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Non-interactive interactivity:
building a seemingly interactive installation

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Abstract

This dissertation aims to improve the knowledge on the mechanisms of interactivity, particularly in regards to interactive installations, through a study of the state of the art, and of known mechanisms of interactivity. This informs the building of a technically non-interactive prototype installation that causes, to those who use it, a perception of responsiveness and interactivity where there is none. With the example of this project, after an analysis both technical and through the eyes of the user, conclusions will be reached that will demonstrate practical applications of certain mechanisms of interactivity so that, in the future, more artists can create more interesting installations and interactive pieces of art.

Resumo

Esta dissertação apresenta uma análise sobre mecanismos de interatividade, particularmente no contexto de instalações interativas, através de um estudo do estado da arte e de mecanismos de interatividade já documentados. Estes informam a construção de uma instalação protótipo tecnicamente não interativa que causa, a quem a usa, uma sensação de resposta e interatividade, apesar de não haver estes fatores no sistema. Com o exemplo deste projeto, depois de uma análise técnica e da experiência dos utilizadores, chega-se a conclusões que demonstram aplicações práticas de certos mecanismos de interatividade para que, no futuro, mais artistas possam criar instalações e obras de arte interactivas mais interessantes.

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1. Introduction

A new interactive installation is being presented at a local art spot. Being presented as interactive, the audience does peculiar dances in front of the camera as the projected images of the installation seem to follow their movements. Suddenly, the creator of the installation walks into the room and moves to their computer, informing the audience that the software wasn't working properly and that the camera was not picking up any movement. The people, who just a few minutes ago were impressed with the responsiveness of the installation are now disappointed.

While in a hurry, the "close doors" button at the elevator is pressed, and its doors seemingly comply, shutting down almost immediately. Later, while reading an internet article about elevators and myths associated with them it would seem that the button that is supposed to speed up the closing of the elevator doors isn't actually connected, as these doors are legally required to stay open for a minimum amount of time. If true, why does the button create that feeling of responsiveness?

In 2016, during an event where multiple brand new installations were presented in an electronic multimedia festival, an installation stood out among the others for me. This installation was not particularly innovative, albeit interesting, presenting the audience with a large, room-sized, tarp, hanging in the middle of the area, receiving a projection of colorful circles and lines that seemed to respond to the users' movements, captured by a *Kinect* camera placed on the ground right in front of the projection tarp, but what made it personally memorable was a particular incident. While about ten people watched from a back wall, one person was trying out the installation, testing its limits, performing various dances and body movements in front of the camera. The audience, as well as this person, gleefully associated the soft movements of the visuals projected against the tarp with the choreographies given by this one user. After a while, however, this testing of the limitations of the installation's systems had this person move closer and closer to the camera, to a proximity often deemed too near to the artistic object, as the unspoken rule applied to art prohibited viewers from being within hands reach of sensitive equipment, be it a painting, the orchestra, or, in this case, a camera on the floor and a precariously hanging tarp. The tension built up, as the person approached, reaching a peak when the projection seemed to react in a completely different way than before, past a certain level of proximity, expanding the circles, clearing them, twisting the previously straight lines, becoming visibly active and much more responsive. Not five seconds passed in this high-movement section of the installation before its software crashed, prompting the creator of it to rush from behind the tarp, apologizing, and explaining that the camera was only picking up people if they were close enough. The audience felt deceived - they have been engaging with the installation, quite successfully in their view, associating the now clearly random movements of the visuals to their own movements; they were informed right then that their experience wasn't "real", which, in their mind, meant that their joy at playing with this system was invalid. They left the room unsatisfied, even though they were perfectly happy and impressed with the installation before they found out the truth. This raises some questions:

- What were the mechanisms that created this feeling of responsiveness and interactivity where, in reality, were none?

- Why was this audience so engaged with a system that wasn't interactive?

- Why were they so disappointed, to the point of dismissing their previous rewarding experience, after knowing the truth?

- Was it possible to recreate this phenomenon, without informing the audience of the true nature of the installation?

