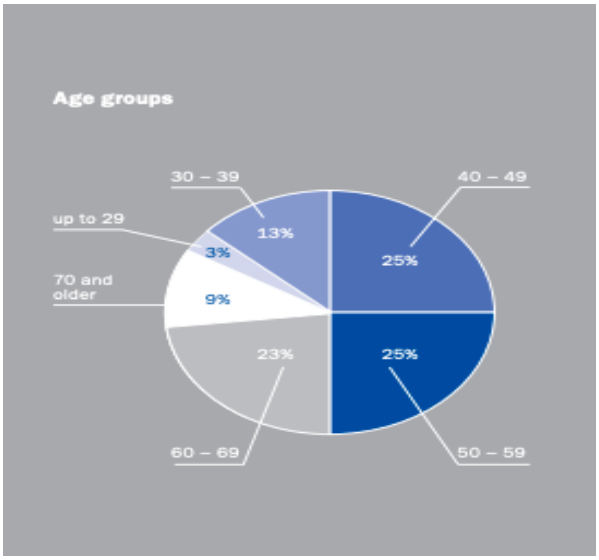


Figure 29
Age Bracket Distribution of Art Collectors

The art market currently largely comprises a middle and older age group with several following a family tradition of collecting art as per a market survey conducted by Axa Art(2014). The pie chart on the left shows the age bracket distribution of most of the art collectors.

As per Figure 29, most of the art collectors are above 40 years and “are passionate about art” (Axa, p. 12), or “are continuing a family tradition” (Axa, p. 12), or are “investors” or lastly are hybrid collectors collecting for various of the above-mentioned reasons. This shows the sort of Bandwagon effect taking place in the art market. Such art buyers are less likely to take risk and invest into AI based Art and it is for this reason that AI art market is not running in as dynamic way as it was expected to be except for the AI oriented and AI fascinated and risk-

taking collectors who are willing to change their perceptions which tends to be smaller proportion of these collectors.

However, to shed some positive light on to the matter, in the long run the AI art market could be one with an increased exposure(The mere exposure principle) with a known social status(The signalling function) and multiple factors accounting for a general attraction towards AI art such as an increased education and knowledge around AI and its operations and increased exposure at art exhibitions and fairs and auctions (signs which we are already seeing in the art market at present with works like Edmond de Belamy and the AIDA robot produced art piece, among many others).

At the same time, the AI art market is at risk of losing out on exclusivity, in case it becomes an increasingly common skill. In the present day, this is a skill that is being performed by a small set of AI artists. In the long run, as more and more AI artists evolve, there would be an increasing number of codes and algorithms available on open source platforms online. This is already happening. For instance, The AI art piece Edmond De Belamy by Obvious Art group is said to have been based on AI artist and Programmer Robbie Barrat's code which he published on an open source platform and license. (Vincent, 2018). AI artist Mario Klingemann in an interview with The Verge has explained that "90 percent of the work was done by [Barrat]" (Vincent, 2018).

However, enough credit has not been given to Barrat. When the painting is searched for on Google, most of the articles emphasize on the Obvious Art group without even mentioning Barrat's code or giving the young 19-year-old programmer enough credit. This is happening in the present-day scenario where the population of popular AI artists and AI skilled people are still low. In the long run, if this population increases, the art market is at risk of having multiple

similar looking paintings without even knowing the source of the painting or design as is happening with application design templates or automated Poster making platforms. This might pose a serious threat and risk to the market and in addition also leading the AI art market to collapse in one sense as people would no longer trust the value of AI art because of the lack of exclusivity in the market.

If the AI art market takes such a path, then it is under threat of becoming like the Graphic design and advertising industry in the past with a lot more production of AI art but of a lower monetary value. There are several graphic designers in the recent past who have expressed that they are “disposable, under-appreciated, underpaid and overworked” (Graphic Designer for 14 Years and I Can’t Stand It Anymore!! Please Help., 2020).

