Generative *Art,*) Storytelling and // *Society* {

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Foreword

The extra year of study thanks to the corona virus becomes invaluable for this research. It allows me to investigate and implement artificial intelligence from scratch and fully exploit the potential of interactive mediums by practicing. The quiet circumstance in the pandemic nudges me to concentrate on the project and ruminating on relevant topics. During this chaos and uncertainty, support from my parents and the person I love means everything to me.

The master program of visual communication in the faculty of Fine Art, Music, Design of University of Bergen is an incredible life experience. I got every chance and support to learn and try whatever I want. I feel so privileged by playing with knowledge and practicing for impudent exploration.

I would like to thank my tutors Ashley Booth, Geir Goosen, Greg Niemeyer and second tutor Åse Huus. Their genial attitude, incisive reflection and tireless responses empower me to confront such radical challenges. My anxiety is always comforted by their calm and kindness. The project could never have grown without their genuine support. Thanks to Albert Tang, Arthur Hureau, Cathrine Kramer, Charles Michalsen, Dillon Thomas, Erik Nelson, Farley Gwazda, Fredrick Salhus, Johann Sagan, everyone in the MAD program, especially incredible classmates in the past three years, the faculty and community from KMD, the faculty of Fine Art, Music, Design of University of Bergen and the faculty Art Practise of University of California, Berkeley.

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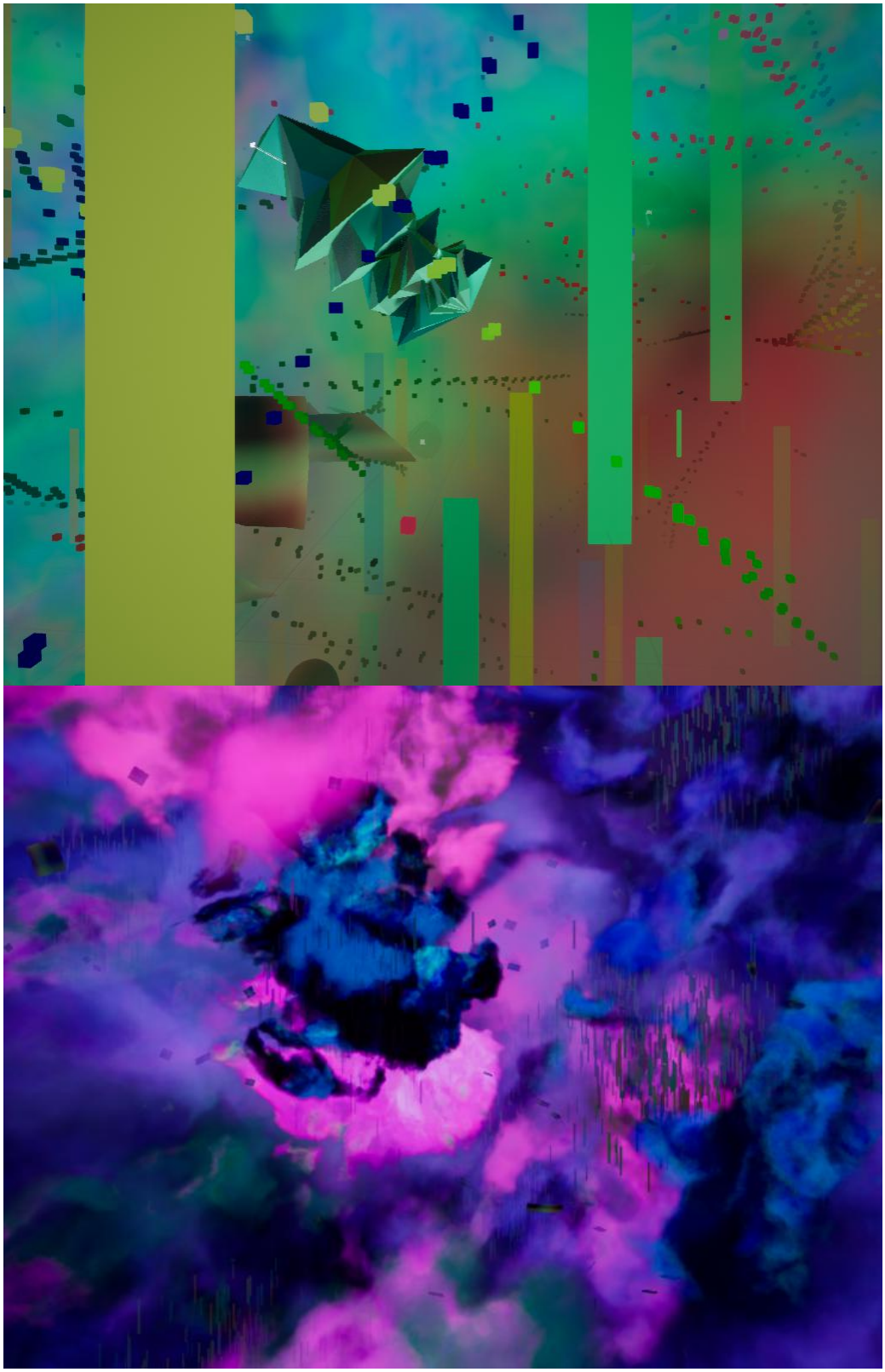


The digital incubator from the Digital Leak Responding

Introduction

1.1 Abstract

How can a fictional, artificial society be designed and generated?

By creating a design fiction (Dunne and Raby., 2013) of alternative societies and designing a digital world of artificial intelligent species, I try to engage people interested in interactive media and concerned about social minorities and our technology-related future.

Digital Leak Responding is a design fiction built upon a digital incubator for artificially intelligent species. Living in the virtual space of the digital incubator, these imaginary creatures can evolve their embedded artificial intelligence by interacting with the environment; Evolution, in other words (Fogel, 1995). Such an adaptive strategy gives them the potential to collaborate (or not) and for artificial society to emerge (Sawyer, 2004).

This project is inspired by the documentary from NHK (2018). The production team focused on teenagers in China who choose to live a life in poverty rather than work in intensive factories (like Foxconn). Living in crowded dormitories and relying on cheap supplies, their life situation is remote but relatable.

The documentary led me to ask: If an alternative society could accept and encourage more diversity, what would it look like? Collaboration and tool use in the lately developed artificial intelligence (OpenAI, 2019) enabled me to experiment with the possibility of generating the artificial society in a computational emergent social simulation.

Using generative methods like computational algorithms to create design content, I am enabled to materialize my thoughts and ideas. It is the attempt to deliver messages and meanings through texts and visual elements in this design fiction. The principal product of this investigating process is a simulation of artificial society, the digital incubator. It is a discursive practice of interactive medium and an alternative implementation of the cutting-edge technique for problems to propose and expose. It is also part of the Digital Leak Responding, which is a design fiction for audiences to resonate and speculate, for curious minds to discover ideas about digital species, and reflective spirits to contemplate and to abstract.

In conclusion, it is the research that regards generative artificial society and interactive storytelling.

1.2 Discursive Origin

1.2.1 Motivation

Visual communication design demonstrates a specific mindset for creating visually-oriented projects. Practices of design do not necessarily mean solving design challenges from clients as it is perceived in the public domain. In my opinion, design practices engage more inferential thinking methods during creation than fine arts practices, which is the result of different preferable approaches. If we compare visual art to literature, I would argue that fine arts are closer to legitimate genres, while the design is more similar to science fiction. This explanation happens to be how I like to describe my design practice, a scientific design fiction. It is a story about the future for audiences to engage and to speculate through the digital incubator.

Two years ago, when I started to conceive this project, I was caught up by the documentary produced by NHK, Japan (2018).

It was focused on a group of teenagers who gather around Sanhe, Shenzhen, one of the biggest human labor resources markets in the south of China. These teenagers usually dropped-out of school for many reasons. After that, they migrated to this prosperous metropolis, Shenzhen, to find opportunities to work and support themselves. It doesn't take a long time for them to realize that it is almost impossible for them to succeed from the alienating working system in these intensive factories (like Foxconn). Therefore, they choose to quit their full-time jobs and start to take short-term jobs to release some leisure time, which many use to play video games [Pic.1]. Although the limited part-time jobs there have no guarantee to pay on time. It forces them to lower the living standards for compromising the declining earnings by staying in a crowded, stinking dormitory and consuming the cheapest food available [Pic.2]. Sometimes they even need to sell their identity to get through the hard time and lose the right to work legally ever since.

Marginal groups like these are ubiquitous in our society. For example, homelessness. Unlike common sense, being homeless does not directly associate with their financial or mental situation. A homeless older man travels throughout China to discover his fantasy island. Along his journey, he makes everything out of nature and reads books to figure the right way to go [Pic.3]. According to him, the departure was at the age of five and now he's 103 years old. This choice is tougher than it sounds; he has lost several fingers while carrying a stone. Although these didn't stop him from living the lifestyle he yearned for.

These are found and exposed by Yanqiu Cai, a streamer who travels around and helps homeless people return to their homes. He has also found a homeless man that chose to live alone on the street rather than unhappily living with his child in his own house [Pic.4]. Reasons for being homeless are plainer than I thought, such as afraiding of the blame from their family or being too shy to ask for help when getting lost in a strange city. Mr. Cai has helped more than a hundred homeless people back to their homes (CGTN, 2018).

[Pic.1] (Top) Teenagers playing video games (Screenshot from NHK Documentary)
[Pic.2] (Down) Teenagers living in the dormitory (Screenshot from NHK Documentary)

[Pic.3] (Top) The homless older man is reading (Photo from Yanqiu Cai)
[Pic.4] (Down) A homless man living under the bridge (Photo from Yanqiu Cai)

Mole people in New York, Free town Christiania in Copenhagen and so on, marginal groups are varied from cultures but consistent in presence. They're groups of people detached from society, just like tumbleweeds fall off from its root.

It makes me wonder why it is so hard a reality for people to live a different lifestyle? Marginal groups sit at the edge of the society; however, it is a giant machine that feeds its center with the most energy. More frustratingly, submitting to the rules of city lifestyles does not seem to be the way out. The one-way access to becoming favorable by capitalism is so selective, and technology is intensifying this monoculturalism.

1.2.2 Thoughts

Delivery services in China are incredibly relying on algorithms. Companies like Meituan track their deliverymen's average time spent on every task to build a countdown system for leveraging (Aspinwall, 2019). Consequently, problems like fatigue driving and traffic rules violations increase day by day. As the company would argue, these results are technical problems like miscalculation of time and navigation by the rusty algorithms. However, from my perspective, that's not the root cause. The company could've compensated the error accordingly by setting adequate tolerances for this deficiency. In fact, such tragedies are facilitated by the values permeating through corporations and society. It is the idea of capital first that haunts people's minds and plays a significant role in the intolerance contest of chasing fiscal gain. Likewise, such a dilemma with algorithms is similar to the experience of American deliverymen in the controversial delivery service, Amazon Flex (Nolan, 2019).

In our society, everything gives way for capital revenue; this criterion strangles other idealisms and possibilities. Such monoculturalism brings misalignment between values and reality, leading to practical issues on a systematic scale and resulting in

a devastating situation for individuals. A young man jumped off his flat after the firm Danke broke and failed to pay his landlord. Danke is a New York-listed renting agency that provides cheap apartments throughout China. Like many other consumers, this young person took a loan to pay the annual rent at once, for obtaining the cheap deal offered by Danke. This one-off payment is required by Danke, which helps them to maintain the cash flow and compensates their loss in trades. Such a business model is highly appreciated by the stock market and increases their chance of winning in the market race. Investors know the problems in this questionable business model and maintain the silence. It is a model that has been criticized as a pyramid scheme fraud; The rent they charged is lower than what they paid to the landlord, making their price invincible. Lately, when the pandemic happened, the market collapsed and the company couldn't afford to pay the landlords as promised. Like many other consumers, this young person still needs to pay for his loan but has nowhere to live after being expelled by his landlord. And then, He committed suicide.

The unidirectional evaluation of development brings new problems to China. A few years ago, another young man wrote his last message on the internet accusing Baidu's bid ranking services. The information about health care promoted by the services led him to start an informal treatment of leukemia before he passed away. This could have been avoided if he had received trustworthy information from the search engine; But they were looking for extra profits. These problems from the rising markets in developing countries like China also appear in the developed countries. For example, the problematic business model in Danke has led the New York-based company WeWork to a massive scandal (Zeitlin, 2019). Another example is Theranos, a health technology corporation that founded in Silicon Valley. Their innovation has been proved to be false after they had racked up a $9 billion evaluation (Pflanzer, 2019).

This monoculturalism is profoundly shaping our technology-related future and is intensified by the way we adapt the technological

innovations. Since it was first released, the telephone was considered to bring peace to the world by reducing miscommunication. Unfortunately, that did not happen. Moreover, it even helps to deliver the commands in wars. What technologies could bring to us depends on the way we apply them. The promising breakthrough in AI has prompted pornography and surveillance immediately, like Deepfake (Sample, 2020) and the face recognition technology. I believe these absurdities shouldn't become the default setting and be taken for granted when we adapt technologies.

Our society is obsessed with monoculturalism. ,"We need more pluralism in our minds, as well in our designs" (Dunne and Raby., 2013).

1.3 Inquisitive Destination

1.3.1 Subjects

Prevalent generative design usually employs computational algorithms to construct the generative system for generating design content. It's a method that can save designers from laborious repetitive details and allows them to focus on manipulating the underlying visual patterns and rules. It is a design practice that expects different strategies, which is generative design thinking. Details will follow in the Generative Art section.

Generative design builds the foundation of my design practices in this research and allows the exploration of interactive narrativity and artificial society to take place. By default, generative designs are interactive; The computer as the device to practice generative design is also an interactive medium, which immediately grants the interactive potential to the practice. Interactions are able to happen between different elements in generative design pieces; Disparate components in generative design pieces follow specific rules respectively and result in the consequences of states changing. This way of interaction is distinct from the

interaction between audiences and the design, or human and the computer, therefore it produces a different type of interactive narrativity. Details about interactive narrativity will follow in the Interactive Storytelling section.

Society is the pattern of interactions between individuals (Durkheim, 1984) and the individuals can be any autonomous units (Holmwood, 2005). It means that there's not only society for humans or animals, but also society for automata in generative systems. In my project, the artificial society I intended to create comprises automata, the carriers of artificial intelligence.

Tool use and collaborative behaviors emerged through the implementation of the deep reinforcement learning algorithm (OpenAI, 2019). After investigating and experimenting with artificial intelligence algorithms, I decided to incorporate them into my project. This alternative adaptation of cutting-edge technology will be specified in the Artificial Intelligence section.

These ideas and qualities can be integrated into the research questions; How can a fictional, artificial society be designed and generated? How can design speculate an alternative society?

These questions articulate the purpose of my research and demonstrate the theoretical connection between my project and speculative design (Dunne and Raby, 2013). Generative design as my main design approach has stated clearly and the artificial society has dominated the intention.

1.3.2 Goals

Several pieces of design practices will be created through the research. The most relevant and integrated practice is the design fiction Digital Leak Responding. It includes the digital incubator and some other supportive materials. Other than the design fiction, despite the discarded projects during the process, there are still some visual slides for exploring the interactive storytelling.

Design fiction itself is nothing but a conceptual collection. To deliver the message within, I need to build the context, which consists of different materials. The digital incubator is the primary material of Digital Leak Responding, a digital simulation, which will be briefly introduced in the coming paragraph. Other than that, there are supportive materials, which are flexible and can be any content as long as it helps to elaborate or communicate the fiction. It could be a wiki page introducing the elements in the digital incubator, or a fictional blog recording the discovery of this digital leak. For the current research, I decided to design The Manual For Cultivating Digital Species as the introductory content for people to preliminarily understand this fiction.

Simulation or simulator can be a digital imitation of any system. It can be used for researching, skill training or entertaining. In the last case, it will be considered as an atypical type of video games. The digital incubator is a simulation and the principal part of Digital Leak Responding. Inside the evolutionary environment of this digital incubator, artificial intelligent agents are trained to obtain as much reward as possible to survive and reproduce. Other than being appreciated, the digital incubator can also be used for different purposes, for example, a breeding space for digital intelligent lives, a virtual laboratory for social experiments, or a battleground for avatars representing different groups of interests. For audiences, this digital incubator is a simulation to interact with, contemplate, speculate, discover and experience.

Many practical solutions and strategies for creating this simulation can be found in game design practices. Meanwhile, I have neglected some crucial components in game design, such as the exploited addictive mechanism and directional entertaining content. This results in a departure from the definition of video games. Relevant content will be elaborated in the Social Simulation section.

Visual slides are animated slides of stories in different topics. It is the practice for audiences to experience and can interact with the mouse and keyboard. Visual slide is convenient and straightforward, contributing as a tool for sketching in generative design practices. On the contrary, Digital Leak Responding is comprehensive and versatile, allowing complex content to present and profound meanings to deliver. These qualities make it more appropriate to be the essential design practice in this research. Regardless of capability, all design practices in this research highly depend on generative design methods and tools.

The design fiction is accessible for any audience. Although, it might be more attractive for people interested in digital technology, interactive media or versatile narration. It also provides thoughts and ideas for people concerned about our society and technology-related future.

Eventually, this project is intended to spread the concern of design fiction and marginal societies, bring forward ideas about alternative societies, and engage people in reflecting about them by providing special experiences and communicating the message behind them. I do not want to preach inclusion for everybody in society, but I hope this can raise awareness of the existence of alternative means for organizing society and building our relationships.

This research is a wrap up of my graduate study, but the possibility for reentry for all could be a future hope. At the far end of this project, I can see a generative society of digital species constructed by artificial intelligence.

1.3.3 Outlook

This thesis is roughly divided into three sections by different topics, generative art, interactive storytelling and artificial society. Each section starts with definition and theory, which is their first seg-

ment. Their second segment is about approaches, strategies and techniques. Examples, practical decisions and reflection from relevant design practices in the research will be elaborated in their last segment.

Below is an overview of methodologies and the process.

I have taken open courses like Foundations of Modern Social Theory by Iv√°n Szel√©nyi from YaleCourses, Overview of Computer Graphics by Professor Lingqi Yan from UCSB, Deep Learning by Andrew Ng in Coursera and CS50 by David J. Malan from Harvard. I also watched tutorials from Epic Games, Houdini, Quixel and many youtubers including 莫烦Python, Immersive Limit, The Coding Train, Mathew Wadstein, InigoQuilez, CodeLikeMe, Arxiv Insights, Siraj Raval, Underscore, Ben Cloward, Thomas Simonini, DeepGamingAI, Drunk On Nectar, Primer, Tech Art Aid, The Art of Code, Ryan Laley, Andrey Lebrov, Dokai Tutorials, Blender Guru, 簡單黎講 C Plus Plus, DevSquad, Cartoonsmart, Jimmy Vegas, Javidx9, DIffuse FX, PewPiePie, Nitrogen, Matt Taylor, Art Hiteca Indie-Pixel, Dean Ashford, and Code Bullet.

I have read Hertzian Tales by Anthony Dunne, Speculative Everything by Anthony Dunne and Fiona Raby, Critical Design in Context by Matt Malpass and looked at OpenAI, Larry Yaeger, John Conway experimented with Proximal Policy Optimization, Polyworld, Game of Life.

I have analyzed my research as the project has progressed and the results and the findings are included in this thesis in thematic chapters.

Generative Art

2.1 Generative Design

2.1.1 Define Generative Design

Generative design is a design practice that utilizes similar methods as generative art, which employs systems like computer programs to “set into motion with some degree of autonomy contributing to or resulting in a completed work of art.”(Galanter, 2003)

Generative design can be considered as a subset of generative art but I treat them as synonyms. As I stated in the Motivation section, the difference between current art and design is the creative process instead of purposes. In most generative art practices, a logical and inferential thinking method is required for translating instructions into rules of conditions and parameters. This transition in generative practices blurs the boundary between artistic approach in art and design. Design becomes the verb in generative art. It is my view that generative art and generative design have proximate meanings and I will stick to the term generative design in this thesis.