This incident, as well as these questions, inspired an academic research on this topic and an attempt at creating an installation and study that could shed some light over the mechanisms that created this feeling of interactivity where there was none.

On a personal note, this particular individual curiosity towards these deceiving techniques has been a staple of my personal work as a creator and composer. Breaking expectation is a powerful tool, as placing the audience in an uncomfortable and unexpected situation can lead them to challenge their own views more effectively. A previous piece of music, composed in 2015, *TV Grotesque*, specifically the fourth movement, is a clear example of a personal leaning towards the use of this tool. This part shows up after relatively short length movements, of three to five minutes in duration, mainly characterized by a relatively high activity and speed. The fourth movement, however, is intensely slow, dragging the same basic chord for around forty seconds before pausing and moving on to the next. This sudden slowness comes as a shock to the audience, who grow restless - they have experienced relatively fast music and were educated by surrounding examples of three to five minutes long pieces with immensely more activity than this forth movement. This uneasiness could be felt and heart, even by the performer (one could hear a "thank god" as the piece ended), and it hopefully made the people consider and reflect on why they felt like that. Why did a forty seconds long chord make them feel so restless? Could they start to learn to appreciate long, slow music, opening up their range of personal taste to include, not only fast, immediately engaging music, but also something more reflective, more intimate? Much in the same way a racist person will feel uncomfortable as they attempt to change the ways their surroundings influenced them, could the listeners of this piece of music use this uneasiness to change the way they look at music and find new appreciation for a slower moment in their very active lives? And could a more curious user of the *Behavioral Economics* installation developed for this dissertation, as they find out that it does not receive their input, use this feeling of betrayal to consider why the joy and engagement with this object existed despite the lack of real, mechanical, systems to interact with?

To an interested eye, there is an immense body of work regarding computer interaction, human-machine interaction, and the sociological, psychological, anthropological roles and mechanisms in the interactions between digital media and their audience. There are many practical examples, works that embody both a theoretical exploration of this theme and a constructing or deconstructing of practical examples, focused on analysis centered on marketing, psychology, computer sciences, communication sciences and art theory.

We propose, then, a two-parted work that deals with the issue by creating a practical project which aims to utilize the knowledge in this area to test it fully by working in its reverse. While projects of interactive sound installations which try to develop more precise ways of creating an engaging, interesting and fully interactive artistic piece are common, we will attempt to create the feeling of interactivity while there being none. We will also attempt to retain the user's engagement, creating a project whose aim is to deceive the audience.

In doing so, it is hoped that new insights into the various theories of interactivity are created, strengthening the existing body of work by showing that by applying such knowledge to even something non-interactive, one can create a semblance of it which would provide new tools for building truly interactive systems.

We will attempt to achieve this by developing and presenting an original installation, while describing the process of its construction and public demonstration, grounding the design choices in already established theories of interactivity. This installation will be advertised as fully interactive, allowing the user to test out this interactivity and be deceived of its presence. The success or failure of this ruse will be noted and analyzed to determine where the points of engagement work and where they stop working.

Prior to this, however, we must define terms and explore the theoretical landscape. One of the biggest challenges presented is how the term "interactivity" has had its meaning removed or weakened by its over-use in perhaps inappropriate descriptions; the public is now confused over what it signifies, and attempts to create a non-interactive installation that is marketed as interactive may prove overly successful, especially if reactivity is present in the piece, as the audience may largely not be able to distinguish between an interactive and a reactive work. To limit the effects of this misconception, led by the turning of "interactivity" into a marketing buzzword, the installation will be as non-reactive as possible, as well as non-interactive.

To build these projects, we will explore terms like "creativity", "randomness", "data generation" and "form", and their importance in creating an experience that makes the user feel like they can communicate with the machine, which apparently reacts to input in interesting an unexpected ways.