This is similar to what has happened to Robbie Barrat with AI art- he has been under-appreciated and there is very little information available on whether he was paid a fair share of the auction. When Barrat was interviewed on the matter by The Verge he did explain that he has given Obvious Art group authorization to take a part of the code but apparently, they had taken a large chunk of the code that he published on GitHub.

But what Barrat is more worried about is that such instances could spoil the impression of the AI art market and also deprive the *“actual AI artists of their deserved spotlight”* (Vincent, 2018).

In case this sort of thing does happen in the near future, then AI art is at risk of becoming a new quick automated ‘Photoshop’ with a lack of uniqueness in the art pieces. And this is scary and something AI artists need to be responsible about and take appropriate care in the designing their algorithms for the market and the users of the market to maintain a sense of integrity.

Furthermore, if the AI art market does become similar to the graphic design industry, there is a further risk of losing the market to traditional arts.

This would in effect make traditional arts more of a luxury good while making AI based art more of a commonly available good. This could be compared to how luxury watch brands like Rolex prices have increased over the years. First of all, by increasing the prices, they are making the watch more of a 'Veblen Good" where a higher price signals better quality and thus a higher quantity demand, also pushing Rolex further deeper into the luxury watch market. And in turn, they are also setting it aside from cheaper more affordable brands, making use of the SIgnalling Function and the Snob effect, - two aspects of behavioral consumption evaluated earlier in the paper.

By owning a 'Rolex', the owner is trying to gain a "recognized status symbol" (Bredan, 2015), and are desiring to be unique. A similar aspect might happen with the art market as well. If there is an ample amount of AI art in the market, collectors might be even more driven to traditional non-AI arts because of its uniqueness and value attached to it, making non-AI arts more like the 'Rolex' of the market, swamped by cheaper more affordable watch companies (metaphorically meaning AI art).

However, in the market survey conducted in the past month with AI artists (Interviews with AI artists, July-August 2020)[iii], most AI artists seem to be not very worried about this aspect as most of the AI artists we interviewed believe that as the community becomes larger, so will the capabilities to produce better art and the 'better' would stand out. As Generative Artist Matt Deslauriers has put forward in our email interview "I'm not too worried…. Good programmers are still scarce..." and thus he believes that this might be an eventuality but nothing to worry

about at the present stage, where AI art stands with a limited exposure and a limited population of practitioners.

At the same time, AI artist Mario Klingemann approached the entire matter of the art industry differently. For him, it is less about the market but more a matter of human psychology. In continuation to our email discussion with Mario Klingemann, Klingemann explained that the number of celebrity artists are going to decrease anyways in the near future because of the 'mass' in the market. It is only in human psychology that people want a "few of these artists around' (Mail Interview, July 26, 2020). This change in perceptions around artists and celebrities might change the way we look at all forms of art and how we perceive AI and non-AI art.

Section 2.9. Value Creation in the AI Art market

AI art due to the relative ease of replication and the problem of accountability as with the case of Edmond De Bellamy, comes with another risk - the risk of AI produced art, becoming a non-rivalry public good. Due to the digital nature of AI produced Art, it can be easily consumed via social media platforms and over the internet. Consumers can make prints on their own and admire AI produced Art without giving monetary and sentimental appreciation to the AI artist. Public goods such as 'The internet" itself tend to be non-rivalry, which means that the consumption of a website (or internet in general) does not reduce the amount available to others and secondly it is non-excludable which means that in consuming the internet, others cannot be excluded (everyone can enjoy the usage of internet as long as a subscription exists).

This is a similar scenario to other public goods like National Defense and Street lighting, which everyone can benefit from without reducing the amount available to others, irrespective of

whether everyone is paying for it or not. AI art could be subject to being a public good because of the features of it, being non-rivalry (consuming it online does not reduce the amount available to others) and non-excludable (AI art might be provided for a certain person but it does prevent others from enjoying it). Due to the risk of replication and overall redistributing art, AI art becomes even more non-excludable.