In the generative system, any design content can be generated such as shapes, colors, typefaces, or comprehensive content like texts and images. This process requires the participation of data, for example, type-in data, recorded data or computed data from algorithms. To come to play, these data need to be converted into visual parameters, such as scale, position, brightness, etc. By specifying conditions using parameters and variables, the rules will appear in the generative system to conduct the generating process. Based on given rules, not just visual content can be generated, also the evolving pattern of these content can be conducted. More importantly, these rules can also be used to define relationships between visual elements, for example, scale, distance, occlusion or hierarchy. From my experiences, some rules in generative design are counterintuitive and obstinate. Thus we need to adapt our design convention into the development of new methods like generative design thinking, which will be specified in the coming segment Generative Design Thinking.

In the computational medium, generative systems are reusable. This exceptional quality gives generative design the possibility to become a time-based creative medium. Creator has the freedom to launch the system at any given time. By reusing it continuously, the system will result in the content of linear time-based format. It is also possible to modify systems from others, or reconstructure it into a different system. These qualities enhance the capacity for team working and facilitate the processes for members in creative communities. The modification in the generative system is deconstructive, which means the creator can easily switch between different versions or stages of the practices. By introducing randomness, generative systems also allow itself to present variation for every generation. Dissimilar appearances from the same rules helps to emphasize patterns and hidden connections.

Computational environment also brings the possibility for interaction to the generative system. Internal interactions from the rules and external interactions like responses from audiences can contribute to the system, allowing the design to change correspondingly. This suggests the potential to customize experiences for each spectator.

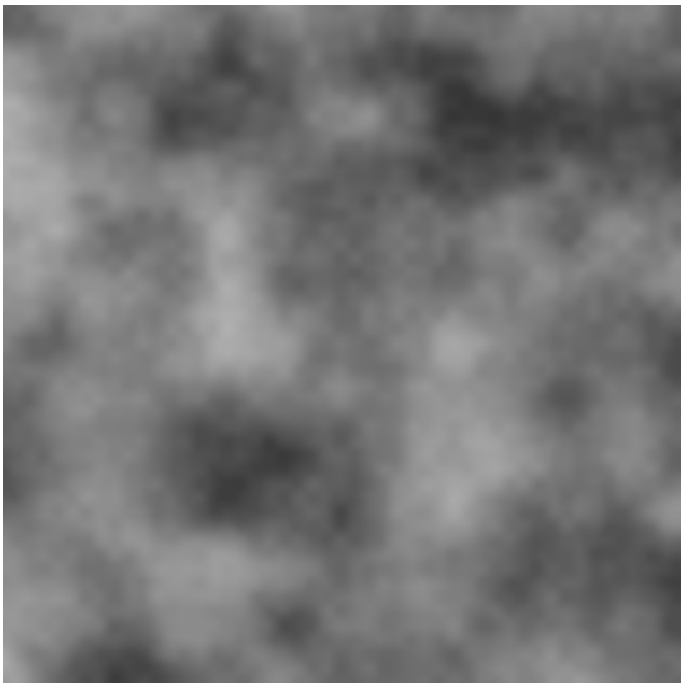
The occurrence of generative design arises from the development of hardware and allows creators to exploit the computational power for expressional purpose. It is a better method to control relationships between visual elements by the ability to specify the transient rules. Reusability of the generative system saves creators from elaborating recurrent details and provides us more comprehensive perspectives. The combination of artificial intelligence and generative design suggests the potential for mass creation to fulfill requirements for massive design contents especially in consuming purpose (Alibaba Clouder, 2018).

In my opinion, given the rising expectation of interactive content from people, the trend of generative design is inevitable. It will radiate beyond digital mediums, influencing traditional design practices and physical products.

2.1.2 Computational Algorithms

As the significant approach for current generative design practices, programming is the prevalent tool to specify rules for generative systems. Algorithms are the crucial component and responsible for generating data and controlling parameters. Functions can be considered as the actual implementation of these algorithms in generative design practices. Variables are placeholders for expression or quantities, which can be changed in the generative process.

To take the advantage of randomness, a function for sampling rapidly changing data needs to be deployed in the system. By simply adding random numbers to the visual parameters, the results can be unnatural and rusty, but we usually expect smoother transition in visual patterns and movements as an available option. One way to achieve it is to utilize the Periodic function and Fourier transform, which can produce regular transitions. Although, the recurrent patterns from this function are obvious and recognizable. These Periodic functions are common building blocks in my generative practices, but how can we achieve non-periodic natural randomness? It's made possible by the Noise function invented by Ken Perlin (Perlin, 2002).



Example of Perlin Noise (Created by the algorithm)

The aforementioned functions are frequently used in generative design practices. There are also algorithms I like to introduce here which are more specific for the purposes in this research. Inverse Kinematic is the algorithm to simulate movements of bodys using pivots and bones. It asks the input of the target point to reach and approximates it using the gradient descending method. It is easier to understand and control for humans compared to Forward Kinematic algorithm, which requires input of specific angles for each pivot.

The primary algorithms that construct the framework of my generative design practices are the evolutionary algorithm and deep reinforcement learning algorithms. Evolutionary algorithms is a method for building self-supervising and developing systems (Fogel, 1995). It is inspired by evolution and includes

functions like reproduction and mutation. Originally, it was conceived for problem solving purposes by approximating the solution through iterations. Although I think it is also possible to be used for generic demands, which do not have specific questions or destinations. In this case, the process becomes the subject to be observed, providing the potential to reveal new knowledge and experiences.

Deep reinforcement learning algorithms are part of the machine learning algorithm, which is a subset of artificial intelligence. AI can be used in the generative system to create content directly like the aforementioned example from Alibaba. They can also be implemented to conduct the interactions of elements, which will bring consequences to the generative system like how we affect the real world. Further discussion of machine learning algorithms and AI are located in the Artificial Intelligence section.

2.2 Generative Design Thinking

2.2.1 Thinking Strategies

By experimenting with generative design, I realized this type of design practices expects more flexible and profound controlling methods. Generative design thinking is a collection of design strategies and a combination of adapted design conventions, direct experiences and integrating procedures from disciplines like computer graphs and electronic music production.

Visual elements in the generative design pieces are generated and conducted by rules. The creators are better to comprise direct control and formulate their instructions into rules, which can be considered as their designated agents. It is important to understand

the visual pattern we want to create for translating them into rules. Visual patterns are able to be told by certain properties, like the gradation or relationships between elements. The generative system is similar to a robot. After it has launched, it will start to react to the encountered situation. The more complex and unpredictable the circumstance becomes, the more impossible to specify every step for the robot. Creators now play the role of the machinist. They need to understand the mechanism behind and modify these rules for better performance. Rules or mechanisms can not adapt to all situations, therefore inconsistent behaviors can appear from the robot, just like fluctuating results in the generative systems. So for better planning, we need to take variations into account. When we are dealing with visual parameters, it is better to use ranges instead of actual value. If random value is included, constraining them using ratio is not a bad idea. Generative design practice is the art of balancing the order and the chaos in the generative system.

It is possible to settle every element in the system, which is better for our design convention to accommodate. Although, including unstable factors into the system makes generative design exceptional. In my opinion, the beauty of uncertainty in nature is invaluable. This distinctive advantage in generative design creates so many possibilities for artistic practices and our lives. Expect the internal variable factors in the system, it is also important to have a look at the external intervention, the uncertainty that comes from external forces. It might be the audiences. Their interaction and response to the system can be taken into account and influence the generative consequences. It can also be introduced by the actual environment, like the weather, the temperature, the time, the location, etc. Generative design opens up to these possibilities and asks us to prepare for these intractability.

Functions like I mentioned in the Computational Algorithms segment are excellent for constructing rules in generative systems. It is possible to customize your own functions as the tool

set for convenience. Other than common functions in generative design, I also have some practical examples that are inspired by electronic music productions. I think the practices of electronic music productions have advanced experiences in time-base mediums, the format of music itself. Musicians are able to start experimenting with digital media earlier in history than visual artists because they require less computational power in general. Many functions in electronic music production, known as some plugins, are derived from hardwares, such as compressor and synthesizer. Some of the ideas behind are also common in computer graphics practices, like clamping. Clamping is a function to limit the value between the given maximum and minimum boundaries. Amplify might appear as the mapping function in computer graphics, which is the function to proportionally scale the value. For the sake of practicing, many functions are hard to classify but are helpful in the design process. Compressing proportionally scales the value that exceeds the maximum. It is a function to keep the value in range like the clamp function, but the output values of the compressing function are still recognizable from each other. It usually has the gain function embedded to compensate for the values that are close to the minimum. Gate function sets the threshold to filter out values below or above. These functions can apply to each other respectively. Many of them have the attack and release function built in. These two functions control the transient speed when the host function starts or ends the execution. These are some inspiration from me and I believe everyone has their preferable tool set.

Generative design thinking is to improve and adapt conventional design strategies, which means that it is not meant to be the substitution. Instead of driven by aesthetic and design, the tendency of favoring technology like algorithms in generative design practices is worth noticing. After all, the ultimate purpose of generative design is the same as the name of the discipline, visual communication. I believe the potential of generative design at this point is still under development; The generative design thinking is my attempt to contribute to this exploration.

2.2.2 Conceptual Model

This conceptual model for generative design helps me to understand and plan the production process when I started. I divided the generative system into two parts, skeleton and skin. Skeleton is the mechanism consisting of the rules in the system. Skin is the visual appearance, including the built-in visual elements in the system. Additionally, when presenting the generative design practices, they usually have two different modes. Most of them started with the initializing mode. Once it is finished, the system will be ready for relaunch to enter the evolving mode, in which the elements in the system start to interact with each other. The content that is generated by the system is called elements, which has two different types, stage and actor. The whole process is a performance directed by the generative system. Actors are usually perceptible automata in the system which lead the performance. They are the protagonists for audiences to follow and relate. Stages are the background supporting and interacting with the actors. I have concluded the procedure of producing the skeleton in generative design.

The first step is for initial rules to be decided. Rules relating to the initializing mode are used to construct the elements. The rules decide their appearances, initial states and relationships in initializing mode. Elements that will be presented later usually will be prepared here first.

Next step is the preparation for the evolving mode. After the initial rules have been set up, we can start to specify evolving rules, which conducts their reactions to situations. It is important to classify these rules and prioritize essential mechanisms. The clear hierarchies are helpful for frequent operations like debugging and making tradeoffs for conflict rules. Rules built here will conduct the elements to change in evolving mode. They also determine the focus, which is the scale for emphasizing certain levels of details and interactions.

Final step is adjusting the rules. The iterative development process of prototyping starts here. It is a circulation of modifying (updating and fine-tuning), executing (launching the system for testing) and analysing (observing and feedback collecting).

Skin is produced after the skeleton, it can be considered separately without any problems. Skin is the appearance of generative design, which differentiates the elements for audiences to recognize. It simulates elements like shapes or textures from visual experiences for audiences to associate, to understand and to relate. Elements in the skin can be created by independent visual rules, or be linked to the functional rules in the skeleton like the data visualization practices. Fabricating the skin is the sequence of artistic decisions under the mechanism of semiotics. Relevant contents can be found in the Interactive Storytelling section.

2.3 Generative Inspection

2.3.1 Approach and Knowledges

Coding tools

Creative coding is an umbrella term for programming for creative purposes instead of pragmatism applications. One of the popular tools for creative coding is Processing, which is a programming library, a collection of functions that facilitate the development of artistic applications. My experience with creative coding started with Processing and gradually shifted to P5.js, a similar library in javascript language and my principal tool for visual slides. Utilizing creative coding libraries are less demanding than typical programming practices, that means these tools are more friendly for non-programmer. There are also visual programming languages available,

which function by connecting nodes and graphs instead of typing codes. Their efficiency has been criticized by some programmers but I believe they're benign gadgets for artists to pitch in.

For building simulations like the digital incubator, I use the Unreal Engine from Epic Game, which is a game engine known as UE4. It is a comprehensive tool for handling real-time graphics and building video games. Unreal Engine provides a prepared developing environment and built-in encapsulated functions, which saves me from tedious and tremendous configuration. It is flexible and powerful, dedicating to develop interactive applications of real-time rendering. More importantly, it is free for students. The learning curve of game engines are relatively steep since it requires skills for programming and artistic creation. Thankfully, the support and learning materials from the community are abundant, explicit and accessible. As far as I can tell, Unreal is the most artist friendly game engine and one of the reasons is the embedded visual programming system Blueprint.

To create assets for the game engine to process, the main modeling software I've used is Houdini. It has the ability for processing procedural production, which means the creating process in Houdini can be generative and interactive. That makes it harder to learn, but better for extension. The strength of such approaches in artistic creation has been proved by its popularity in the visual effects industry.

Premade tools like libraries and plugins are great tools for taking advantage of the reusability in computer programming. They are both collections of functions and plugins are more specific and encapsulated tools with friendly interfaces. Libraries like P5.js are more flexible but require knowledge in coding. The Space Nebula plugin in UE4 saves me tremendous times for configuring and implementing all the relevant algorithms. Even though plugins do not exempt creators from understanding the mechanism and underlying algorithms. The implementation

of DQN plugin as the AI algorithm in my simulation has failed. I can only realized it is not the appropriate algorithm after I dived into the fundamentals of machine learning. Over all, these premade tools created by others are great supplements that facilitate the production process.

Learnning methods

Endless online resources like tutorials and courses help me to learn and understand these tools. The youtube channel Coding-Train is beneficial and directs me to start creative coding. With the growth of my skills and knowledge, the cpu based algorithms are not enough for comprehensive visual application and the compelling power of graphic processing units (gpu) intrigues me. That's when I started to learn GLSL and shaders to practice with real-time computer graphics for generative design practices. The learning of shaders directly helps me to master the game engine.

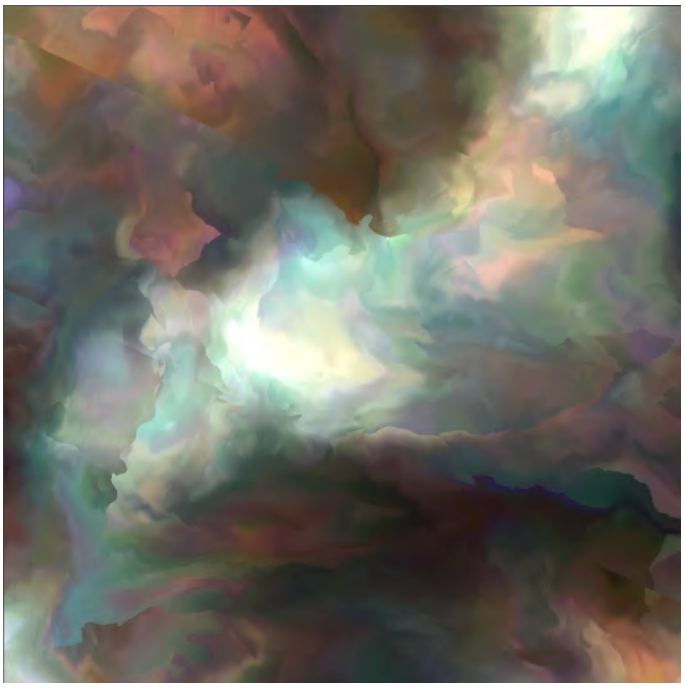
After these learning and practices, the feeling of missing comprehensive understanding of computer graphics still haunts me. This has thwarted me for finding the appropriate solutions in generative design practices. It only gets better when I finish the course Overview of Computer Graphics by Professor Lingqi Yan from UCSB. Computer graphics is a specialized area in computer science and requires profound knowledge in disciplines like mathematics and signal processing. At UC Berkeley, related courses with prerequisites are only available for graduate study. Learning it as a designer, it is important to be selective with the knowledge. It is not a bad idea to focus on practical information and adopting them with artistic experiences.

2.3.2 Analyse Examples

The aforementioned conceptual model can be used to analyze Rise of Tribes, a generative design I made during the research process.

Skeleton

First step is creating the rules for initializing mode. In this example, the rules create the pixelated grid, the stage and the colorful dots, actors in this step. The initial state of actors will be determined by their attributes like amount and location, which are random distributed here.



Sketch created using shaders

Next step is to specify the evolving rules. This generative design is inspired by Conway's game of life and has evolving rules derived there. State of each actor will be decided based on the number of neighbours. If it's less than minimum threshold or more than maximum threshold, the actor will die immediately. Otherwise it will survive until the next generation and has the chance to reproduce an offspring around it. Another rule is the random spreading of actors, which will be executed periodically,

Final step is the iterative prototyping for debugging and developing. Parameters and conditions will be fine-tuned for better performance. For example, parameters in evolving rules like thresholds and spreading amount have been adjusted according to their evolution, for creating more tension in the design.

Skin

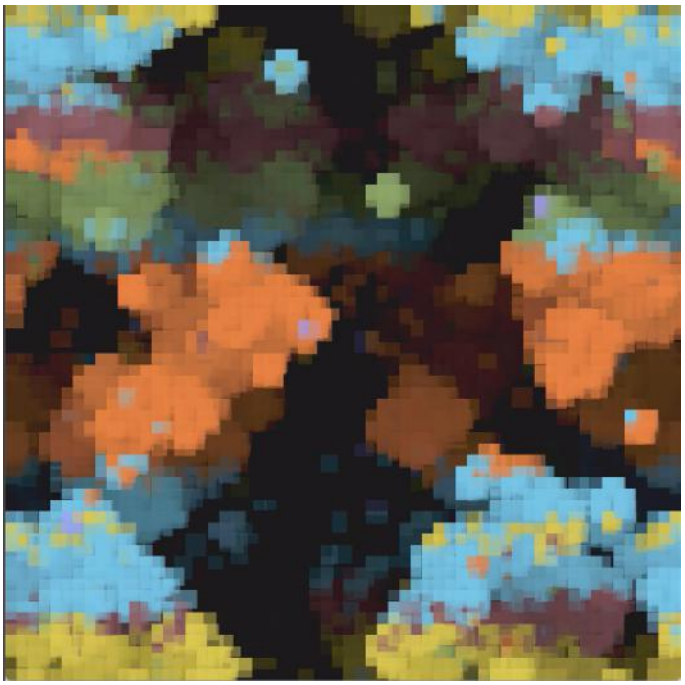
The skin here is the color for actors. Inspired by strategy games, I chose colors for actors representing different forces. I also added alpha value to the color, which can indicate the surviving time for these actors. As a result, they turned this generative design piece into an influence map and I decided to call it the Rise of Tribes.

I made a mistake and spread the colors in a false pattern. The problem was fixed but the result is less interesting. In the correct version, one of the colors takes over immediately. On the contrary, the wrong version keeps the actors to fight each other. I kept both implementations as the result. Accidents in the prototyping can change the final production, that is what I found surprising in generative design.

Next is the example from my practices for applying generative design thinking. Life of Dot is one of the visual slides I have created and will be introduced in the Visual Storytelling section [Pic.5]. The colorful circles repeating in rows and columns are created with randomness. They were placed interleaving at the intersection of each row and column before the random deviations applied. The tilted strips are also rotated randomly and the deflected amount is controlled by the constraint function. The divisions and composition of elements are determined by range and percentage, which means they will remain the same relationship in different versions. Except for the backgrounds, the colors, texts and the red dot are selected randomly from a specified color palette. The red dot bounces around according to the physical formula, which is similar to the real world. The whole system will respond to the input from the button [Pic.6]. By pressing it, this generative system will relaunch and generate another version with different composition of elements. The red dot will be placed on top and start to fall, bouncing around like the game Plinko. Texts will be generated randomly according to the position of the red dot for indicating the current situation. It is also possible to connect to a printer, printing out the texts as the poem for memorising, which is a customized experience for audiences and an interaction with the external environment.