Finally, we will detail the design and construction of a prototype installation and a full installation where little to no human-system reactivity is present. The knowledge gathered by the previous analysis of the state of the art and related examples will inform the design decisions taken in the creation of these installations. Since they have been presented in a public context, not only will we analyze how these objects were built but also what the reactions to them were by the testing volunteers.

Lastly, we will gather all the lessons learned in the study of interactivity and the building and testing of the example installations in a simplified list of tools a creator can use to create the feeling of interactivity in their work, even if their system is fully interactive and reactive.

2. Interactivity

Before engaging in the intended project ahead, we must define important terms, to decrease misunderstandings and to allow us a clear understanding of the separate mechanisms we will learn.

We'll attempt to describe "interactivity" in a way that is helpful for the developing of interactive (or perceptibly interactive) works of art, focusing especially in separating it from the concept of "reactivity". The present importance of this distinction will also be debated. Before we challenge these concepts, we must understand their meaning and their use in common language versus their use in the specialized groups that work with interactivity - the common audience versus the common creators. To start with, we will explain that, to achieve an interactive system, we will require (1) gathering of input, (2) analysis and processing or otherwise use of input, (3) and output of the result in a (4.1) mostly unpredictable, (4.2) creative and (4.3) valuable way. An input is required, or there would be no contact with the user, a basic need for interactive systems. There also must be some process that utilizes that input, be it data-driven or rule-based, "whether the system's behaviours, choices, and ultimately its creations are generated by the system itself or are based on data external to it" (Carvalhais, 2016, p. 180), or we'd be simply repeating the user's input, creating a responsive system which holds no surprise to the audience. We need an output, or the user would not be aware of any work done by the program and said output must be recognized by the audience as something valuable - creative and unpredictable - or they will not accept the output as art, dismissing any technical interactivity we may have placed in our system.

"Creativity", then, is the first step to understand interactivity. The audience is a key element to think of when creating art, particularly artistic objects that engage with the user in the way we need to, and, therefore, must be the target of particular care and consideration in the creative process. While the creator may hold on to the technical and mechanical processes that may make their design capable of interactivity, if nobody but them are able to experience that interactivity then the possibility of interactivity has not granted them an assurance that their work will be portrayed, used and seen as interactive by an audience that doesn't have knowledge of the inner workings of the system. The main way to guarantee that at least most people will recognize the work as interactive, prompting a deeper exploration of the system's relation to the user, is by outputting objects that appear creative - one must aim for the installation to appear to have a human controlling the input processing and output, much like the famous Mechanical Turk, which presented itself as a machine while actually having a master chess player hiding inside of it.

We must then take a look at data, or where the input comes from and how the processing of said input into a valuable output is made. This is a very important part of our goal of creating a false interactive system, as input will not be provided, forcing us to think of ways around this lack of data; this knowledge will also help a creator of truly interactive systems, as creating the feeling of responsive input helps creating engaging input devices.

The way this data is created leads to another problem - how to organize it. Here comes one of the most important methods of building creativity; while in a truly interactive system, part of the feeling of creativity comes from the user itself, as they are human and therefore transpire creativity when they engage with the system which inevitably must show results in the output, in a non-interactive interactive system one must in one hand predict possible inputs and on the other compensate for the inevitable flaws in these calculations.

Lastly, we must also consider the importance of choice, its relevance to the medium we are trying to work with, and its relationship to interactivity itself. While it seems clear that an interactive system must also be reactive - able to receive and process input - some media seems to challenge that notion by being included in a genre where interactivity is paramount - notably, videogames.

By the end of the chapter we will have new tools to help us build interactive and falsely interactive systems.

2.1 Defining creativity

> *To explain creativity, we first need to agree on what it is, and this turns out to be surprisingly difficult. All of the social sciences face the task of defining concepts that seem everyday and familiar. Psychologists argue over the definitions of intelligence, emotion, and memory; sociologists argue over the definitions of group, social movement, and institution. But defining creativity may be one of the most difficult tasks facing the social sciences.*

R. Keith Sawyer (2012, p. 7) begins this way his definitions of creativity on his book *Explaining Creativity: The Science of Human Innovation*. The task of not only defining but understanding the mechanisms and social roles of creativity and creative works is a monumental task that branches into psychology, sociology, anthropology and human-machine interaction, not to mention various artistic disciplines and genres. For this dissertation, however, the topic of creativity is a central one, as understanding how creativity is perceived, its origins and its definition, is crucial to create an interactive system, one that suggests to the user that the machine has some human hand in how it processes data, that human hand being perceived creativity.