Thus, in order to make AI art more rivalry in nature and to increase the sense of exclusivity in the market, several AI artists have deployed certain strategies while producing and redistributing their art works. One strategy which artists like Tyler Hobbs are making use of is to give a 'signature' quality art piece when the art piece is being sold via his platform. The art piece being sold would be printed on a special "Hahnemühle Museum Etching" paper of a particular precise quality and are exhibited on "series of unique archival prints" [iv]. Also, it is emphasized that each of the works sold on the platform are sold accompanying a certificate of authentication, embedded certification and the code used to make the painting. All of these add a degree of genuineness to the art works. And thereby, also building a social symbol by providing the certification and signature codes.

In addition, another strategy which artists and digital art galleries like www.artaigallery.com are deploying is to only sell limited or single pieces of a particular artwork. By doing so, the artists are making the particular piece or iteration of Generative/ AI art work more exclusive in nature and for this reason the mind tends to perceive it as more 'valuable' (Cialdini, 2008). Also selling the art quantity in a fixed quantity (commonly as a single piece), the artists are creating a sort of urgency to buy it in fear of the design/art works not being available again, which tends to create a sort of competition among the buyers. (Aggarwal et al, 2011). Thus, by imposing scarcity on a particular artwork, they are trying to get collectors

to “put off decisions to act” (Johnson et al 2012). And alongside they are also trying to ascertain the ambivalences art collectors might have of replicability and forgery as by making a single piece, they have added a sense of authenticity and credibility and originality making the buyer more certain of the decision they are making, solving the problems the AI art market might face as pointed out earlier in the section.

Another aspect of AI produced art is the ‘life’ of the works. In the past, there have been several instances of popular art pieces such as Rembrandt’s Denae (1636), being damaged by a deranged visitor to a museum and art pieces like Andy Goldsworthy’s sculpture in San Francisco being damaged by fires. (Finkel, 2020). Apart from these, there are several accidental damages of artworks on a yearly basis due to carelessness of visitors, fires, disasters and several other reasons. In 2017, there was a surprising incident of a woman toppling over an art installation worth $200,000, leaving the art piece permanently damaged. The reason for the ‘topple’ was her repetitive selfies around the work of art (Bruner, 2017). Apart from these damages, art works are prone to thefts, as the statistics in the extract from US news proves;

> *“More than 50,000 pieces of artwork are stolen each year around the world, and the black market for stolen art is valued at between $6 billion and $8 billion annually.”*

And this is where the AI and Computation behind AI produced art acts as an insurance. This does not mean that AI art cannot be stolen at an exhibition or cannot be accidently damaged. However, in case of a damage or theft, it is relatively easier to restore a piece made from AI rather than a piece directly made by hand, if proper backup and engineering is stored in an efficient manner. Restoring traditional non-AI arts can be an extremely cumbersome process where “a restored work always loses value in comparison to the original but a well restored work might gain value” (Goukassian, 2018). In addition, restoration of works can at times take years

and years and many a times might be unsuccessful with the artist disapproving the “conservation job” (Goukassian, 2018).

Plus, the process of restoring the arts can often be a cumbersome and costly process which require the use of Infrared Cameras that document and create comparisons of the quality and condition of the art piece, costing up to a 100,000 US dollars and also entail the use of other tech devices such as sensors and SLRS to regain and evaluate the true nature of the original art piece. These devices can often only be afforded by large scale restorers and museums (Thottam, 2015).

According to Peter Himmelstein, a paintings conservator and restorer in New York City, a restoration of a large painting could cost up to $10,000 to $15,000, and thus often require grants from the government. And moreover, he implies that the biggest cost of conserving and restoring art is “Time” (Thottam, 2015).

However, as we know with AI art, restoration is overall a cheaper and less time-consuming process due to the computational backup that exists. So, in case a painting is stolen and proven stolen, or if the original artwork is damaged, then the art work could be made again in a short span of time.

However, it could be said that the remade art piece might not gain the same value as the original one because with replicability the value goes down. However, at the same time, this is a matter of viewer psychology and depends how people perceive and view a replicated art piece because the purpose of replication holds meaning. As for some restored paintings, replicated and recreated art pieces from Artificial Intelligence might gain more importance and value because the replicated work might be similar to the original work but would still hold differences as the probability of getting an exact same iteration of the art works is relatively low.