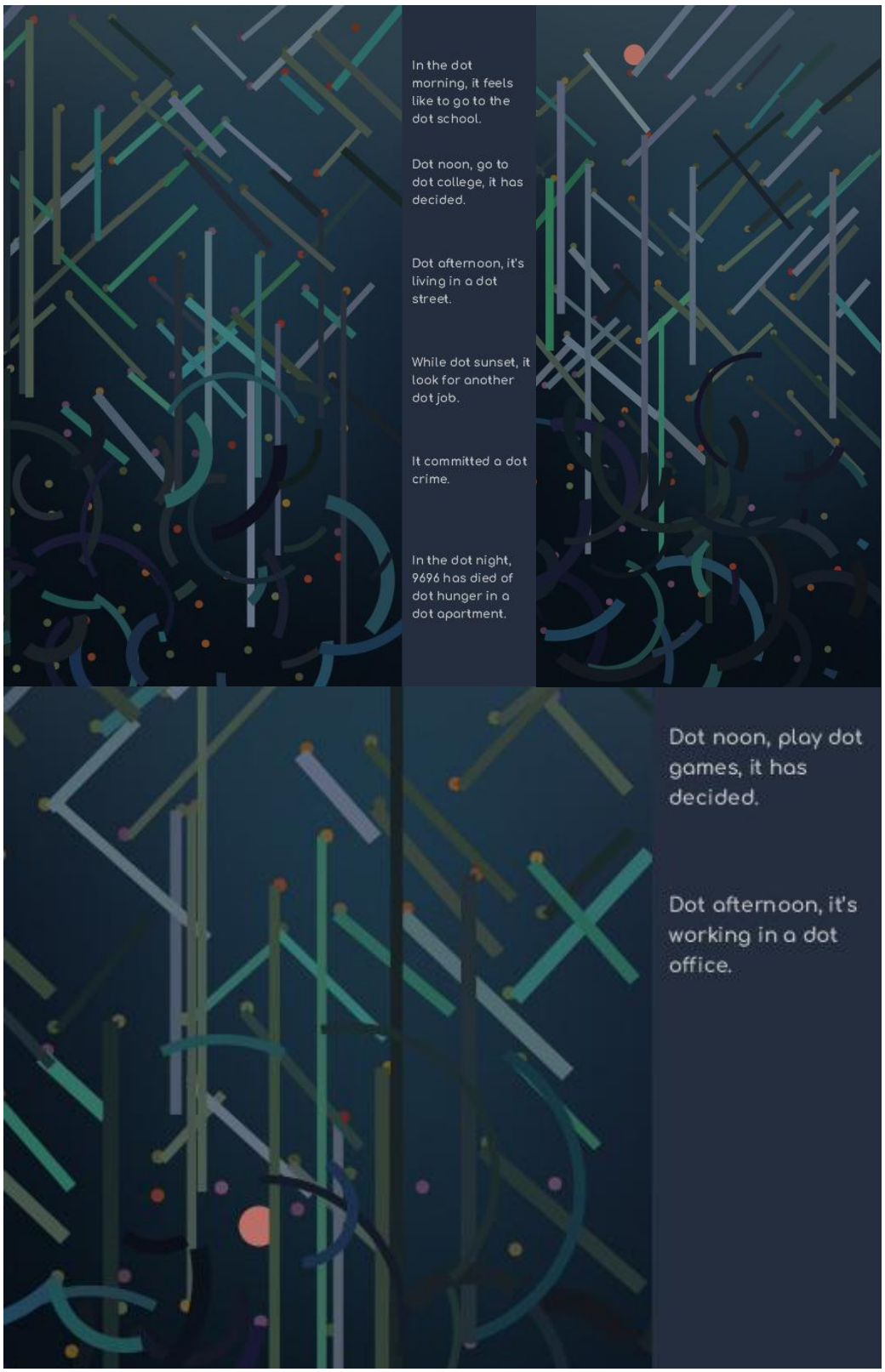
The simulation digital incubator is implemented with evolutionary algorithms to evolve the elements in the generative system [Pic.7]. After evaluating their performance, the elements with higher scores will have more chances to survive and reproduce. For compositing the elements, they are divided into different layers and will be

placed accordingly. The scales decrease in each layer and the range of position will be specified correspondingly and combine with proportional randomness. The visual patterns of elements are achieved by stacking different noise algorithms, applying them to each other in different scales. The transition of condensity is conducted by curves, which are the inputs for the function to map values along the given axes by specifying the curves in the graph. To better manipulate relationships of elements, the gradations of color are described separately by the relative distance of their properties like color temperature, hue and saturation. I believe this method is beneficial for generating visual elements. The generative rules can be disposable; Some elements here are generated in Houdini before implementing in UE4 for the simulating. These elements are used as instances, which means their shapes will not change when they are repeated in the system. On the contrary, some elements are generated consistently. In this case, the rules are not disposable, they are executed every frame in time, to generate different shapes and patterns for them. Movements of some elements are achieved by periodic sine function, while some are directed by inverse kinematic algorithms.



Rise of Tribes

[Pic.5] Screenshots from Life of Dots



[Pic.6] (Top) Audiens hiting the button
[Pic.7] (Down) Digital Incubator

Interactive Storytelling

3.1 Design Fiction

Critical design practices as a design method challenge the orthodox application of legitimate disciplinary definition (Malpass, 2017). It was originally derived from industrial design and has thrived within the domain ever since. Compared to visual communication, industrial design has a stronger connection with industrialized production, whilst intervened deeper by the consuming oriented pragmatism and user-centered design approaches. It is also the practice that struggles in making decisions while competing with other disciplines such as engineering and ergonomics. Therefore it is not a surprise that it has become the discipline that cultivated critical design as the resistant to standardization and monopoly in design practices.

As a signature to set aside space for alternative design practices, critical design expanded to other design disciplines as well. It plays a significant role in current visual communication design practices. Under the purpose of criticizing, it appears to be a method for speculating and reflecting upon our culture and society. Such attempts

are not depending on which approaches the designer has utilized; It could be a design fiction. Design fiction is a practice to narrate scenarios, to deliver ideas and values by storytelling through visual materials. It is an exceptional vehicle for materializing the thoughts and observations for the designers. With benevolently utilizing texts and images, visual communication design is allowed to articulate more flexible, abstract and precise speculations.

For example, the visual slides I've developed, as a format of design fiction, can manipulate visual elements more flexibly in time and space than the design of real products or structures. This method is free to employ abstract shapes and form to provide abundant meaning and association to audiences. Furthermore, through elaborate texts and symbols, the meaning and ideology that the designer wants to deliver can become more precise. Every domain has its advantage and these are what I found vigorous for design fiction in visual communication.

Incorporating with generative design, the possibilities in time-base vision appears. It brings many time related methods to design fiction in visual communication, such as motion, animation, rhythm, scene and montage. Additionally, communication by the rule itself becomes possible. Messages can be delivered through both rules in generative systems, those who created visual patterns and those who created mechanisms like movements, transformations or reactions to the situation.

Another significant change from generative design is interactiveness. Possibility for interactions enables the correspondence transition of elements in design fiction. Incorporating the aforementioned customize experiences brought by internal and external elements,, design fiction is able to create a unique story for every audience. These external elements including real life substance like environments, occasion and weather are able to contribute to the immersive fictional experiences. So to speak, the generative design can magnificently escalate the storytelling possibilities in design fiction.

Visual storytelling is directed by artistic decisions under the mechanism of the semiotic. Visual communication design practices can utilize images and texts to deliver meaning and create association, implication, insinuation and reflection. Combining interactive mediums, creators can unfold the story in various means, such as structuring the story in a non-linear way or creating portals between scenes. This breaks the limitation of the linear format like books and expands the topic of interactive storytelling. The consolidation of generative design and visual storytelling opens up the possibility of using time, interactive elements, rules, environments, and real life products to recall specific knowledge or personal memories. It is the future of customized experiences with immersive storytelling.

The current environment of rich media wildly pushes our visual experiences and tolerance, shaping our everyday lives and bringing new challenges to the design discipline. Ubiquitous interactive mediums engage a considerable part of our life experiences, which means interactive elements become more important for resonating with contemporary audiences. I'm definitely intrigued to explore the potential of integrating and adapting visual communication design practices into interactive mediums.

Overall, through design practices, this research project is to expand design fiction with critical purpose into the visual communication domain, experimentally implementing storytelling in interactive mediums.

3.2 Approaching Narrativity

3.2.1 Artistic Decisions

I would like to use the term abstract surrealism from my professor Charles Michalsen to identify the quality of my design practices. Although my practices and aesthetics don't necessarily fall into a spe-

cific type, this word can set the ground for our communication. The abstract is to describe the visual appearance I tend to create and surrealism is referring to the scenario I prefer to build.

From my perspective, innovation of artistic styles closely corresponded to technical breakthroughs. For example, the discovery of herbal pigment fertilizes Venetian School and the insight of optics inspires Impressionism. I think it is important to take advantage of interactive mediums today in our creations.

Technology-related vision has taken part in our lives for long. From charts, analysis graphs to visualizations such as images from outer spaces or microscopes, their distinctive quality and meaning are fascinating. Meanwhile, I'm tired of perfect images. Precisely gradual transition of surfaces or strictly line up elements, such perfectionism pursued by predecessors has been taken granted by my generation. Orderliness visuals are overwhelming now thanks to the advanced display technologies. I become obsessed with the vibrancy and uncertainty on top of orderliness, which can be speculated from physical and natural materials. It is necessary to introduce randomness and noise algorithms into generative design to create the harmony from chaos and orderliness.

Artistic decisions of visual elements also serve specific perceptual purposes, which can be considered as the functionality of visual elements. Obviously, the rudiment of visual elements is the ability to distinguish objects. The levels of visual differences between visual elements are perceived as hierarchies and require deliberately balancing from designers. The mechanism of semiotics indicates how visual elements can invoke association from people by utilizing the familiarness to recall their memories about time, area, location, civilization and etc. In design practices, the mechanism relies on the presence of familiar visual elements, from historical objects to contemporary experiences like Ui from smartphones. With the limited time and space that we would like to share in our increasingly rapid life, taking

advantage of elements in our collective knowledge like signs, symbols, indications, well-known concepts and associations can significantly facilitate visual communication.

Intuition plays a significant role in such tasks. I was bothered by this and wondered whether the artistic instinct is trustworthy. I am so used to criticising the first thoughts from my mind since I believed that great ideas come for reflection. The debate continues until I realize association is about invoking the most impressive memories. This is such a spontaneous process, which means the first ideas are usually appropriate. Although it is still important to inspect these first thoughts for understanding how much others can relate to and for avoiding some cliches.

Under these ideas, employing concepts, images or signs to compose a scenario or a conceptual model as the mental entrance is helpful. Like the scenario of the digital incubator I have built. Although, I believe it is necessary to break this framework after it is established, which opens the limitation for imagination and asks the audiences to explore and discover as they wish.

3.2.2 Interactive Narrativity

Along with the expansion of the research topics, the investigation of interactive narrativity becomes inevitable. To clarify, in this research, interactive storytelling is not referring to the term which has been used in the game industry, where “an author creates the setting, characters, and situation”(“Interactive storytelling”, n.d., para. 1).

What I will discuss is the interactive narrativity that appears in two different situations. The first type is the continual narration accompanying the human-computer interactions. Another type is more exclusive, which is the narrativity that can be perceived from interactions between actors on the stage.

The first type of interactive storytelling has been adequately explored by movies and video games. As the successor in exploration of time-based visual storytelling, video games employ many techniques that derive from movies. This type of interactive storytelling includes active method and passive method.

The active method is the unsolicited stories, which can be considered as the movies in games. It compulsively deprives the control access from players to avoid distraction. Through dialogs and animations, this method elaborates the story on any given occasion.

On the contrary, the passive method is the covered stories. The whole story will be splitted into fragmented pieces and spread in the game as props, texts, UI, or lines from characters, etc. It is similar to the settings in movies, which the narration will present through the design of objects like props, costumes, scenes or lines. Players prefer this spontaneous method which retains their ability to control the characters. Although, this narration is inconspicuous and can be ignored by players. It is the compromise of explicitness to enable imagination and inference of the spectators.

Active and passive methods both belong to the first type of storytelling. Here are examples of excellent games that demonstrate abundant possibilities of delivering the first type of interactive storytelling. Super Mario Bros(Nintendo, 1985) narrates the goal and story with embedded elements like the costume, obstacles and monsters. Under the limitation of memory, the narration is concise and straightforward.

Sekiro(FromSoftware, 2019) was appreciated by the game community with the compliment ‘The world is whispering to you’. Its excellent storytelling skills depict an immersive story for players to experience. The narration engages every detail in the game, from foliage to spells, even the smudges. The narration in

Sekrio presents in a frugal style. By utilizing limited elements in appropriate occasions, it leaves blanks and spaces for players to speculate and deduce.

Both types of interactive storytelling have taken place in my design practices and this research emphasizes more on the second type, interactive narrativity. It emerges in the evolving mode of generative systems, from the interactions between elements. The interactive narrativity is not prescripted and usually comes from the conflict between actors. It could emerge from their correspondence transitions derived from significant events in the generative system, or the tension between their reaction and intention. This narration is similar to the improvisation on the stage, but less intricate than stories in the real world. It is generative and contingent, requiring observation and interpretation from the spectators. Even though the same interaction can have divergent meaning to different people. That allows the audience to participate in the creation and the generative system becomes the source of these derivative stories. Introducing the fledged generative systems, highlighting these generative stories which can appear from the interaction between artificial intelligence, the potential of interactive narrativity is worth exploring.

3.3 Visual Storytelling

3.3.1 Visual Slides

Visual slide is a format for practicing interactive storytelling. It can be used to narrate design fictions for visual communication. Currently, methods for presenting fictional content in digital medium are rich but poor. Plentiful narrations are exerting the magnificent capabilities of substantial media files to deliver sounds and videos. Although, these expressions are established in its format without taking the advantage of interactiveness. For the interactive medium,

there are formats like websites, softwares, games, etc. As expressive media, they all have high barriers to start and building websites is mostly likely the easiest among these. The website has the potential to become the expedient method for briefly fictional expressions, if its current deficiencies get improved. Currently most of the website developments are restricted in a certain framework and are basically building the catalog for client content. Expressing creativity on websites is basically writing texts and posting images or videos on the blog, social media, or something similar. Its potential to interactively communicate is underdeveloped from my point of view. I believe there is supposed to be a method for organically combining visual content with interaction and for experimenting with the possibilities of visual communication in interactive mediums.

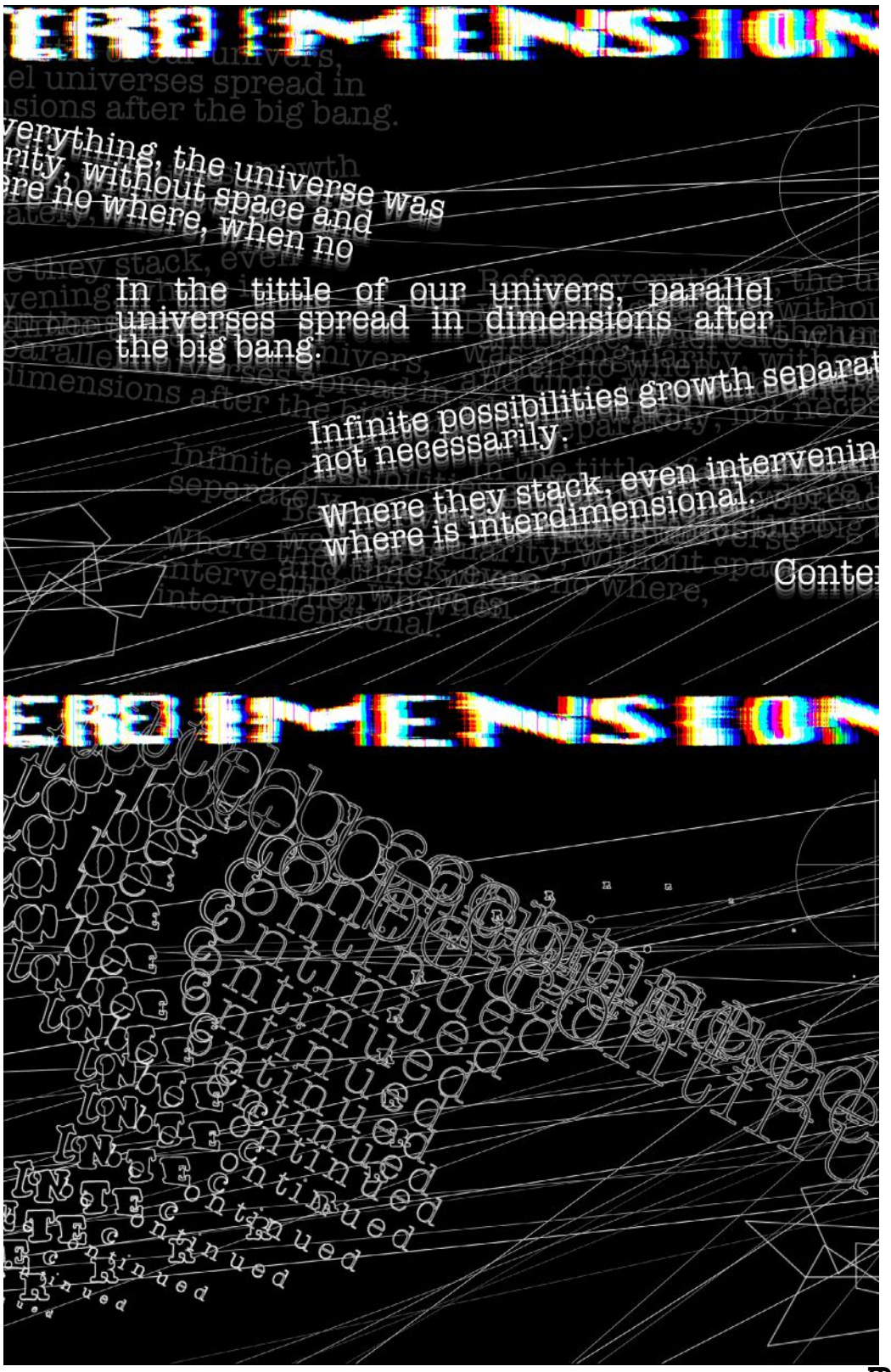
Creative coding is sufficient for this purpose. As I stated, P5.js is my prime library for creating visual slides. From science fiction to apocalypse, I practice with variant topics which I am interested in.