We will not attempt to portrait a complete, fully nuanced and exhaustive picture of the vast range of theories of creativity, as such knowledge will not be strictly necessary for the construction of non-interactive systems that appear interactive and, therefore, creative. To build such objects, we require only focus on the most useful definition(s) of interactivity, its role in human-machine interaction and how to create the perception of creativity so as to convince users of this target installation's ability to take input and respond to it, despite such processes not being present or being present in a very limited capacity.

The books *Artificial Aesthetics* and *Explaining Creativity: The Science of Human Innovation*, by Miguel Carvalhais (2016) and R. Keith Sawyer (2012) respectively will offer a guide to this exploration of the different ways to define creativity, as they sum up the different theories of creativity, exploring each of them in depth. After this analysis we will then settle on one theory, or unification of theories, that we will use for the construction of the proposed installation.

It is fairly uncontroversial that creativity requires originality, as creative action is one that necessarily aims to create something new and unique in some form - "creativity is indissociable from originality" (Carvalhais, 2016, p. 80). The level of originality may vary; not every aspect of the work needs to be new - we may consider a symphony composed in the 20th century as creative, despite the symphonic form having existed for centuries before, for example. The meaning of originality, however, needs further clarification.

We must detect different paths where original thought may exist. We can understand it from the audience's perspective, meaning original thought must be historically new, or from the creator's perspective, where even if the composer creates a piece identical to a previous work by another composer, it is original if this was not intentional, if by chance the new work is similar to the old (Boden, 2004). Boden (2004) presents us with an additional definition, closer to the audience, stating that "if, by some miracle, a composer had written atonal music in the sixteenth century, it would not have been recognized as creative. To be appreciated as creative, a work of art or scientific theory has to be understood in a specific relation to what preceded it..." (p. 74). This will tie in with our exploration of form, of the way data is organized into more or less recognizable forms - if the general audience cannot identify a human hand in the creation and organization of data in a work of art, they will not see it as creative, even if, by some other definition, it is; this is particularly important in the current setting, this dissertation's goal to help in the creation of artistic objects that can convince the audience of something that isn't there, our main objective is for the audience to recognize interactivity and, therefore, creativity.

Without committing to a specific definition, or even suggesting our own, as the one true meaning of the term, we will initially use this last reasoning, as it will be more helpful for our goal.

Originality is, as we discussed, inevitable when creating a system capable of creativity (or of giving the impression of creativity to the unknowing audience). While the system's data, the individual bits of information, must be original and clearly new to the users, there is a need to organize them into a recognizable style. This can be done at the generation level, by creating original and interesting data from the start, at the organization level, by arranging random or unpredictable information into familiar shapes and forms, or by a combination of the two, where a recognizable data generation algorithm's contents (using a tonal scale, for example) are organized into a form that can be understood and predicted by an audience (by organizing it into a sonata, for instance). If the data generated by the system is not clearly seen as creative, then an organizing process may be used, something that demands an aesthetic criteria which give the impression of more purposeful behaviors instead of random ones. In this case, coherence is extremely important to increase the predictability and therefore the ability of the audience to recognize these forms, which can be achieved by adding a system of retrospection that can analyze previous decisions and act in similar ways, without being too soft, reaching nonsense or too strict, which would lead to cliché and exaggerated repetition (Carvalhais, 2016).