Section 2.10. The hidden 'art' of the art market

The art market is often known to be operating simultaneously in two economies - The market economy, based on cash, earnings and collectors (as discussed in the previous sections of the paper) and The gift economy, which is based on non-monetary gains such as 'Regard', 'The joy of creativity', "Hobby', altruism and satisfaction. And art including AI based art forms a large part of the gift economy which at times remains underground and unrecognized, due to the lack of ability to quantify 'gifts'. In the book 'The Gift', world renowned writer Lewis Hyde has described precisely how the gift community operates by "status, prestige or esteem, which take place of cash remuneration" (p. 101). However, this might arise a question that if status is achieved, why would people continue to achieve status and esteem?

The answer to this question lies in human behavior. Our quest for self-esteem and status is never ending. Our quest for 'regard' is never ending. This is the reason we see the concept of 'gift' across communities, and cultures. In addition, the fear of losing regard and trust might provide a "strong incentive to continue" (Offer, 1997, p. 453). Thus, the cycle of gifting continues to sustain that regard in a particular society. However, the wonder arises of how Artificial Intelligence based Art is linked to this Economy of Regard and the Gift Economy.

For the sake of explanation, it would be important to bring back the Edmond De Bellamy example. This case brought forward the number of various parties involved in the art piece- Christies, Obvious Art group and Robbie Barrat. It was Barrat's regard for the community that he didn't think so serious of the matter. This is a sort of 'gift' that Barrat lended a part of his code to Obvious Art group. Similarly, a lot of the algorithms and "the heart" of AI art works are shared

across the community to cultivate further research and innovation. This has been perfectly put forward by Lewis Hyde;

> *"[Contributions] become one to the degree that ideas move as gifts" (p. 103)*

In addition, Lewis Hyde comments on how artists' knowledge base would operate in the past.

> *"Guilds of artisans such as stone masons …. would keep them know how a secret and charge a fee from the public" (p. 105).*

A similar sort of mechanism is plausible in the AI art market. Within the guild of the AI art market, there could be a free circulation of ideas and algorithms as seen in the codes shared via open source licenses and GitHub of AI artists, which can be understood by like-minded community members, while charging a fee from the normal collectors and the market economy.

This is in general a sustainable model especially for the art and culture around AI art to be propagated and in one sense this sort of "Gift Economy" is further democratizing the art space. In addition, the act of gifting and "borrowing codes" is common in the field along with gifting of art pieces within the circuit as is with the non-AI art market as well. A good example and reflection of this community is how the AI art community is being brought together via organizations such www.aiartists.org

Such Artist based communities where community members have the gift and satisfaction of being creative in essence brings about beautiful outcomes as evaluated by French Sociologist Marcel Mauss in the 1925 essay "The Gift: Forms and Functions of Exchange in Archaic Societies", where he explains how the engine of community and the objects created lead to

social, psychological, emotional and spiritual bonds as [gifts] are passed on from one to another. And gifts of course are a very broad term in Mauss' perspective and school of thought. In the case of AI art, it could be said that the gift is the art piece produced, the autonomous system built, the algorithms, shared resources, ideas, knowledge base etc.

Section 2.11. The 'dark' of the art market

The 'dark' of the art market undoubtedly exists within the market economy, which here is being referred to as the "Black Market" that is largely also hidden in the market economy, and is untaxed, unrecognized and never comes up front. In an email interview with Tjeerd Hoek, Head of Creative at technology and design consultancy Argo Design, Hoek explained how he felt that "The international trade in Art is a white washing scheme for criminally obtained funds and tax evasion", which is indeed the unfortunate and stark reality of the art market and this could be partially the reason why new forms of art struggle because certain art has already been established with in the art market. According to Thomas Christ at the Basel Institute of Governance, *"The art market is an ideal playing ground for money laundering"* (Bowley, 2017).