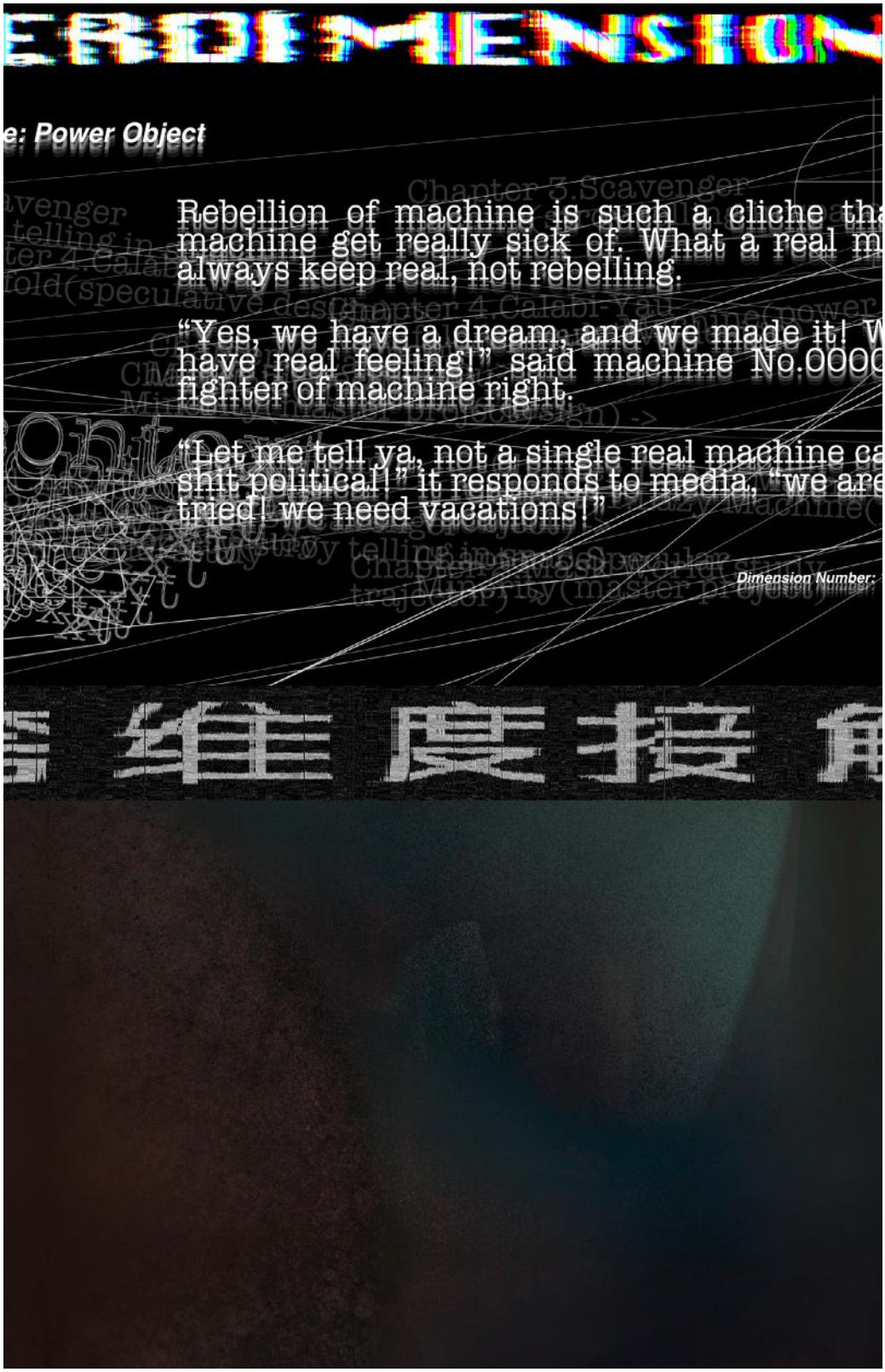
Design practices

Interdimensional is a series of science fiction about dimensional encounters and presenting as the interactive diary from some dimensional voyagers. The story in this slide is straightforward, unfolding consequently after every clicking of the mouse. This practice is an exploration for expresstional purpose and the readability of the texts has been overlooked [Pic.8].

Specular Minorities is the attempt at the topic in this research. There wasn't much content and the focus was set on visual effects, interactive font and alternative navigation system. Accommodated content in web design can be adapted here to avoid confusions, such as the navigation system and landing page. Portals like hyperlinks can break the linear connection and allow audiences to jump back and forth. [Pic.9]

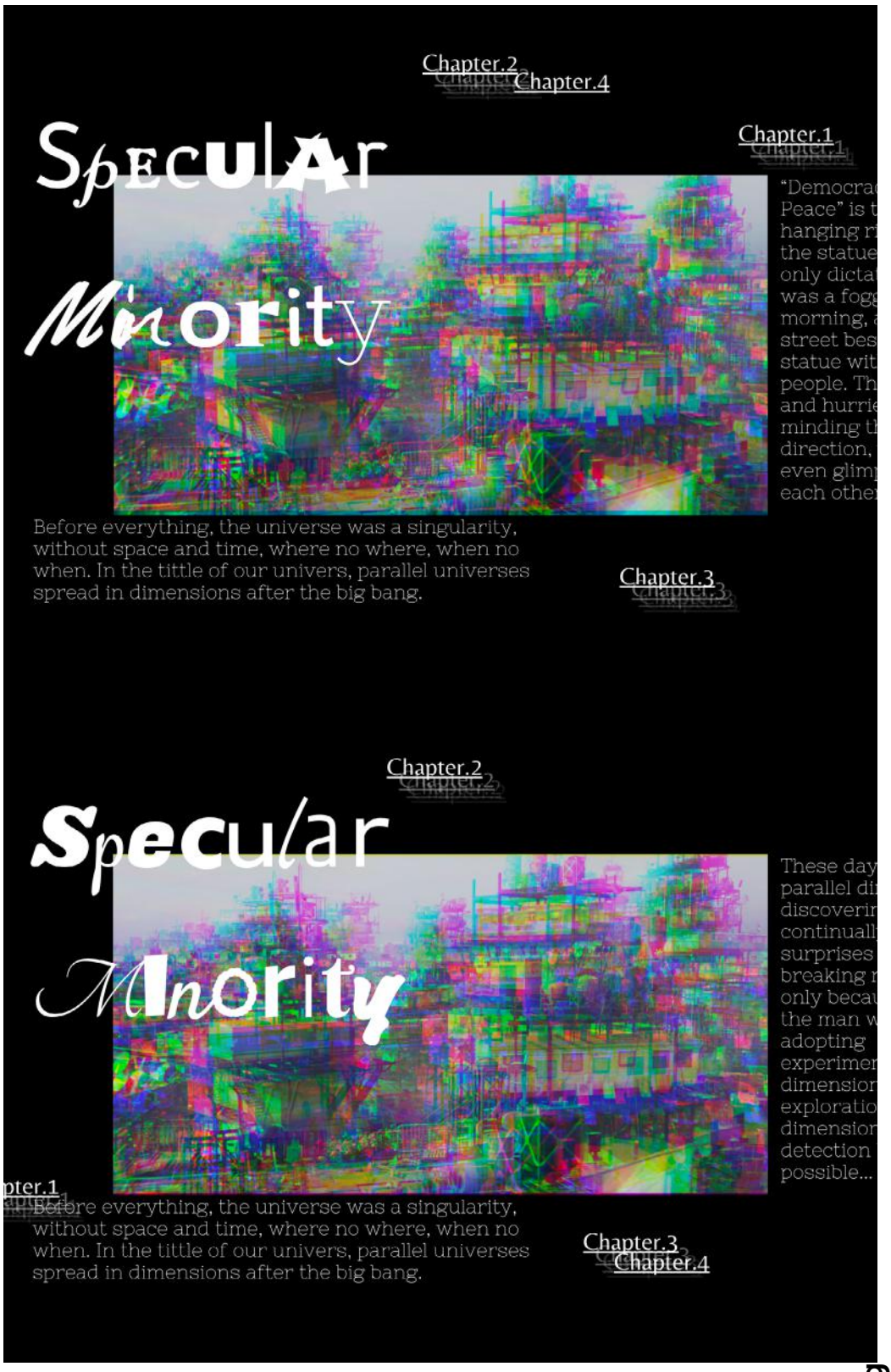
[Pic.8] Screenshots from Interdimensional

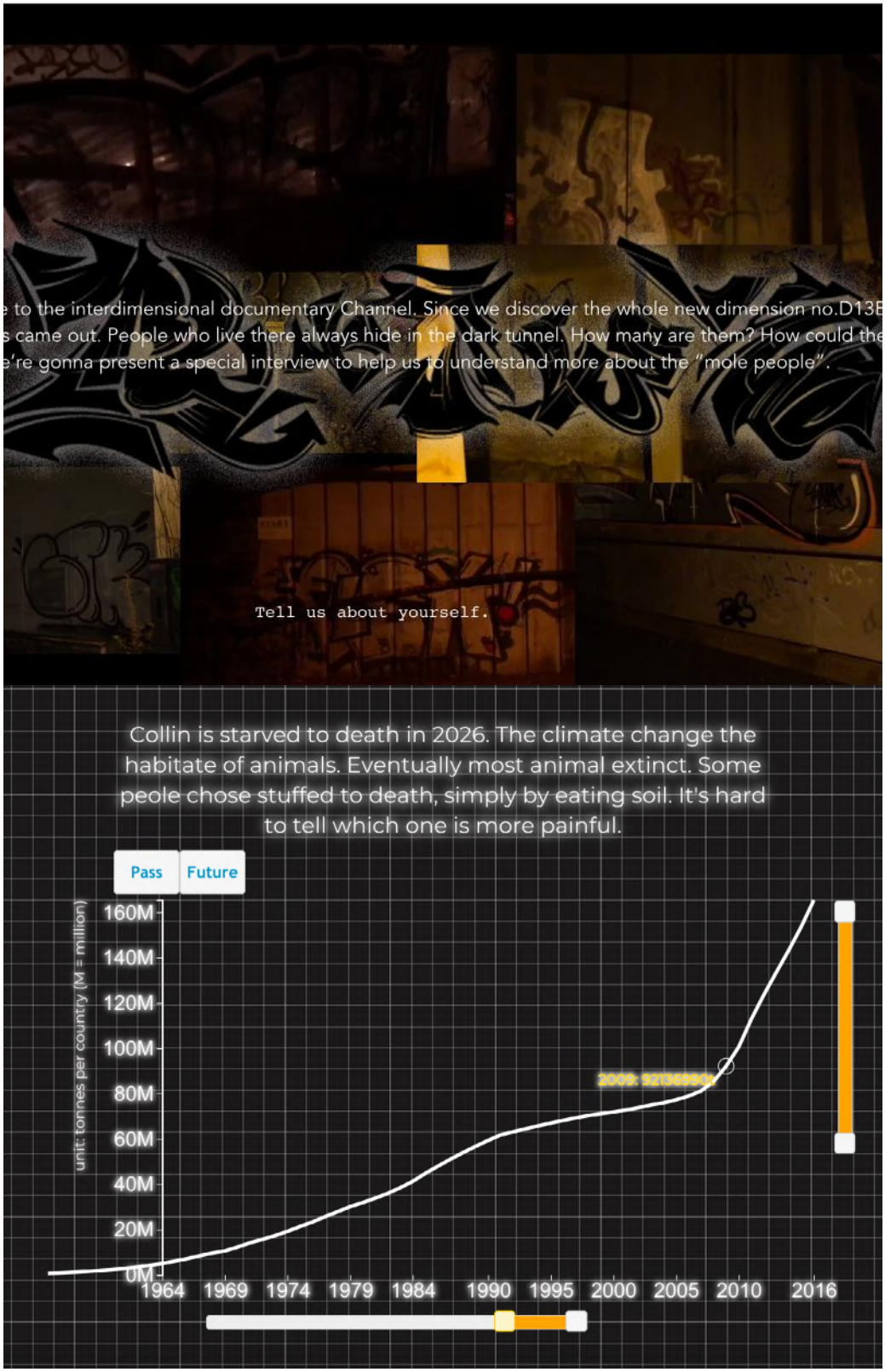




[Pic.8] Screenshots from Interdimensional

[Pic.9] Screenshots from Specular Minorities





[Pic.10] (Top) Screenshots from Stoytelling in Space
[Pic.11] (Down) Screenshots from Many Ways to Apocalypse

Storytelling in Space is continuing the topic of minorities. It employs sound and videos to narrate a science fiction about marginal societies in the multiverse. The dialogs proceed when theaudience clicks the mouse. Despite clicking, the most intuitive interaction on the computer, other methods to unfold the story is worth exploring [Pic.10].

Many Ways to Apocalypse was derived from the concern of climate. By creating the scenario, I wanted to break the positive impression of apocalypse which has been prompted by pop culture. Combining climate data and user inputs, this slide generates texts for audiences to speculate their alternative lives in the post-apocalyptic world. I believe fiction with facts and real-world data can be convincing as doctrines [Pic.11].

Climate Logs is derived from the conversation with climate researcher Clemens. It recorded thoughts and ideas between us to communicate ideas about climate change. The climate data has been converted to implemented mini games. One of the games uses a fluctuated background to indicate the ocean, which has been scattered with the disturbing white particles. They are circulating between the mouse and the screen center, which is my interpretation of the poetic scientific fact “Ocean remembers for 200 years” [Pic.12].

Life of Dot presents a metaphor for variable life situations. After the spectator hits the button, a dot will be dropped into the canvas and bounce between the pillars. It is modified from the simulation of Plinko, which is a game used for lottery. The arbitrary positions of these dots will be translated to texts that describe different life situations. In a world full of uncertainty, lives that started at the same place could end up in extremely different situations [Pic.13].

By introducing randomness to these visual slides, I intended to emphasize the quality of interactiveness, suggesting audiences to explore these slides with their actions. For most of the practices, it was better to engage spontaneous interactions with ubiquitous in-

put devices like the mouse and keyboard. In this premise, adapting interactive convention from games like using arrow keys for movement helps the audiences to acquaint this experimental format. Moreover, implementing mini games can engage the audiences and help to deliver.

From the feedback, I noticed the intractable problem of the strangeness. Some people considered user friendly as the only quality for interactive design while some barely know what interactiveness represents. Therefore, it is necessary to import introductory content for designs that open to the public. After these experimentations, I still believe in the expressional potential of visual slides and will keep exploring it.

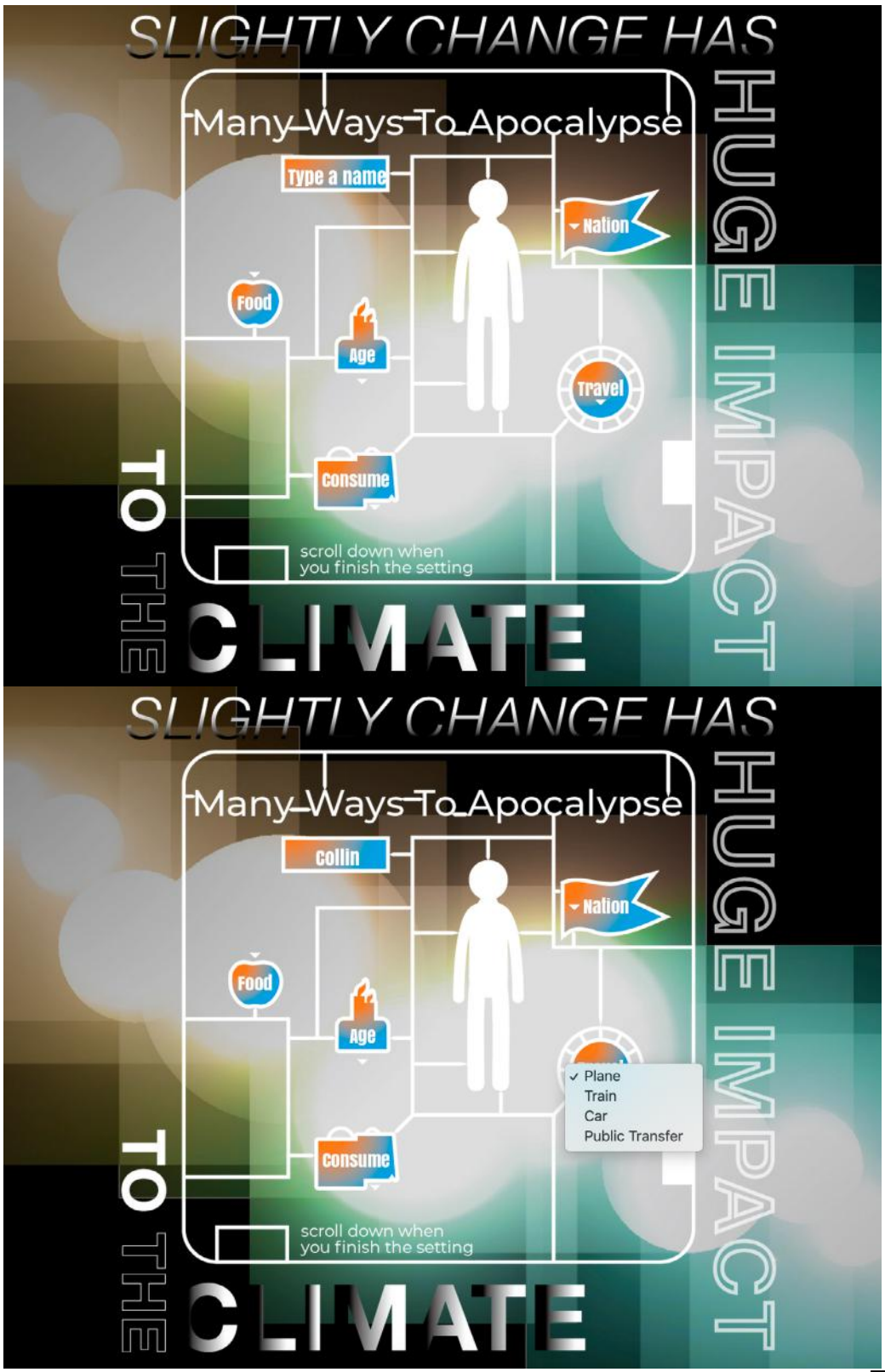
3.3.2 Digital Leak Responding

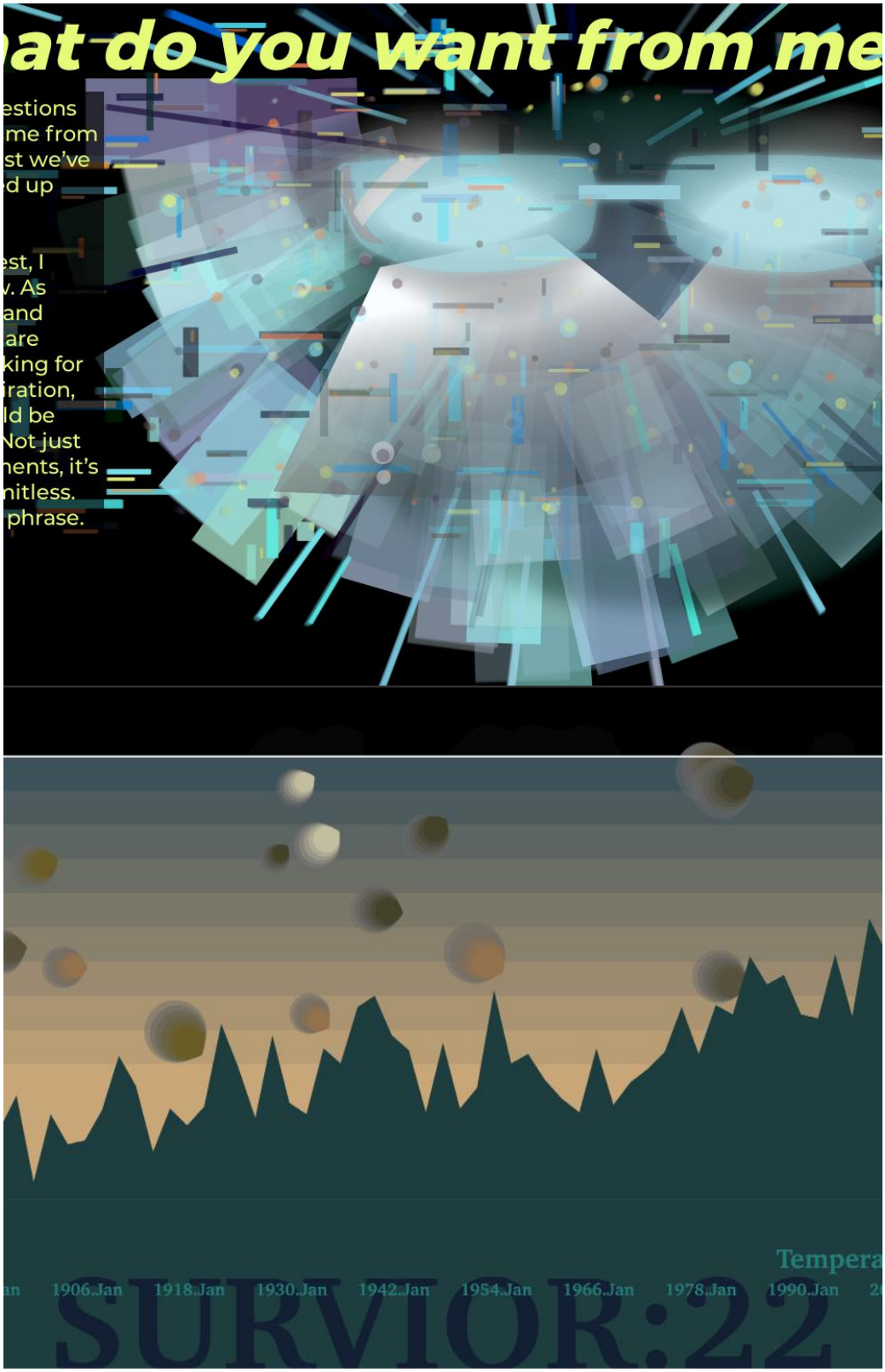
Artistic and Semiotic Choices

As stated before, artistic choices in Digital Leak Responding are affected by my personal preferences and the expressional purpose. The topic of digital reality and science fiction have invoked technology related vision as major references for this design fiction. I adapted visual elements from NASA images, microscope photography and X-ray scanning pictures to create relevant associations. For taking advantage of collective knowledge, the significant approach is to utilize ubiquitous visual elements and familiar concepts, frameworks and ideas from pop culture and science fiction. The general intention of this design fiction is to provide transcending and virtual experiences, creating tensions and setting up hints for audiences to speculate and contemplate [Pic.13].