This topic also touches on the subject of artificial intelligence. As we aim to create a system capable of creativity, we must question its level of humanity, as a computer perfectly able to simulate human creative methods would arguably reach strong artificial intelligence. We can differentiate the two levels of artificial intelligence by placing the dividing line in "human-like intelligence, or as Carvalhais (2016) explains, "strong artificial intelligence seeks to develop general purpose systems that match or equal the intelligence of humans" (p. 84). Of course, current state of the art in the study of intelligence and creativity still fails at giving us a clear understanding of these phenomenon, which blurs the line between strong and weak AI. This machine would not have a strong AI, as explained by Carvalhais and by John Searle's Chinese Room thought experiment (1980, p. 418), as follows:

> *Suppose that I'm locked in a room and given a large batch of Chinese writing. Suppose furthermore (as is indeed the case) that I know no Chinese, either written or spoken, and that I'm not even confident that I could recognize Chinese writing as Chinese writing distinct from, say, Japanese writing or meaningless squiggles. To me, Chinese writing is just so many meaningless squiggles. Now suppose further that after this first batch of Chinese writing I am given a second batch of Chinese script together with a set of rules for correlating the second batch with the first batch. The rules are in English, and I understand these rules as well as any other native speaker of English. They enable me to correlate one set of formal symbols with another set of formal symbols, and all that 'formal' means here is that I can identify the symbols entirely by their shapes. Now suppose also that I am given a third batch of Chinese symbols together with some instructions, again in English, that enable me to correlate elements of this third batch with the first two batches, and these rules instruct me how to give back certain Chinese symbols with certain sorts of shapes in response to certain sorts of shapes given me in the third batch. Unknown to me, the people who are giving me all of these symbols call the first batch "a script," they call the second batch a "story. ' and they call the third batch "questions." Furthermore, they call the symbols I give them back in response to the third*

batch "answers to the questions." and the set of rules in English that they gave me, they call "the program." Now just to complicate the story a little, imagine that these people also give me stories in English, which I understand, and they then ask me questions in English about these stories, and I give them back answers in English. Suppose also that after a while I get so good at following the instructions for manipulating the Chinese symbols and the programmers get so good at writing the programs that from the external point of view that is, from the point of view of somebody outside the room in which I am locked -- my answers to the questions are absolutely indistinguishable from those of native Chinese speakers. Nobody just looking at my answers can tell that I don't speak a word of Chinese. Let us also suppose that my answers to the English questions are, as they no doubt would be, indistinguishable from those of other native English speakers, for the simple reason that I am a native English speaker. From the external point of view -- from the point of view of someone reading my "answers" -- the answers to the Chinese questions and the English questions are equally good. But in the Chinese case, unlike the English case, I produce the answers by manipulating uninterpreted formal symbols. As far as the Chinese is concerned, I simply behave like a computer; I perform computational operations on formally specified elements. For the purposes of the Chinese, I am simply an instantiation of the computer program.

Searle's experiment divides a human mind and a computer program by the person's ability to understand the stories, as opposed to simply translating them and providing an appropriate answer by use of a program with syntactic comprehension of the words and phrases it is provided with, but not their semantics, their meaning. A human mind understands the stories, a computer formally processes them, according to Searle (1980). This divides a strong AI from a weak AI as well - a strong AI understands the stories, a weak AI formally processes them.

In 1984 he provided a formal logic version of this argument that may be understood more easily (pp. 39 - 41):

1. Brains cause minds.

Now, of course, that is really too crude. What we mean by that is that mental processes that we consider to constitute a mind are caused, entirely caused, by processes going on inside the brain. But let's be crude, let's just abbreviate that as three words – brains cause minds. And that is just a fact about how the world works. (...)

2. Syntax is not sufficient for semantics.

That proposition is a conceptual truth. It just articulates our distinction between the notion of what is purely formal and what has content. (...)

3. Computer programs are entirely defined by their formal, or syntactical, structure.

That proposition, I take it, is true by definition; it is part of what we mean by the notion of a computer program. (...)

4. Minds have mental contents; specifically, they have semantic contents.

And that, I take it, is just an obvious fact about how our minds work. My thoughts, and beliefs, and desires are about something, or they refer to something, or they concern states of affairs in the world; and they do that because their content directs them at these states of affairs in the world. (...)