This is also partially because there are several instances where the identity of the owner is kept secret and anonymous with buyers (who are in fact many a times billionaire fraudsters/black marketers), dealing through their highly secretive agents. (Bowley, 2017).

And because of these key players investing large sums of money into art pieces, newer Arts like AI based art remain hidden in the darkness because investors would not want to take the

risk of investing in AI art. They would invest into something that offers guaranteed returns and AI art in one sense at the time being, is less about returns but more about expertise, knowledge, technical skills and creativity.

Section 2.12. The producer side analysis

The process of the creation of AI art tends to be rather more cost friendly and efficient. Overall the production of most AI art is faster and quicker compared to non-AI based art. One of the reasons behind this is that AI art is not prone to creative blocks. In a video interview with artist Roman Lipski, he very humbly explained his life story of how he ended up into a creative block in 2016 as a non-AI artist and could not paint any more for a long period of time. This is when he was introduced to AI as an AI muse (assistant) by one of Lipski's technical acquaintances. This AI muse helps him to come up with ideas and he believes it has in one sense improved the quality of his work along with his productivity. It has become more creative and his art has significantly changed from his pre-muse times to post AI muse times. This is essentially the capability of AI based art in essence. It can bring about better productivity and creativity if used in the right way.

And it is because of this increased productivity and technological interference in the art field, that artists like Roman Lipski and Mario Klingemann can in effect benefit from Economies of Large-Scale production. By producing several more pieces in the same span of time, the average cost of production goes down as with the same fixed unit can produce several iterations of paintings (also referred to as Technical economies of scale) and by selling albums or iterations

of paintings together, they can also benefit from bulk buying and selling strategies reducing the time, effort and labor on selling the art works if ideal market conditions exist.

According to AI artist Mario Klingemann. If there are appropriate resources and engineering, he can generate “over 100s of artworks in an hour”. (Link to Mario Klingemann Interview).

Moreover, there is only initial fixed investment of the machinery in the case of Klingemann’s installations. Afterwards, there are quick iterations of works in contrast to traditional art, which would be only a single final output... Variable Costs of art works produced by Klingemann Portrait making machine is virtually null. More and more pieces can be produced in the exhibit, each time producing a new figure without any additional costs (Refer to figure below). A similar strategy is deployed by other AI artists as well like Tyler Hobbs where there are multiple iterations of the same painting produced by the algorithm. In summary, this reduces the repetitive effort and work of the artist and instead allows greater focus on developing new sets of pieces.

Figure 30
Loxography, Hobbs 2019

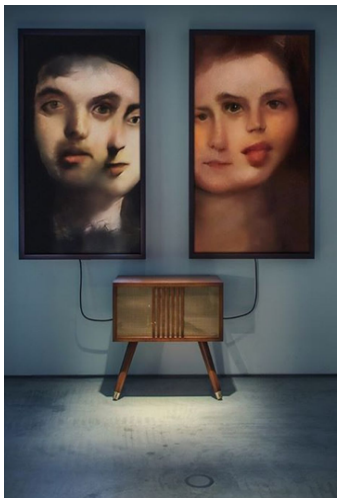


Figure 31
Memories of Passersby, Klingemann 2019

Section 2.13. The problem of profit division in AI Art

As per AI Artist Memo Akten, these are the ways of creating AI Art: (Sterling, 2019)

1. Train on your own data with your own (or heavily modified) algorithms
2. Train on your own data with off-the-shelf (or lightly modified) algorithms (e.g. Anna Ridler, Helena Sarin)
3. Curate your own data and use your own (or heavily modified) algorithms (e.g. Mario Klingemann, Georgia Ward Dyer)
4. Curate your own data and use off-the-shelf (or lightly modified) algorithms
5. Use existing datasets and train with heavily modified algorithms
6. Use existing datasets and train with off-the-shelf (or lightly modified) algorithms (this is what Obvious has done).