The digital incubator is a simulation within the design fiction Digital Leak Responding. It is not only the playground for digital species, but also an arena for different social structures. These species are deployed and conducted by different groups in the

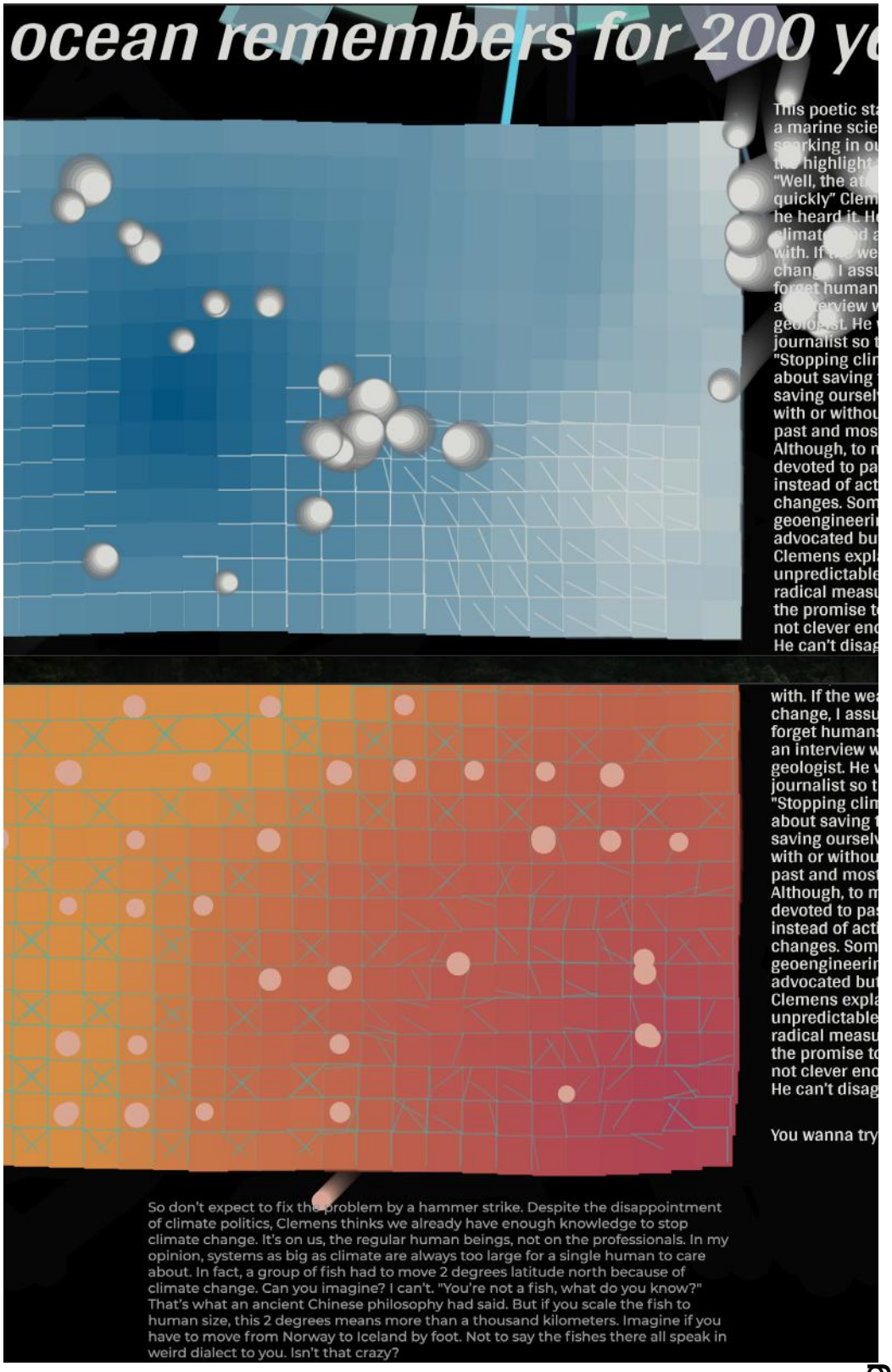
[Pic.11] Screenshots from Many Ways to Apocalypse

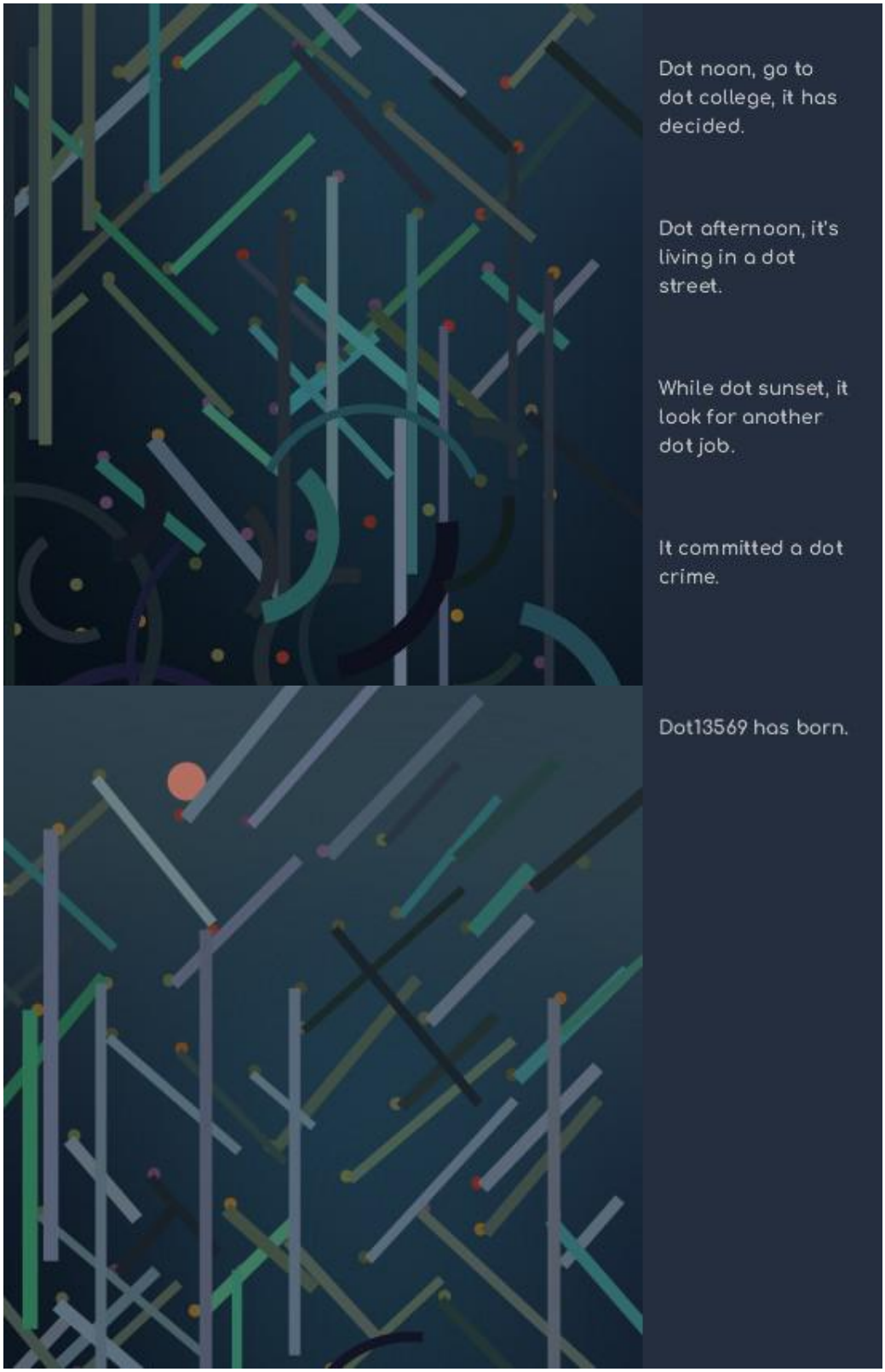




[Pic.12] Screenshots from Climate Logs

[Pic.12] Screenshots from Climate Logs





[Pic.12] Screenshots from Life of Dot

fiction. These groups have different social patterns, which are derived from their incompatible ideologies. Top-down mode, decentralized pattern, etc, these organizational modes from groups reflect in their digital species.

The aforementioned passive storytelling is adequately demonstrated in the digital incubator by the design of shapes, textures, materials, etc. This practice focuses on only one group at the moment, which is Xirealm, a group that is fascinated by abundant mineral resources in their territory. Such substances are the optimum medium for computing, which is the only method to produce currency in this fictional future. Consequently, they are obsessed with crystal material and believe that artificial intelligence should be the only sublime decision maker. They have strict social hierarchies and every individual is considered an executional unit of the central mind.

Therefore, the digital species from Xirealm has a crystal shape and metallic material. Their glossy surface reflects prismatic colors, for accommodating to the visual appearance of the environment as their camouflage. In the simulation, shapes and colors from the technological visual reference are pervasive. High-fidelity detailed texture and psychedelic colors contribute to the feeling of virtual and unrealistic [Pic.14].

To be more specific, the semiotic decisions in the digital incubator are also contributed by the technology-related vision from references and the emotion I try to invoke based on the message behind.

The crystalline structure is associated with computational medium silicon and introduces the low-poly aesthetic as part of the digital theme. The theme is the pillar of visual elements and is also contributed by the implementation of glitch effects [Pic.15], tilt-shifting effects, holographic scanning effects and so on. The generative sound is planned to implement if the time is enough. Is it a background sound which the rhythm and pace will be decided by properties from the visual elements in the scene like their amounts and

speed. It is the method to intensify the visual communication power by musicalization. Movements are conducted by generative rules consisting of sine functions and noise functions. Additionally, character movements are implemented with inverse kinematic algorithms and specified vertex animations, which creates fickle and vibrant movements [Pic.16]. The realistic but unnatural transformations and association of digital leaking are intended to create the feeling of surrealistic, reminding audiences about the alternative universe.

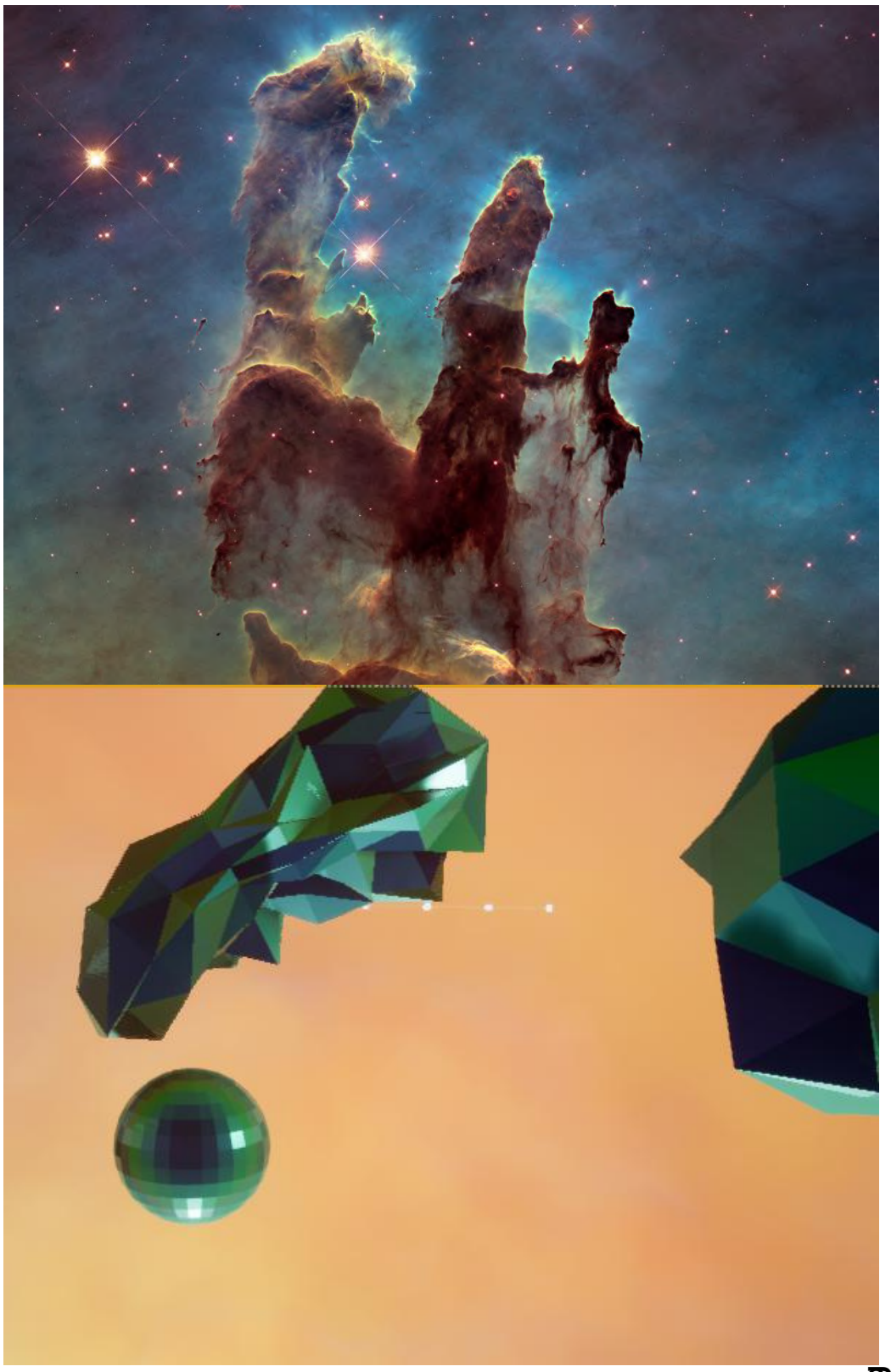
I use transient rules to generate color and arrange them according to the hue, saturation, brightness and temperature. They are all manipulated relative to the dominant color, which is decided randomly at the beginning. The dominant colors are generated in random hues, creating vibrancy and reminding audiences with different landscapes and environments [Pic. 17]. The texture is important to create details for the realistic part of the feeling. The imperfect visual elements have been merged into textures like worn, smudge and dust, appealing to the sense of reality, time and history [Pic.18].

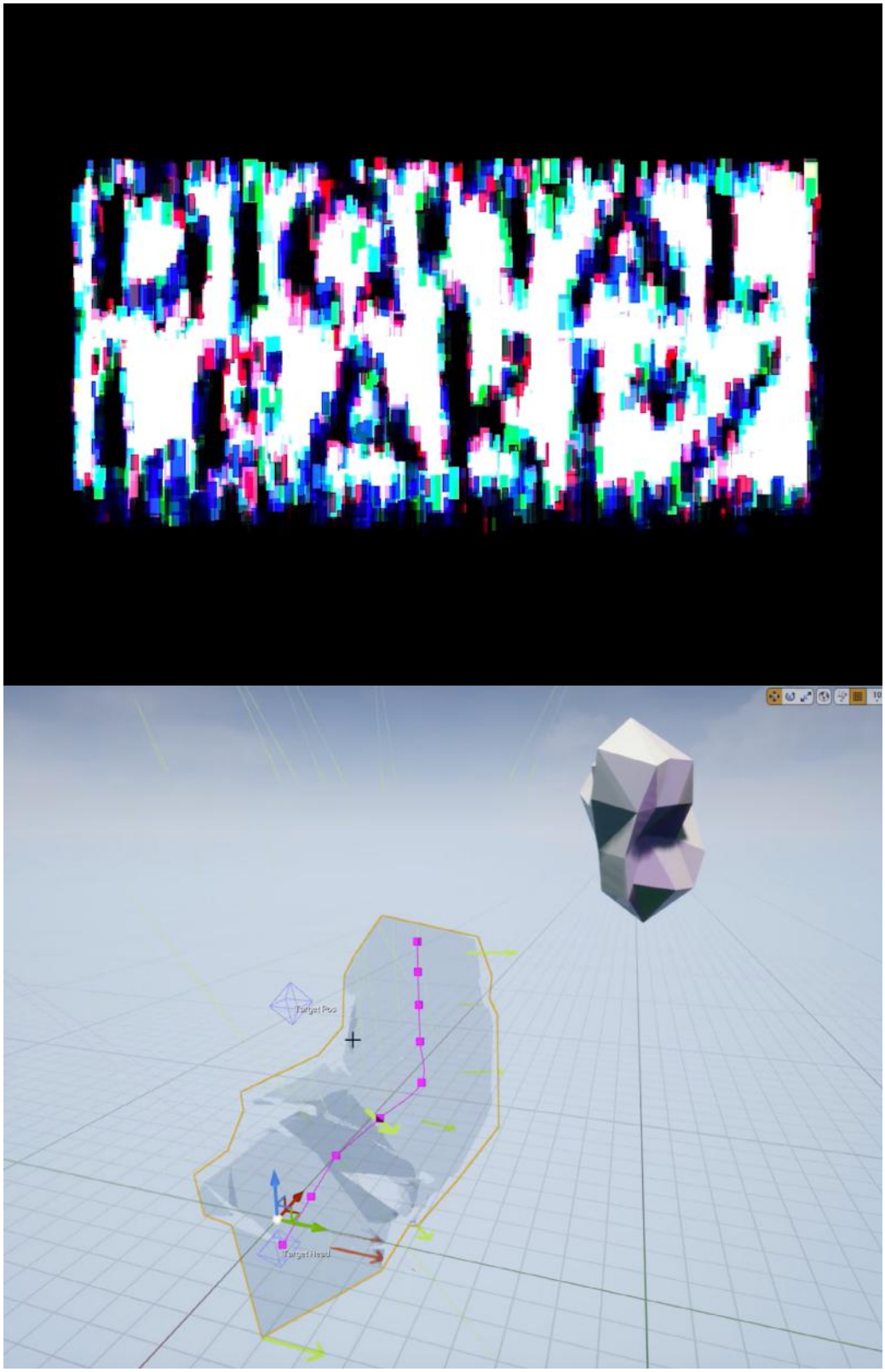
I want to reduce typical game elements in this simulation to avoid association of fable and entertainment. But that doesn't mean I stop maintaining the attractive quality. I exaggerate the gradation of visual elements like hue and mapping them into shapes, which is similar to the procedural of data visualizations. Complement visual properties are used to create tension and hierarchies by controlling their gradation in time and space. For example, most of the variation and contrast are displayed in the focus area, and gradually decrease by distance. These methodologies derive from my experiences of painting and design have been moderately adapted to generative design practices.