CONCLUSION I. No computer program by itself is sufficient to give a system a mind. (...)

CONCLUSION 2. The way that brain functions cause minds cannot be solely in virtue of running a computer program. (...)

CONCLUSION 3. Anything else that caused minds would have to have causal powers at least equivalent to those of the brain. (...)

CONCLUSION 4. For any artefact that we might build which had mental states equivalent to human mental states, the implementation of a computer program would not by itself be sufficient. Rather the artefact would have to have powers equivalent to the powers of the human brain. (...)

Weizenbaum (1976), similarly, separates these two modes of artificial intelligence into *performance mode* and *simulation mode.* In *performance mode*, the machine attempts to seem intelligent, merely to convince the user (Weizenbaum (1976) gives the example of the early years of flying, when "virtually all early attempts to understand flying or build flying models were based on imitating the flight of birds" (p. 164)), while in *simulation mode* the machine simulates not only the appearance of intelligence but also the whole human mind.

For the purposes of this dissertation, and the building of its accompanying installation, perhaps it is better to take an approach close to Turing's, with his famous Turing test. This test functions through an analysis of the language processing capabilities of a machine, as well as its conversational ability. While an understanding of the semantics of words, functions of phrases, irony, sarcasm, emotional charge, cultural markers and other variations define the human understanding and use of language, as explained by Searle, a machine could pass the Turing test without these skills, so long as a human cannot differentiate between human or machine output. This machine would, in certain, perhaps more practical definitions, fit for other uses, not be considered hard AI, unlike in Turing's definition. Since the aim of this dissertation is to deceive an audience into attributing intelligence and the ability to be creative to a machine, it is, then, best to utilize a definition based on this capacity to create in an apparently human-like way as our working definition, judging our artistic object's by that description rather than Searle's.

We will then, according to the Turing test, describe our installation by its ability to deceive an audience into believing a person (the users themselves) created the output, rather than a computer. Our system needs only give the impression of creativity to be, in the practical sense we apply here, creative.

To demonstrate why this choice was made, we can use the example of the ELIZA, a system developed by Joseph Weizenbaum (1983) that attempts to perform the role of a therapist using only conversations via a computer, as if a human was on the other side. This machine has only weak AI, in his definition, or is in *performance mode*, as it does not fully understand the human input that receives. It processes language, the syntax of phrases, to output something human-like without fully simulating the mind. Weizenbaum noted that his secretary, despite knowing the inner workings of the system, began projecting meaning into its output, behaving towards it like it was human, something that was later called the *Eliza effect*.

For most audiences, a system that *performs* creatively and originality so as to deceive its users is indistinguishable from a hard AI that fully *simulates* these processes in a human way. While weak artificial intelligence may be more than enough to deceive most users, a higher level of intelligence, complexity, and versatility in the systems that are created would be, unquestionably, an advantage, as the more a computer approaches human-level thought, the more it can create and organize data in a more recognizably human way. However, it is clearly not a requirement for the creation of *machine creativity* - "computational systems that are, or appear to be, creative to some degree" (Boden, 2004, p. 1), changing only in the degree of number of people deceived and intensity of this illusion.

Since, for an audience, a system can be seen as creative even when using weak artificial intelligence, and since our aim with this dissertation and project is to deceive as many users as possible, we should try to increase the intelligence of our system so as to place it between something that can *perform* creativity and something that can *simulate* it.

But why did J. Weizenbaum's secretary feel enthralled by his system, even thought she knew its inner workings?