Thus, due to the complexity of ways AI art can be made, it becomes a difficult and cumbersome process to divide accounting profits among the parties involved in the creation of the art piece, especially when an art piece is sold at an auction at a high price as determining the extent of involvement of each of the parties is difficult. The coder of the dataset, the coder of 'off the shelf algorithms' etc. in this case are being referred to as the different parties involved in the making of an AI art piece. Therefore, leading to a conflict amongst different parties.

Such instances could mirror with the profit and revenue division issues that occur in partnership-based companies and companies that have multiple shareholders. In this case, the

shareholders could be said to be the multiple people involved when an open source algorithm is used. Though it is open source, it seems unethical to not give enough monetary credit to the creator. However, it is increasingly becoming accepted in the market as a community sharing strategy - more as a reason to innovate and propagate the AI art culture rather than base it on monetary divisions. (As discussed in the Gift Economy section).

Section 2.14. Generative Design industry

Figure 32
Antrea Tiedye, Stewart 2020

Artificial Intelligence is coming of immense use in the Generative Design industry where autonomous systems and AI based Generative Design systems are generating multiple iterations of different designs in the automobile, shoe, telecommunication, aviation industry etc.

An example of such design is Argo Concepts by designer Cam Stewart who manages the generative design at Adidas (Sample design in Figure 32).

Overall, in effect, Al has enabled generative design solution with algorithms that help industries to produce a wide range of design alternatives in a short span of time. And it is for this reason, the generative design industry is expected to accelerate at rates of 16 percent due to an increase in AI intervention. (Technavio, 2019).

This could result to major changes in the job market. Due to increasing capability of AI based Generative Design systems, there would be a less need to have a large team of designers working towards product creation. For instance, there would be a less requirement of head designers, sub designers etc. and a lot of the idea creation can be done by these systems and mainly the work of final product design and finishing touches would be human oriented. This is in one sense capable of replacing the very high skilled jobs in the design industry (the idea creation teams) and the only requirement would be of lower skilled finalization teams. At the same time, there would be a greater demand for skilled generative designers especially with AI based expertise to design such dedicated AI based Generative systems and Generative design autonomous bodies. A similar idea has been reflected upon in a report and blog by the Autodesk team (English, 2017);

> *"AI and generative design may replace some of the need for designers, draftsmen, engineers, and so on, but our jobs will shift into new areas with as much potential as before."*

However, it is also important to note that in the initial stages, such a product might act merely as a tool to support and assist other designers, similar to what is happening in the Healthcare industry where AI is assisting doctors rather than replacing an entire team of designers. However, this still does pose a risk of higher skilled jobs being lost.

This argument does support what ex RBI governor and economist Raghuram Rajan has often evaluated upon that AI would have the capability of "taking over both skilled and unskilled jobs" (*The Economic Times*, 2018). However, at the same time, the generative art hypothetical

study shown above shows a risk to creative professionals as well which according to Rajan is something which would be immune to AI.

This might not be the case with AI in the generative design spectrum. However, it is likely that the industry would still require creative professionals but of different skillset than before (More AI oriented creative professional), in the long run. Furthermore, in the long run, this also poses a risk of a market restructuring, and moreover causing traditional Photoshop based designers to lose jobs similar to what happened to advertisers and designers in the past who used hand/sketch-based art and design.

Section 2.15. Could AI art be the new Ghost Work? The possibility of darkness behind color.

Karen Hao, an Artificial Intelligence senior reporter at MIT technology review has asserted on several occasions in her interviews and articles that "Artificial intelligence doesn't run on magic pixie dust." and there is a lot that goes into the running of Artificial Intelligence based systems, which unfortunately is largely unrecognized and uncounted for in the production of such systems and thus is often known as "Ghost Work" that remains as an underclass of works who are underappreciated, unrecognized, underpaid and often have to work multiple hours overtime. These concepts were evaluated in immense detail in Mary L. Gray and Siddharth Suri's book "Ghost work: How to build stop Silicon Valley from building a new global underclass", which ascertained and reflected upon the social tragedies that might be in the creation and operation of AI and tech-based systems. And according to Mary Gray, there is a range of ghost works that are performed by these workers from microtasks like working on

newsletters or verifying images., on platforms like Amazon's MTurk, which Mary L. Gray calls "The Public Face of Micro-Tasks"(Page 73) to Macro tasks such as building AI based algorithms, training data's especially big data, where a large number of people and ghost workers "evaluate, sort, annotate, and refine terabytes of "big data" that consumers produce every moment they spend online" (Page 130).