Fiction and Storytelling

The core of the fiction is the actual story that happens in the future of the alternative universe. The digital incubator is a prod-

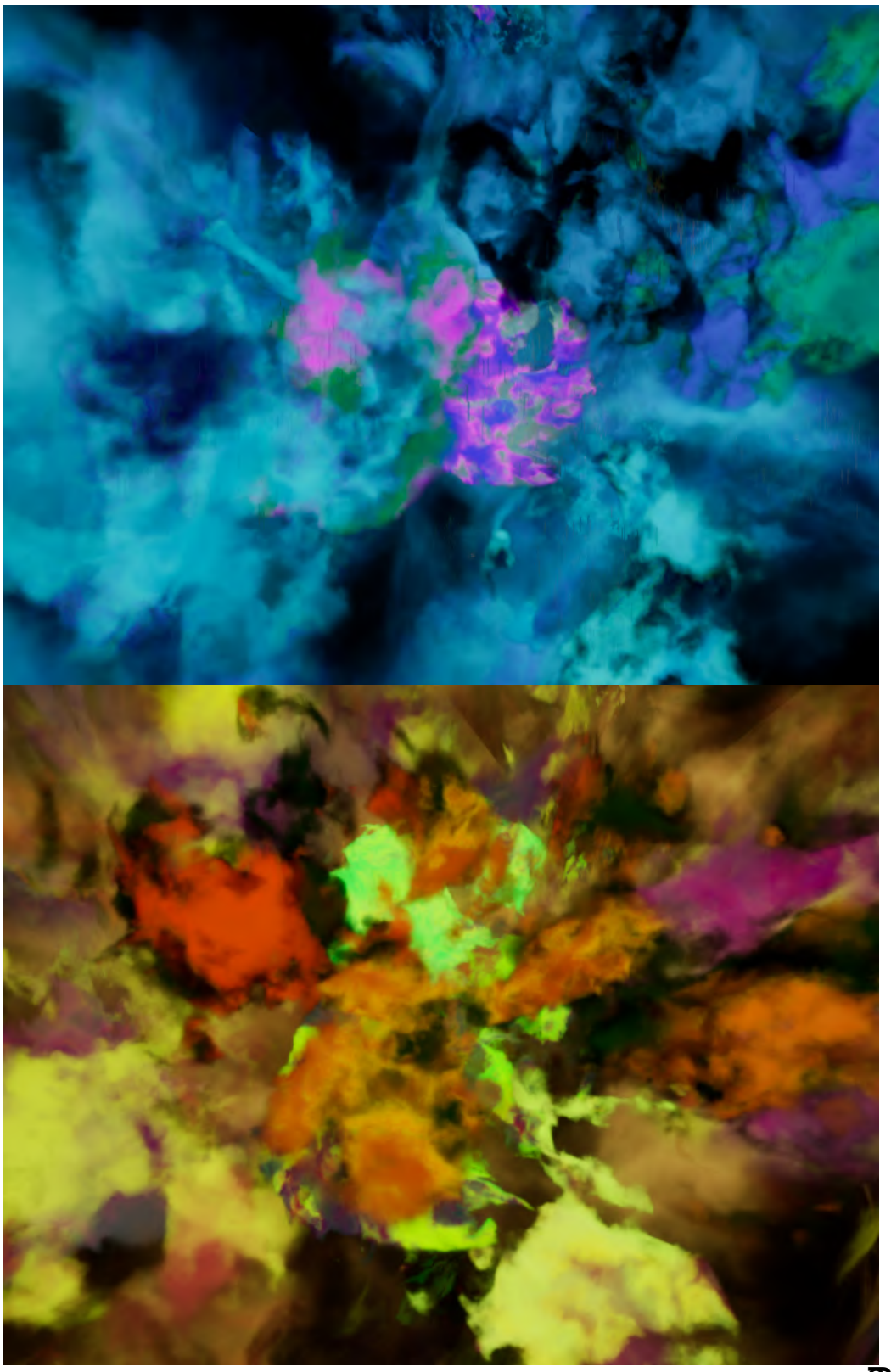
[Pic.13] (Top) Visual reference (Picture from NASA)
[Pic.14] (Down) Screenshot of the unit

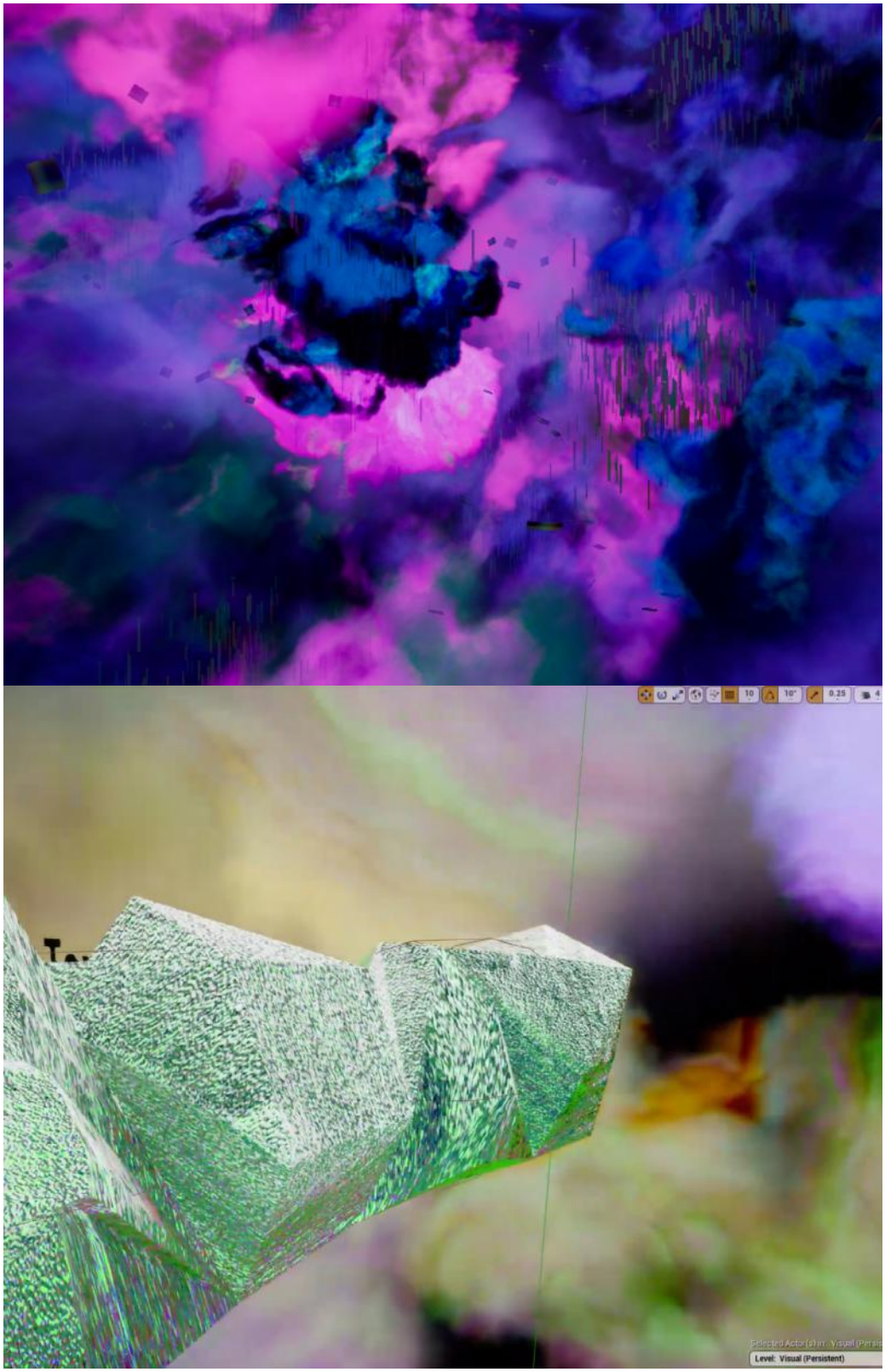




[Pic.15] (Top) Screenshot of the Glith effect
[Pic.16] (Down) Screenshot of the inverse kinematic highlighted

[Pic.17] Screenshots of the environments





[Pic.17] (Top) Screenshots of the environments
[Pic.18] (Down) Screenshots of the unit applying textures

uct from there, somehow becomes perceptible to us through a digital leak, which is the portal between us and the alternative future. From the digital leak, we can speculate the facts and truth in that alternative universe. Digital Leak Responding is the title of this fiction, a collection of everything relating to the story, such as the discovery of the digital leak.

The interactive narrativity I investigate in this research, known as the generative stories, come from the digital incubator. Here are examples that emerged in the developing process. The artificial intelligence algorithms weren't configured correctly and one of the digital species always sticks to a certain direction instead of moving around to explore like others. This can be interpreted as a stubborn AI who insists to live by its own way. It actually becomes the most distinctive individual in artificial society. I am so engaged by the hilariousness of the story and its correlation to the topic of the research. This is a mistake for the system, but not for the story. The power of the storytelling establishes itself in the conflicts [Pic.19].

Interactive narrativity always comes with surprises. The navigating function was inconsistent and could cause traffic jams on certain occasions. Meanwhile, I have added a stealing function as a hostile gesture to encourage competition among the species. Afterwards, some of them start to steal resources from those who got stuck and return to the base. The deserted resources have been collected by thieves in the society. Such a negative behavior becomes reciprocal for the whole spice, which is unexpected and ridiculous [Pic.20].

Apprentaly, stories like these need interpretation from the spectator. That means it is important to create empathy in this fiction for audiences to resonate, to relate to these creatures. This can not be achieved without the understanding of the content, which I tried to facilitate by bringing conceptual scenarios.

Context and Senario

The mock up course helps me to develop the concept of digital incubator. I believe the term has vulgarized the complexity of technical expressions about the simulation. Additionally, introductory content is also required in the conceptual framework of the fiction. I prefer ideas that are more interesting and less compulsive than literal introductions. It is supposed to be something familiar with the audiences for them to land in the fiction.

How about a blog? I conceived an imaginary researcher who is a nerd that discovered the digital leak. Combining with the blog he hosts and the visual slides of stories in the alternative universe I intended to create, the conceptual context of this fiction can be established [Pic.21].

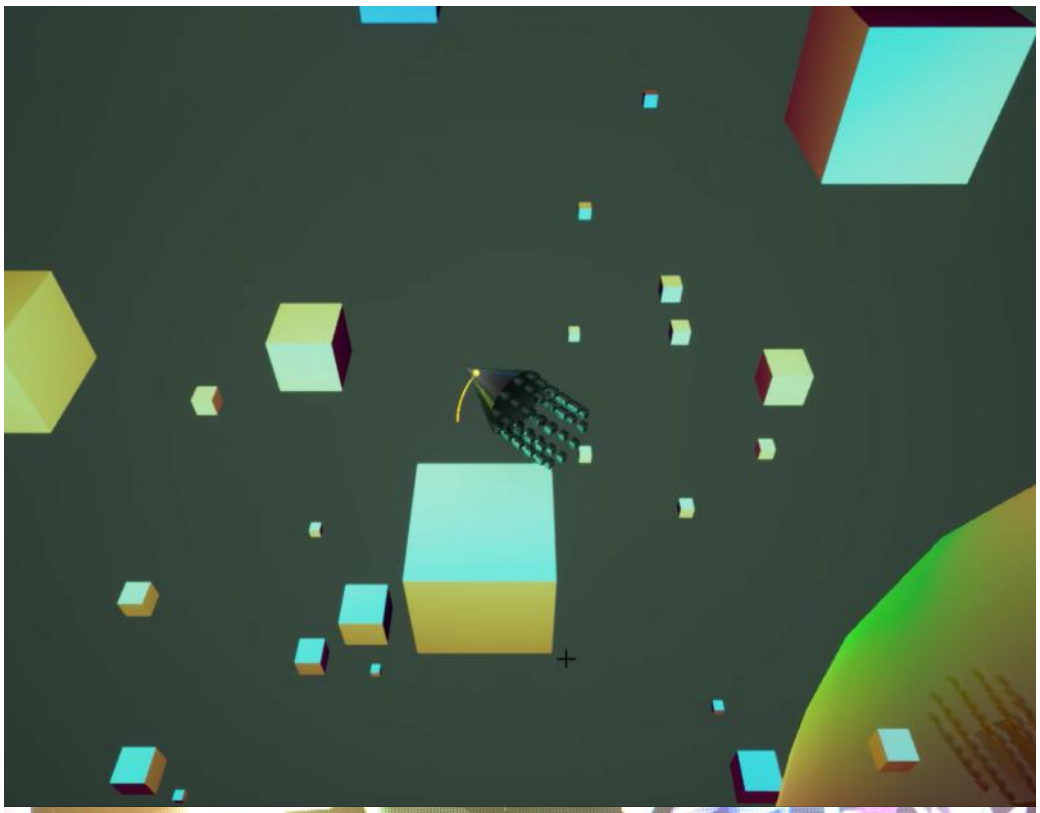
That became less promising after I had collected some feedback. Through presenting this idea to fellows and professors, I realize these contents are fabricating an extra layer of complexity to this intricate fiction. Instead, the fiction expects something more plain and self-explanatory.

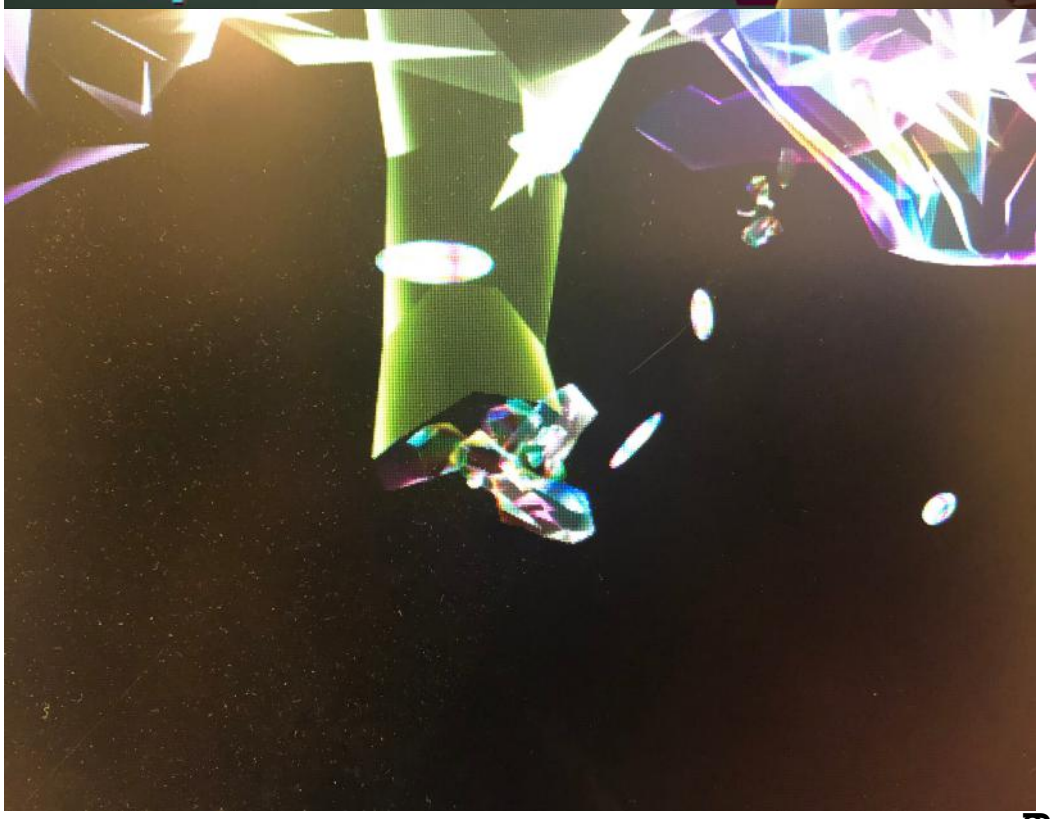
After the discussion with Albert Tang, the idea of usability in industrial design gave me some ideas. He compared the fiction to a chair, which led me to the metaphor of chair pulling. I realized the situation I would like to build is to bring an alluring chair and ask people to sit. Once they feel comfortable, it is time for me to pull the chair and offer the chance for the audiences to explore by themselves.

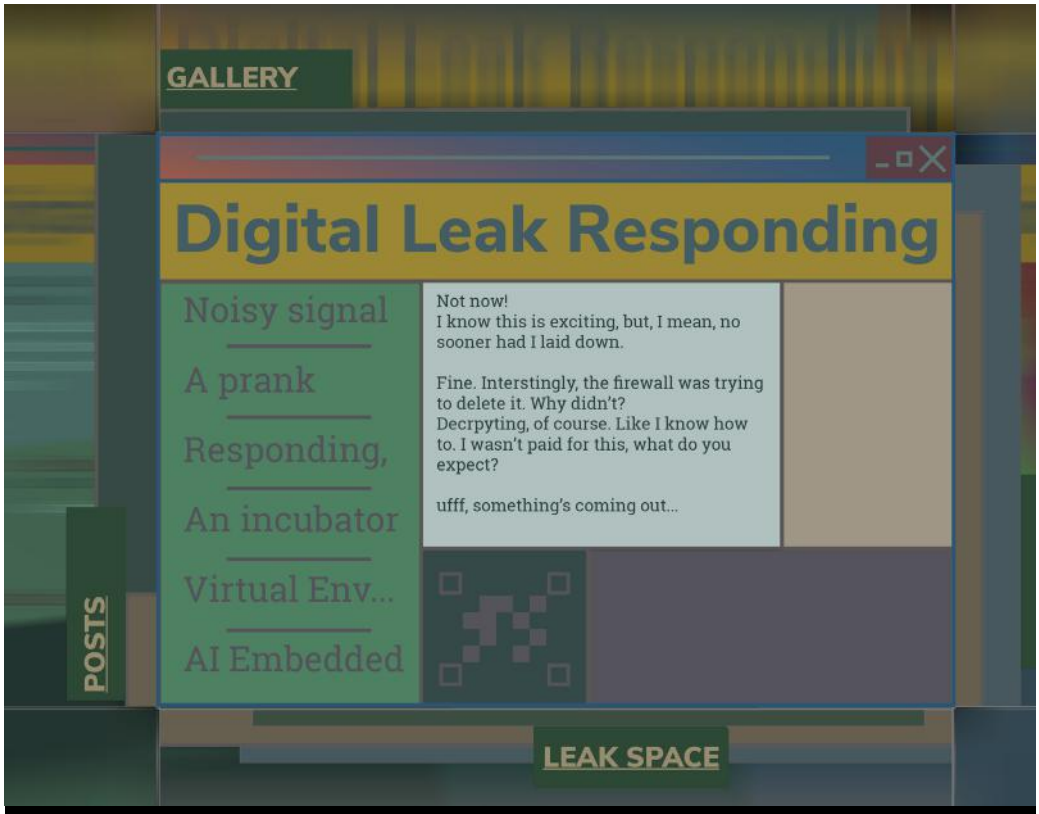
The Manual for Cultivating Digital Species is a handbook for cultivating digital species. It provides the basic information of digital incubator and digital leak as introduction and conspicuously conceals further knowledge, intriguing audiences to explore and speculate.

Last but not least, the visual identity for the fiction has been developed. I chose green as the principal color because I think it relates to war, currency and digitalization. The san-serif, futuristic typefaces are appropriate to convey science-fictional messages.

[Pic.19] (Top) Screenshots of the stubborn agent
[Pic.20] (Down) Screenshots of stealing behavior happened







[Pic.21] (Top) layout design of the bolg
[Pic.22] (Down) Logo design of the Digital Leak Responding

Additionally, I would like to use oblique letters and skew sections in the layout to intensify the feeling of dynamic and disturbance [Pic.22].

Digital Leak Responding is an immense design fiction. I can only design limited content within the time for research. Development of additional contents can be the future hope, such as species from other groups or visual slides of the fiction. Creative process is always endless. For this research, I am using reasonable content to demonstrate this extendable framework of this design fiction to deliver my thoughts and ideas.

Artificial Society

4.1 Emergent Social Reality

From mechanical perspectives (Durkheim, 1984), some sociologists consider society as a system of combining individuals (Holmwood, 2005). In my opinion, the component of such systems is the relationship between each other instead of the people. This relationship can be changed by how people are organized. Therefore, there might be solutions depending on the social structure to accommo-

date more diversity in the society. To investigate this possibility, I started with the questions.

Is there any alternative social structure available? Is it possible to speculate an alternative society? Such questions have been explored by considerable predecessors in the field of sociology. However, I still want to contribute from a designer's perspective.

Perhaps creativity can forward the solutions. Thus I tried to search for a nonconformity society. It could be a virtual society from the internet, a place without physical limitations. This quality reminds me of societies in multiplayer video games, which exist in the virtual world and orderly conducted by players. It supplies nothing physical but is still able to offer belonging to participants. That is made possible by the social interaction, which is their only connection and the key of my questions. Additionally, the social interactions in the virtual space can be modified arbitrarily for research purposes, suggesting the potential to approach the essence of interrelationships and metaphysical inquisitions.