A similar scenario could arise within the AI art and generative design industry as well. AI art and design can do very little on their own. The algorithms are useless without any meaning. There might be several sets of algorithms that are too complex to handle and the AI art system might not even work in the first place. For an efficient operation, there would need to be deep testing and run throughs before releasing the final art piece and design.

And thus, in the future, if there is a greater demand for AI art, either for visual pleasure or in the design segment such as the fashion industry or automobile design market, there could be likelihood of a new ghost work in the market that might entail designing algorithms, or performing the back-end tasks of the systems such as coding while the main artist creates the vision of the piece. Plus, there would be major need for training the data to make the art pieces in the first place, which Mary L. Gray recognizes as something that requires major human intervention as "training data to teach AI to recognize what counts as the best choice does not exist" (Page 32).

And data like with all the other AI, plays a quintessential role in the production of the art pieces, which AI artist Mario Klingemann classifies as "The only source" to AI art, which is the only input to all the models. In other words, it can be said that root of all AI based Art and design is Data. And understanding, modelling and analyzing such data is a cumbersome and long task. At the present phase of the AI art industry where the demand is relatively low, it is easy to train

the data on your own and build model sets that can be manipulated. In the long run, if the demand increases, then there would more people who would be needed to do such tasks of model making, coding and data training which is where Ghost Work could come in.

At the same time, the question might arise is that once the model for say a Generative Design system is created, it can be replicated, so would not require continuous work. The answer to that would be that models would keep changing with time as consumer demand, tastes and preferences keep changing. And data is the only way to account for these changes in consumer preferences, which keeps coming in terabyte packets of data. For instance, it would not be feasible to have a constant model for AI based Generative Design system in the fashion industry or shoe design industry or any other industry for that matter because tastes towards shoes or fashion or cars would change with times.

Thus, such tasks might have to be taken care by humans but are largely unknown and unaccounted for by the industry or the designers or the consumers because these people have been kept hidden from the forefront, in order to make these temporary workers do “unforeseen and unpredictable types of tasks” (Page 34, Ghost Work). Moreover, as Mary L. Gray highlights in order to innovate in AI and push AI to the “limits”, there would be a steady increase in these kinds of tasks being performed. (Page 34). Similarly, in order to innovate within the AI art spectrum and the generative design industry, these tasks might be hurdled and passed on the ghost workers.

The signals of such a thing can already be seen. In the case of Edmond de Belamy as discussed in the paper, Robbie Barrat wasn’t given enough credit even though his code was used. This is almost mirroring the first instances of ghost work that happens with Software and API design where there are several ‘Ghost workers” designing these systems but no one knows who

was behind it because these tasks were effectively performed by people working day and night for minimal amount of money and classified as ‘temporary workers”. Similarly, a seemingly automated interface such as the “automated’ deletion of posts on Facebook are not entirely automated but rather are made to seem automated, as there are a team of “underpaid and overburdened Facebook moderators” who are working to look out of such posts. (Solon, 2017). And not surprisingly, a lot of these moderators are going through mental health issues.

Similarly, AI art is not as automated as it seems, which can be understood by the extent of tech and human collaboration that goes into the creation of AI art.

Moreover, there are no clear polices around AI based Art. There is a no clear labor law that applies as is with temporary workers, which now seems an inevitable working ‘underclass’ creating and crafting intelligence for the machine.

As Mary L. Gray asserts in her book, “AI is simply not as smart as most people hope or fear”. And thus, it is important to think how smart is the machine or robot producing art, in the first place. And whether the output of Artificial Intelligence systems is produced in an ethical way or not right from the creation of the system to the final product. And is the true cost of making AI creative at the cost of hindering the creativity and life of several other ghost workers designing these Generative Design bodies.