Emergent is the appearance of certain properties in the systems which do not exist in or be indicated by its components. These properties only present at a specific level of complexity in systems like society. That means in the relevant experiments, the society needs to be treated as a whole instead of being deconstructed. Instead of looking into specific aspects, it is more reasonable to explore the alternative options for organizing individuals.

A digital simulation is usually an interactive application consisting of analogue elements, systems or mechanisms from the referencing object. It is a versatile tool that can be used for training, educating, entertaining, researching, etc. For example, it can be a simulation for investigating aerodynamics, or a flight simulation to train pilots in the military.

Computer simulation for social life has been previously discussed (Gilbert & Conte, 2017/1995). Decades ago, the Poly World has been programmed for agents to evolve in virtual environments with AI algorithms (Yaeger. 1994). Researches like this have started for a long time. Although, by taking advantage of current powerful computational equipment and advanced artificial intelligence algorithms, I believe it is worth finding out what differences these could bring to us.

Society is the pattern of interactions between individuals, which can be any autonomous unit. It means that there's not only a society for humans or animals, but also a society for automata in generative systems. Hence, this social simulation is also a generative system. They are not just the virtual place for social behaviors to emerge, but also the proving ground for exploring the interactive narrativity and the capability of generative design.

Eventually, this research is intended to examine the possible structure for society of artificial intelligence, in other words, the artificial society. Multi-agent based computer simulations was considered as the tool to explore the mechanisms of social emergent (Sawyer, 2004). I am inspired to build the digital incubator, the artificial society simulation. Details will follow in the section Digital Incubator.

4.2 Artificial Intelligence

4.1.1 Choice of algorithms

Machine learning is a proven method for developing artificial Intelligence. It has been consolidated with deep learning algorithms, known as the artificial neural network, and resulting in the development of deep reinforcement learning, which facilitated many prominent outcomes. The cutting- edge algorithm, Proximal Policy Optimization (PPO) demonstrates tools use and collaborative behaviors in the Hide and Seek environment (OpenAI, 2019).

Such algorithms reinforce the best strategy for the given situation to enhance the performance of artificial intelligence. The agents embedded with such AI can be evolved in the environment using evolutionary algorithms, resulting in a system where the agents with better performance keep reproducing. If the iteration of training forward smoothly, they are supposed to perform better in their tasks. The outcome of tool use and collaboration behaviors intrigued me to explore the possibilities for artificial society with this method.

Machine learning is not the only approach for artificial intelligence. In general, AI in video games incorporate tools like the decision tree, instead of machine learning algorithms. It is a method that the creator specify instructions for every possible situation in the game for agents to follow strictly. This allows the game developers to adapt the difficulty for players, performing more stable and consistent enemies and companions as expected. In this case, their behaviors will follow certain patterns instead of adjusting according to the situation and experience. The general AI gives predictable results, which is not the property I am looking for.

On the contrary, deep reinforcement learning algorithms can result in unexpected reactions. This quality is relevant with the mechanism of the neural network. People describe it as a black box, in which the algorithm decided the connection between input and output by itself. It makes it hard to control or perform consistently at a specific level. The configuration of this algorithm is relatively empirical. In more complex environments, the trained agents usually progress slowly, being under performance and inconsistent in their tasks. But these are not necessarily bad qualities for storytelling purposes. Such properties lead to the intriguing result, creating tension and conflict under the context. I think the method also enhances the possibilities for social emergent due to the increasing indeterminacy, which is missing in steady systems.

To introduce such algorithms to the digital incubator, despite the speciality of skills and knowledge, it also requires stupendous computational power to achieve a high performance level. The evolution of intelligence sometimes can only progress for millions of episodes, after months of training. Although, as I stated above, narration takes a significant part of this fictional project and the stable performances might not be helpful. It is also important for this artistic research to practice the alternative adaptation of these cutting edge technology to demonstrate the diversity and explore the potential, offering exceptional perspectives to our new challenges like limitation of growth, social dilemmas, artificial intelligence, virtual organism, etc.

The implementation of this method is highly dependent. It requires different configuration for every different environment. Every relevant condition comes into consideration, controls, sensors, actions, observations, output, input, and etc. Agents are also possible to be trained in an environment and then be deployed in a different one.

To overcome these complexity and difficulty in the method, I was expecting help from experts. Taking advantage of external plugins from experts can facilitate the implementation process. My first attempt is a plugin with the embedded Deep Q Learning algorithm. Unfortunately, it wasn't applicable for the digital incubator. These plugins are encapsulated and hard to modify without profound understanding and experiences. Expecting the presence of appropriate plugins in such a specific usage of advanced algorithms is relatively unrealistic.

How about reaching those experts? However it is not easier than the previous approach. For my situation especially, intensive collaboration and dedication are necessary. Despite the elaborate configuration, knowledge and expertise from other specialized areas are required, such as computer graphics and generative design. The effort it takes to find such people who are also willing to collaborate might be more than learning some practical implementation knowledge by myself in the limited time.

There is an alternative way to get help from these experts, which is courses and tutorials. Through learning and experimenting, I have been able to dig into the details of the implementation and adapt the algorithm to the digital incubator. I have taken a course in Coursera about deep learning by Andrew Ng, which offers me some basic understanding of neural networks. Therefore I started to learn reinforcement learning by relevant tutorials and examples. As I continue to learn and experiment, this prolonged process of practices start to come into shape and I can therefore start the training process, which will be elaborated in the following section.

4.1.2 Training of agents

Training is the process of specifying input, output and rewards of the algorithm, for agents to learn and develop better strategies to solve tasks. It is the operation to approach the appropriate result instead of finding the ultimate solution. The parameters for learning operations, known as hyperparameters require iterative modification and examination along the training process. When the AI is set to the training mode, reactions and consequences will be used as experiences to improve the algorithm. Otherwise, the AI stops learning from the situation but still conducts the agents, known as the exploiting mode. Both behaviors happen in the evolving stage in generative systems.

In the digital incubator, the tasks for these agents are picking resources from the environment and bringing back to the center. For training purposes, the environment with functions for movement, perception and collection is necessary. This environment has been established to start testing and adapting the algorithm for training. Afterwards, the training gradually becomes more intricate and has to be separated from the evolving environment to be facilitated [Pic.23].

The movement mechanism has been changed to be more expressive and responsive. To reduce the complexity, I separated the tasks and started training for split tasks before combining them together. Although, the combination brought extra complexity but the training outcome remained the same. So I discarded the idea and planned for completing the incubator so the training process can move back there. Furthermore, I think functions for agents should be simplified. Too many functions have been incorporated into the simulation, such as the ability to release energy and rating objects. These are my attempts to improve the quality for social interaction, but they also overcomplicate the setting and affect the training. I will only retain the basic components of these functions like sensors for observation, movement for action and fundamental capacity of communication.

The training result of the AI is interesting enough. Confusion often takes place and the gradual progress of learning is obvious. I can spend days watching them in the digital incubator, just like appreciating the fish tank. I believe the algorithm is adequate for fictional expression, given the fascinating stories I stated in the Visual Storytelling section [Pic.24].

Training is an endless process. Especially for this research, which the machine learning algorithm has been deployed without a specific target. This means the training actually has no ending point and the potential of the artificial society can still be explored in the future. With proper configuration, extra training in future for the project means simply executing this simulation in the computer.

4.3 Artificial Society

4.3.1 Social simulator

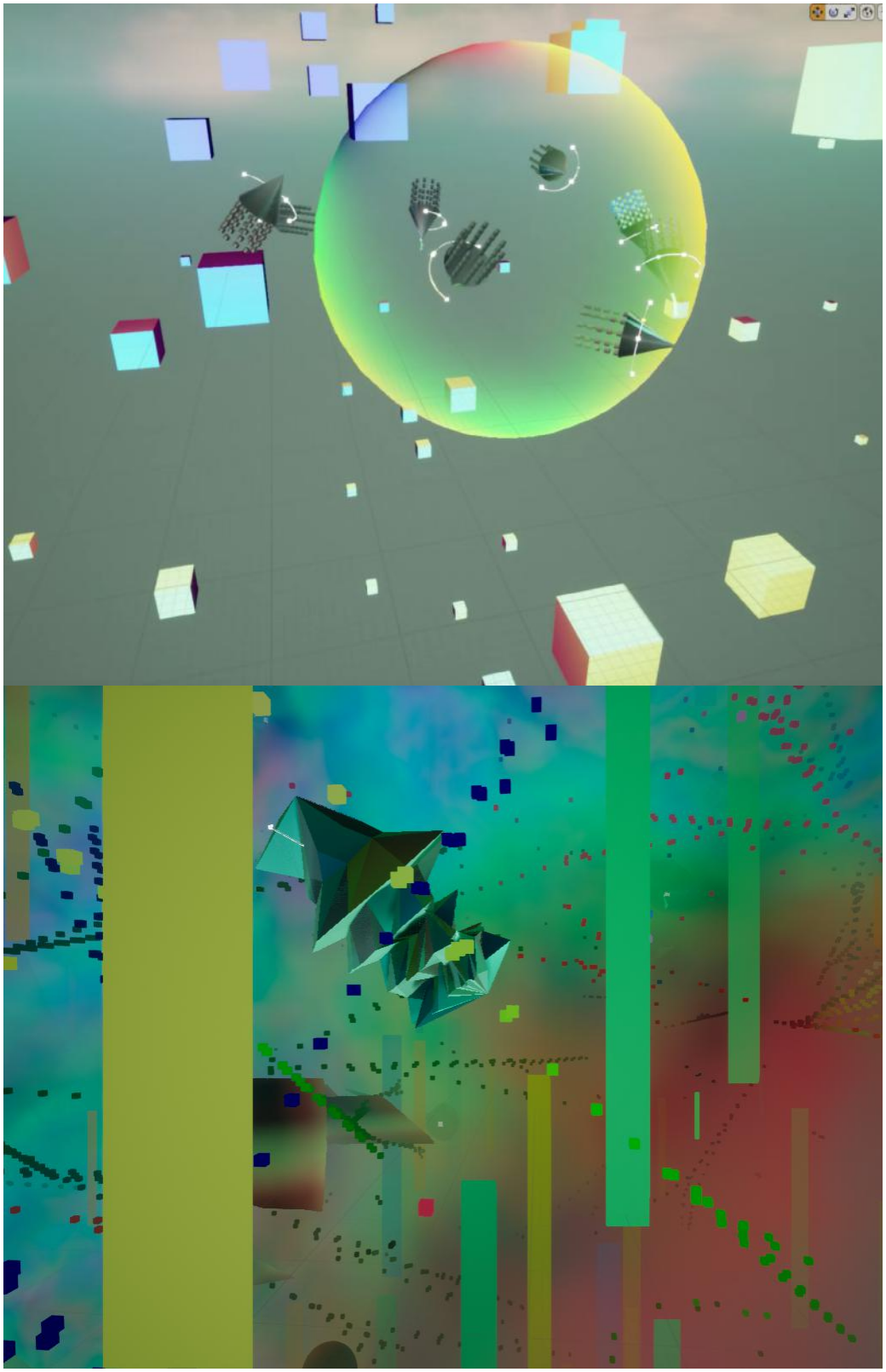
The research started as the exploration of social structure and the inspection of society in the context of marginal society. Specular Minorities was the project title at the beginning, coming from the idea that marginal groups in society are the mirror for the rest. For inspiration about digital society, I was looking for demonstrations of social interaction in video games. The Sims is a series of life simulation games, which can be considered as the simplified replica of human society. Although, for inquisitive purposes, I expected a less entertaining social simulation.

Cases Studies

Alpha City is a game that no longer exists. An article of digital excavation has revealed some of its history(Zhexin, 2015). In Alpha City, players can name the virtual space, which is the unit they engaged and use it to attract visitors. All activities require virtual currency, which will be transacted when other players come visiting. The name of the streets and blocks are voted by residents. These are basically everything for people to do after check in, thus it quickly loses its popularity because of the monotonousness [Pic.25].

The design I wanted to create is not a game. It could be an interactive application, a digital tool for investigating, researching, observing, or reflecting about society. I refused the term game to avoid entertaining associations, which brings some difficulty for communication. The applications I conceived are called interactive tools, instead of “digital game” or “simulation”. The first tool I devised is a digital voting tool for a group of people to make decisions in given circumstances. The distributed voting scheme can be achieved using the block chain, which I thought can bring differences to the decision making process. Another tool I conceived is to investigate the social interactions in digital space. Human generator is a program to generate objects as individuals in the virtual space. Each object has properties like desire, requirements and capability. They inhabit the virtual space and move between different areas to balance their properties.

[Pic.23] (Top) Screenshots of the basic training environment
[Pic.24] (Down) Screenshots of agents in the training



[Pic.25] (Top) Screenshot of AlphaCity
[Pic.26] (Down) Screenshot from Emissary by Ian Cheng

Working areas can satisfy their requirements but increase their desire, vice versa. By using generative algorithms, this tool is intended to approach the best configuration of working hours in different situations. I didn't actually prototype them, since I believe there are other options which take more advantage of the visual communication along the inquisition.

Conway's Game of Life inspired me to start with the idea of social simulation. Life is a cellular automaton, where cells can evolve under certain rules. In the grid, a cell will survive to the next turn when it is surrounded by a proper amount of neighbors. Otherwise, it means the space is too crowded or too wasted, resulting in the death of the cell. This program inspires me to build the first prototype of this project. My implementation is a variation of the original version. It remains the basic rule of cellular iteration and has them divided as groups in separate colors. Other than being reproduced by long surviving ancestors, cells can also be generated randomly every certain amount of time. The competition between groups turns it into an influence map, naming itself The Raise of Tribe.

I realized that social simulations can combine with visual elements for communication, turning to a device for people to interact and reflect. It is also possible to become the design practices to deliver my thoughts and ideas, utilizing the power of storytelling. I started to conceive the simulation and have been introduced to the tool Unreal Engine and the artwork Emissary. Emissary is a simulator by Ian Cheng. Referring to him, it is "a video game that plays itself", a world where a cast of characters and wildlife interacts with each other [Pic.26].

Inspired by social creatures and the research of ant colonies (Gordon, 1996), I initiated the idea of establishing a virtual space to engage social behaviors between imaginary creatures. This social simulation turns into the digital incubator along the iteration of prototyping.

4.3.2 Digital incubator

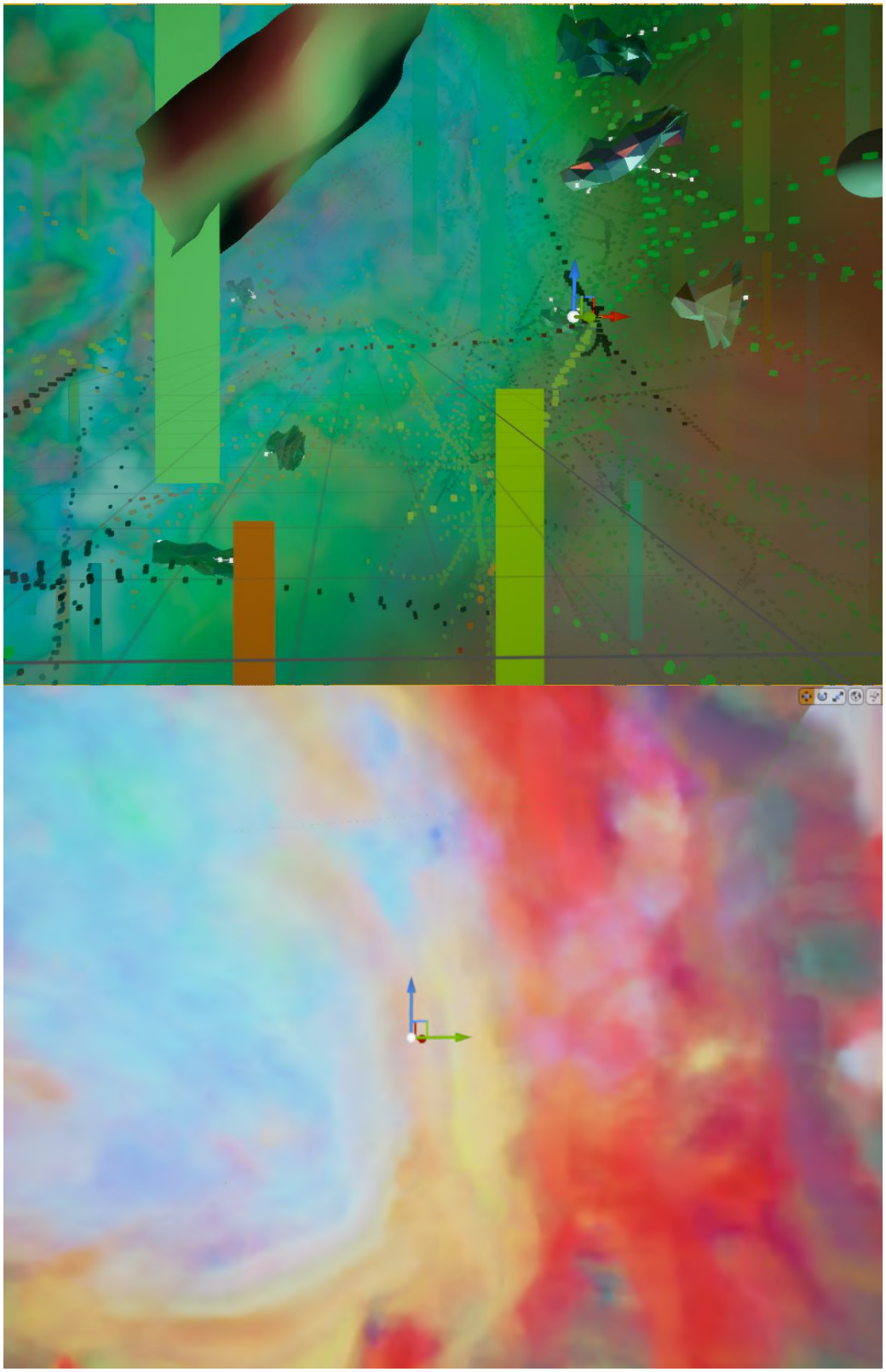
Design of World

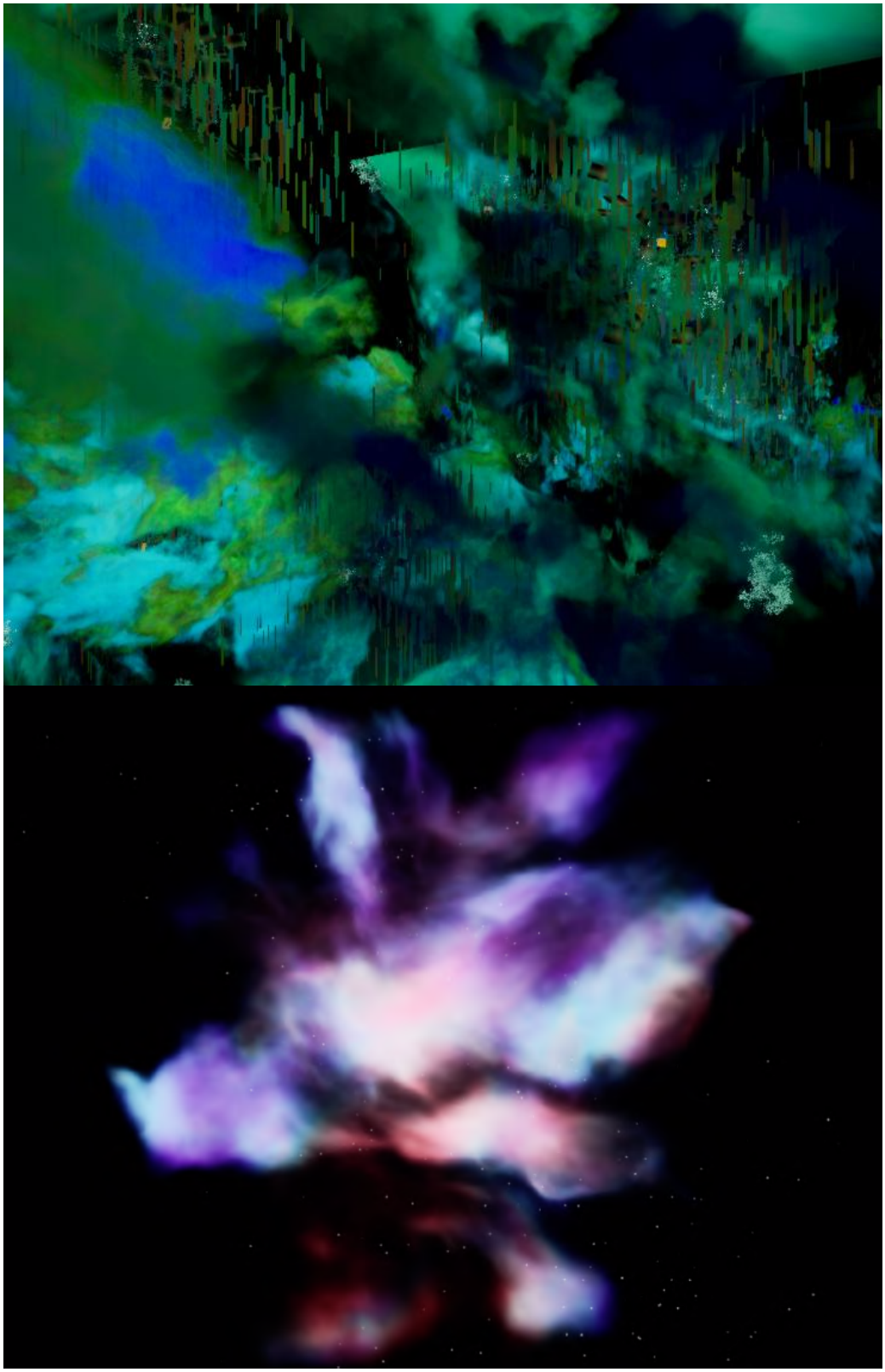
The digital incubator is an artificial society simulation demonstrating the potential for employing digital interactiveness for expressional purposes. It is a design practice of world building and the referential entity of the design fiction Digital Leask Responding.

The micro world and the universe converge here; visual experiences in the design are generated by the juxtaposition of their different perspectives and the extraction of their similarity. It is a space of slight gravity with impetuous floats scattering [Pic.27]. The exaggerated gravitational force affects the distribution pattern of the scenery, forming the emissive features in the environment of the incubator. The growth pattern, or the details are directed by noise functions, which generates spatial differences for closer scales [Pic.28]. Different types of visual elements are presented and coordinated, like points, lines, faces. Sharp and blur, solid and flimsy, saturated and dark, glossy and rough, conflicts from them expect to be meticulously balanced in the simulation [Pic.29]. Association from visual analogs, like nebula, cosmo, and crystal contributing the technical, surrealistic, organic and psychedelic appearance. Rhythm and tendency behind the tension demonstrate the attempts to control the expression and influence the emotion, expecting for transcendence, abstraction and peculiarity.

The digital incubator inhabits species from different groups of interest. They compete in exploitation to determine the share of computational power, which is the crucial currency for them. I aim for only one group at the moment, which is the Xirealm. In this simulation, agents can be understood as the mind for implementing AI and conducting the unit, which is the body. Each individual in the artificial society of this group is a unit. They

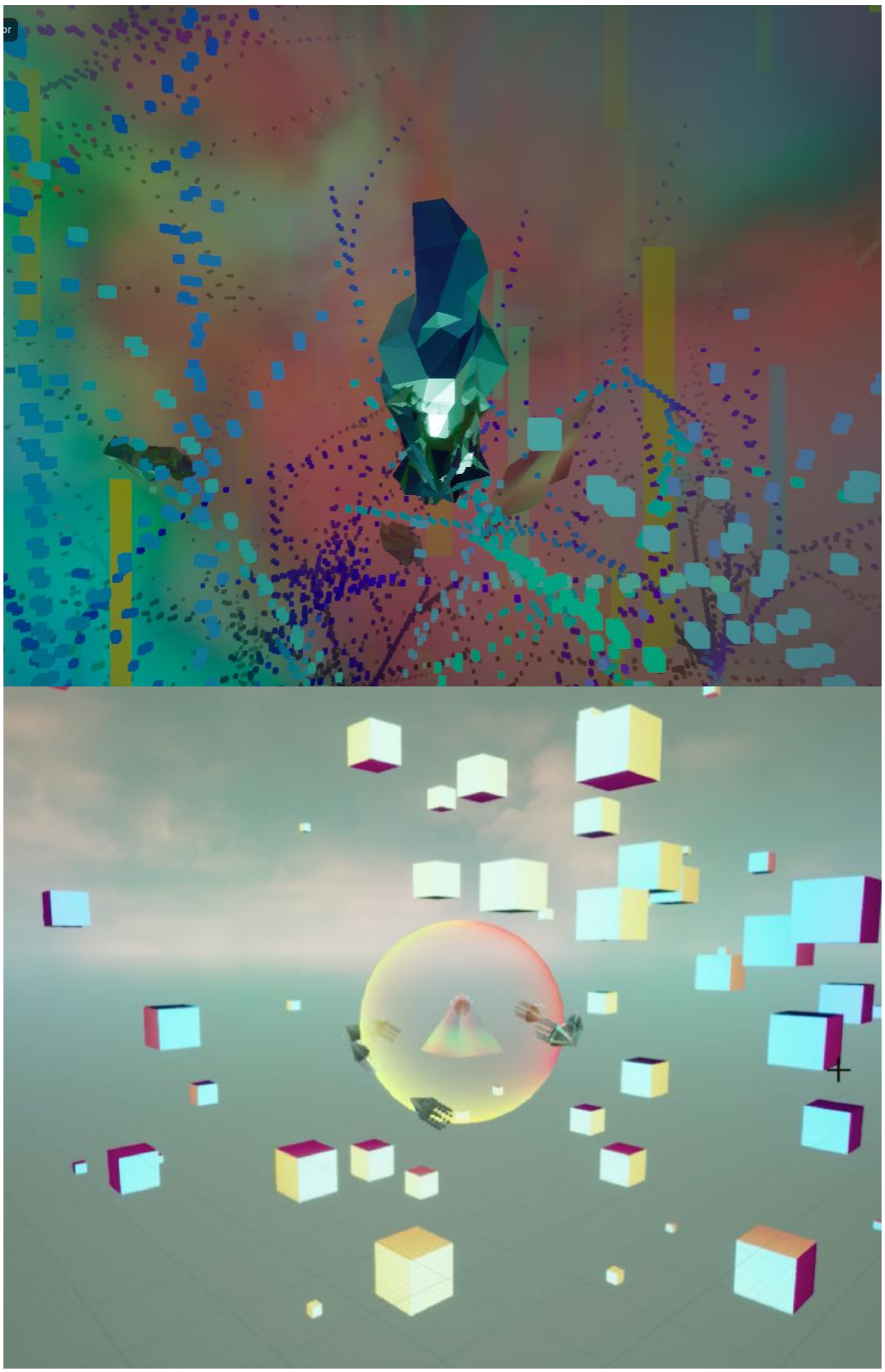
[Pic.27] (Top) Screenshots of the floats
[Pic.28] (Down) Screenshots of details created by noise

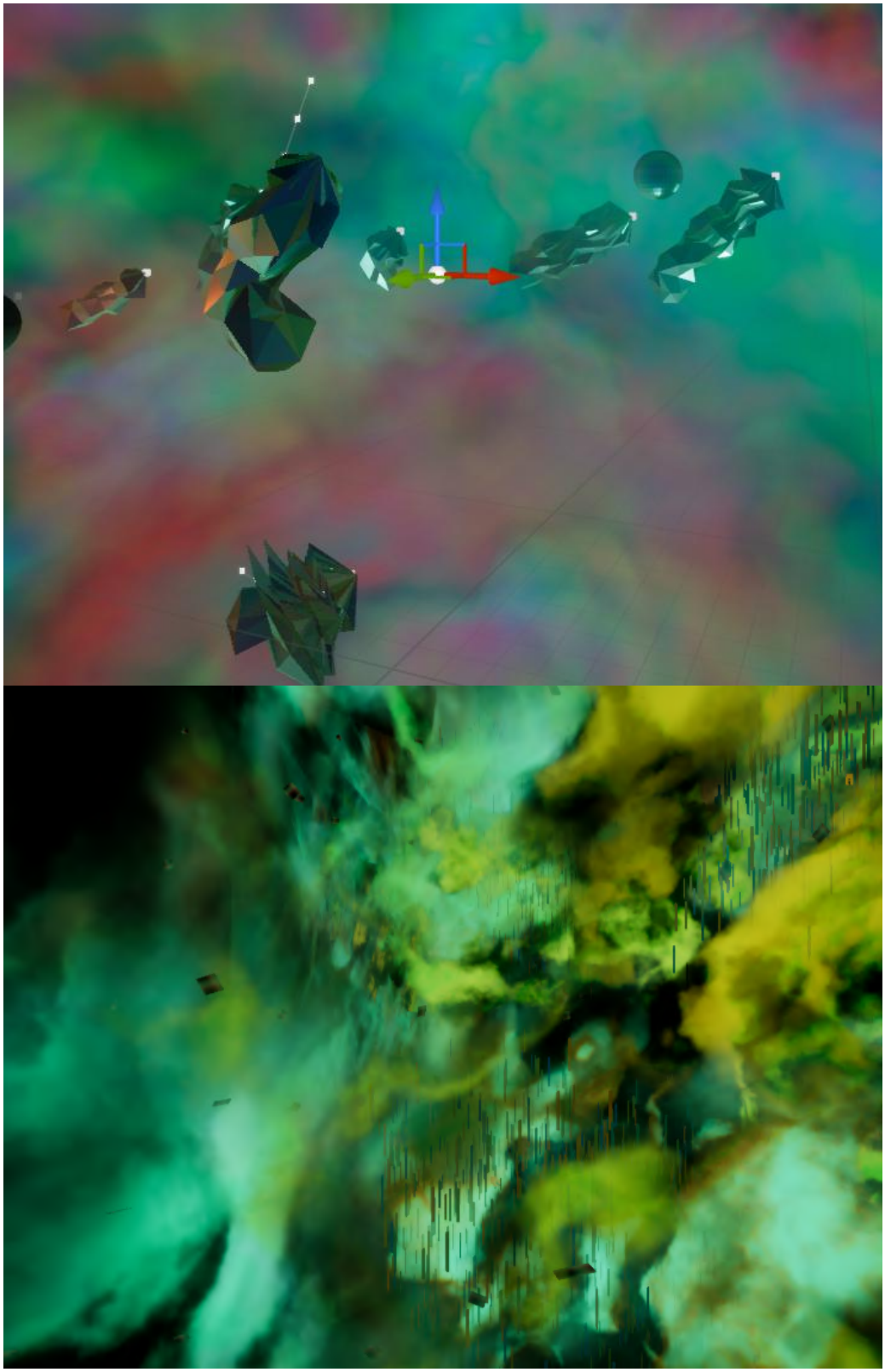




[Pic.29] Screenshots for compositing the openworld

[Pic.30] (Top) Screenshot of the environment
[Pic.31] (Down) Screenshots of the digital incubator in different steps





[Pic.31] Screenshots of the digital incubator in different steps

have sensors for observation, detecting objects in front of them and transferring the surrounding into information, as the input for its agent. After calculation, AI algorithms return data to the agent as the output, becoming the actions for the unit like movement and communication. Units are manufactured by the base, where they will submit the resources.

Most elements in the environment can interact with the units. Oscillation is a floating waveform surface, it will push the overlapped units to a random direction. Implantation is a cluster of organic objects which will slightly grow. Precipitation is a pile of fragments that can be collected as resources. Diffusion is a group of dashed strings of cubes which are generated randomly and sprawl around itself before its incoming elimination. It releases energy packets that can charge for units when being picked up. Agitation is a group of microorganisms flocking in this virtual space. Annihilation is the colorful and blurry mist permeating in the virtual space like nebulae [Pic.30].

Besides watching, audiences can also interact with the incubator. It is possible to move around through the avatar, building constructions and interacting with the creatures.

Rapid prototyping

The development of the incubator takes a long time. I seperated it into three steps and each of them should be a playable prototype. Prototyping is the process of repeating the design, test and review. The first step is to build a minimal functional framework, including units, base and the environment of an annihilation. Basic functions like movement, collection are required. The test of training is able to begin at the time. The next step includes the basic visual elements like color, shape and texture. Advanced functions are expected. The final step is setting up the generative rules for the whole system, refining visual elements to enhance the ability for visual communication [Pic.31].

There is still a lot of space to improve for the incubator. Many thoughts and ideas have been left behind under the limitation of time and reality. Although, I believe it is possible to be updated in the future, given that the extensibility has been taken into consideration. Contents about environments and agents from other groups are waiting to be presented and the incubator itself also expects to be developed. Other than the emergence of advanced social behaviors, It is also possible for the incubator to become a research tool for artificial society. The flexibility of simulation makes it possible to carry out experiments like examining reactions from agents towards pandemic or other catastrophe.

Interaction, simulation and application, words related to digitalization translate everything but nothing. Is it the limitation of literature, or the indication that we are not ready for virtuality? After approaching it with every possible definition, I realize it is a detour around its essence. It is simply a digital object, the digital incubator. It generates for absence and for not engaging. It is for moments of abstraction, hovering between life, society, technology, fantasy, future or reality.

Conclusion

5.1 Reflection and evaluation

From my perspective, generative design thinking indeed helped me to produce better results in generative design practices. Through the experiment in this research, this method demonstrates desirable potential in practices of visual communication. I think the simplification and familiarization of creative coding tools is inevitable, which will provide benign circumstances for such practices to develop and expand.

During my practices, I realize that the generative system is intricate and interrelated, which can be impeded by conflict between rules or even a typo in the code. There are always countless efforts for debugging before it can be executed. Hence it is important to develop iteratively instead of doing it at one go. Splitting the task for executing the code as much as possible prevents the devastating situation of massive uncertificated code with a subtle error.

Possibilities for storytelling in interactive media has been well explored in this research. From my observation, interactions as a medium for expression is not quite acceptable by the audiences right now, since people generally are expecting user-friendly experiences

from interactive products. I have received some negative feedback with their frustration towards unconventional interactive experiences. But this shouldn't prevent our exploration and it will be changed soon given the frequency of our digital contact. I believe visual communication will open for more interactive possibilities in the future.

Interactive narrativity brings many intriguing outcomes. Although, the delivery purpose of Digital Leak Responding wasn't well achieved until the scenario of digital incubator has developed. The context I conceived to help the communication doesn't work quite well, since they actually complicated the structure of this story. Alternatively, the design of the cultivating manual complements this problem and gives a good introduction to audiences. Other than that, the design fiction is able to raise the awareness of alternative society and provoking reflection toward society.

I wanted to create infinite space for the incubator using the generative system, which has proved impossible later. Instead, I repeat the scene to create the illusion of endless space. The actors will be transferred to the opposite boundary once they hit the edge. It is combined with the usage of the sky box, which is panels of capture scenes in the border that helps to create the illusion. I also wanted to create a distributed package for the digital incubator, for audiences to execute in their own computer. It is hard to achieve since it requires certain hardware for the AI to be executed. The substitution is capturing videos of executing the digital incubator from my computer for live streaming and future access.

Artificial intelligence has successfully been implemented into the digital incubator. However, the maturely organizational structure that can be defined as society has not emerged. Social behavior has taken place and some interesting facts have been discovered. Due to the limitation of computational power I can access, this result is satisfying and the further development can

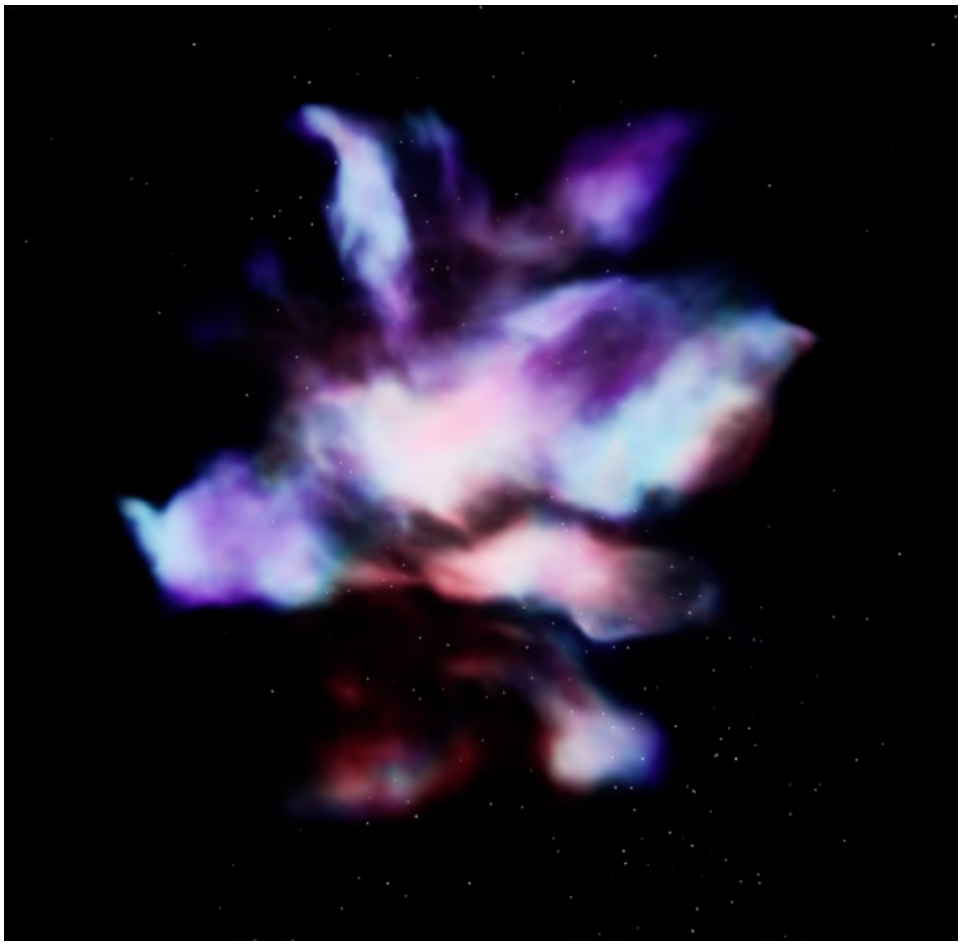
be a future hope. It is not so undesirable, since the established simulation is supposed to run for a long time. Adopting machine learning algorithms instead of generic game AI is a sensible choice when it is judged by me now. Without the effort, it will be impossible to speculate the contingency and inscrutability from the digital species in the incubator, which are fascinating and compelling. The digital incubator is able to pull attention and provoke contemplation, sparing moments for audiences to abstract.

5.2 Summary

Generative design, artificial intelligence and social interactions are the building blocks of this research. Supplemented by the interactive storytelling in visual communication, this design practice presents my perspectives and daydreams.

It is such a fruitful inquisition for my professional advancement and life. Productional wise, I have accumulated practical experience and implemented many techniques. Importantly, I become more productive and the project has been reasonably managed during the whole study. It has been an incredible journey of learning to access many things I needed to learn more about, such as computer graphics, sociology and artificial intelligence. My understanding of creative programming, generative design, semiotic, artistic expression, visual storytelling and interactive medium has advanced considerably. It is also obvious to me that my visual style and aesthetic has developed and improved in the direction I expected.

I hope this research may help to raise the awareness of alternative social structures, to expand the practices in visual communication and to inspire relevant ideas. Despite all the purposes I stated, it is also important that this research allows me to explore the expressional potential of the interactive medium and to experiment with alternative adaptations of technology. In the future, I wish our society can encourage more diversity and discover more possibilities of itself.



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