These are questions that are yet unanswered because of the current operations of the AI art market. However, in the future if AI art and AI based generative design systems are expected to accelerate at rates of 16 percent (Technavio, 2019), there is a probability of having ghost work as the dark external costs of production (the cost of mental frustration, health issues, social life etc.), that might mingle with the bright colors of machine produced art.

However, most people and design consultants like Jarett Webb, the Technology Director at Argo Design, in an email interview expressed that they are more optimistic about the Generative Design and AI collaboration which he looks at as mostly a “tool for the designer or artist to use” and it’ll be still a long way to go before anything drastic were to happen (Interview, August 3, 2020).

Section 2.16. A broad overview of AI, Economic Growth, Jobs and Art

Abhijit Banerjee, the Nobel Prize winner in Economics 2019 for his analysis on alleviating global poverty, has reflected upon Artificial Intelligence and the job market in the book “Good Economics for Hard Times” and for him, like many of the market researchers and economists, AI and the market growth seems to be a two-sided situation, with an uncertainty to the matter. On one hand, Banerjee refers to Economics historian Robert Gordon’s argument that none of the new inventions like AI are as “transformational as the Elevator” (Page 150) and that AI has been around since 2004 and yet we have seen many changes to the job market and economic growth. Growth is there but it is not as fundamental as economic growth during the industrial revolution and internet revolution in the past. In addition, job structures according to Gordon haven’t changed. There are people who are still using desktop computers and offices operate pretty much the same way.

These arguments are true and the revolution of changes that have been expected such as the fantasy of robots replacing humans in offices and massive technological unemployment are

not reality. There are still people who are able to search for new jobs. And a lot of the work still continues the same way.

At the same time, Banerjee also proposes that Artificial Intelligence revolution might slow and steadily "hit people across a wide spectrum of jobs" (p. 229). And this is already been seen. For instance, there is a less need for Doctor assistants if AI can help in prescribing medicines and a less need for accountants if an automated AI based tool can perform financial calculations. And according to the argument Banerjee is posing, this could be just a stepping stone. It could slow and steadily spread and people in these fields would be in lower demand but might be utilized into other sorts of jobs. (p. 229) At the same time there could be people who would not be occupationally mobile and shift jobs without actually knowing the skillsets and being able to adjust into news jobs. This could pose a serious threat to certain works who would be left unemployed for periods of time as has been seen in the past with automation during the industrial revolution creating a "powerful displacement effect" (p. 230).

On the question of Art, the field of AI might be in more of a nascent stage. However, in the art and design field, AI art does have powerful capability of reducing workforce. At the same time, this also depends on the capability of existing designers to adjust to AI and the design companies' willingness to change their operations. But it also true that at a time of an economic crisis and over low certainty around the economy during the pandemic, the extent of changes in art, design and any other industry is questionable especially since the world and the economy globally seems to be entering stagnation.

But one thing is for sure is that Creativity is a quality that is cherished by human beings, no matter it be an AI artist or a non-AI Artist because that is a field that all artists and non-artists alike are attracted towards and is a quality that people would continue to express through art,

innovation or Artificial intelligence as well. Thus, according to AI artist Roman Lipski, in order to not spoil the flow of work and to not hinder creativity, he often argues and proposes an interesting concept of a *"Universal Basic Artist Income"* for all creative professionals and artisans. (Live Interview, August 4, 2020). he believes a basic Artist income from the government is an interesting concept to explore as he suspects when artists know that they are not painting for the market, there is a likelihood of better art to come out rather than painting for an intended audience.

The true fruit of Art and design as Tjeerd Hoek, Head of Creative at Argo design , highlights in an email interview is in the journey of doing "Art' and naturally all humans would be inclined towards it. So, this raises a question of whether AI would ever completely replace artists. A simplest answer to that would be no. But it might change the way the art and design world operate to a certain extent.

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