Clearly, for her, this machine had passed the Turing test in some occasions, exploiting the psychological phenomenon of confirmation bias, where the context played a key role. Questions posed by therapists to patients always have meaning, an attempt at explaining or framing a problem in a certain way. A user of the ELIZA would, then, assume significance to questions the system presented, even if vague, projecting their own expectations to the computer's output. In Weizenbaum's words (1983, p. 26):

> *If, for example, one were to tell a psychiatrist "I went for a long boat ride" and he responded "Tell me about boats," one would not assume that he knew nothing about boats, but that he had some purpose in so directing the subsequent conversation. It is important to note that this assumption is one made by the speaker. Whether it is realistic or not is an altogether different question. In any case, it has a crucial psycological utility in that it serves the speaker to maintain his sense of being heard and understood. The speaker further defends his impression (which even in real life may be illusory) by attributing to his conversational partner all sorts of background knowledge, insights and reasoning ability. But again, these are the speaker's contribution to the conversation. They manifest themselves inferentially in the interpretations he makes of the offered response.*

In the building of a system that attempts to create the feeling of interactivity without any or limited reactivity, we can apply similar techniques. Confirmation bias is, as we can see, a powerful phenomenon to explore to succeed in our goal.

The context where a possibly creative machine is presented to the audience is of great importance - only when the system can create an expectation of being more intelligent and creative than it actually is can the audience project meaning into the output it produces. Environments such as artistic contexts or videogames can direct these expectations towards what we desire.

When attempting to predict input the user may give to our system, this bias is also important, especially if tied to context. If presented as a game, with a clear goal or objective, the audience can be expected to attempt to reach it, giving us a tree of possible actions that will be followed in most experiences.

Creativity must be seen by the users in two key areas - their input, as they will apply their own creativity in their decisions, even if we guide these choices, and the system's output, as, in order to create a feeling of interactivity, some measure of communication with the machine must be detected, even if none is there. The system must be seen as able to take the input received and process it in a human-like fashion, altering it and using it in an apparently creative way.

Another tool a creator may use to mask the lack of real responsiveness and interactivity of their work is the notion of *comtivity*, as explained by Cope (2005, p. 27), "complexity masquerading as creativity", where the level of complexity perceived by the audience seems greater than their own capacity to understand it. It is, however, important to use this technique cautiously, as for some it may increase levels of frustration and lead them see through the illusion. This perception of complexity as creativity may come from cultural backgrounds, where audiences identify complex outputs as creative, when presented in an adequate context.

Comtivity may be used both at the data generation level and at the data organization part of the processing utilized by the system. One can create a complex algorithm in order to generate huge and complicated sets of data, a task particularly unchallenging for a computer. This data can be created beforehand, to be stored and then utilized, so that the best sets can be used to improve the feeling of a creative hand inside the system. This approach can be compared to the techniques of serial music composers who built complex matrices and algorithms to create and organize data for their music, many without the aid of a computer. It is also possible, regardless of data type chosen, to apply *comtivity* to the way information is organized, so long as it is recognizable by the audience as something valuable, which aids at the creation of a feeling of creativity, as well as interactivity.

In the next few chapters we will be exploring these subjects - methods of data generation and organization - leading up to a more comprehensive examination of the topic of interactivity, after these pillars of said state are discussed.

2.2 The importance of data

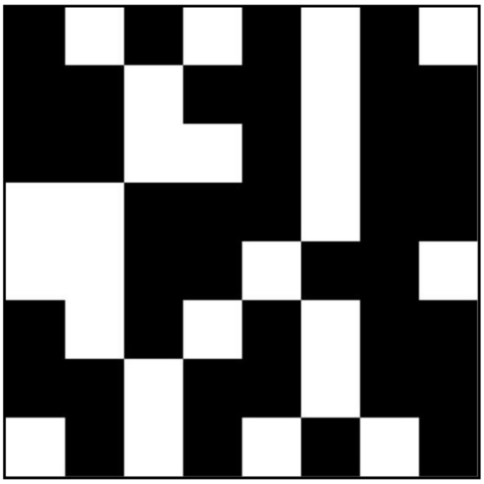
As proposed by Carvalhais (2016), himself drawing from the work of David Cope (2005) - *Computer Models of Musical Creativity* - we can organize the computational processes that develop new data into two categories - *data-driven* and *rule-based*, "whether the system's behaviours, choices, and ultimately its creations are generated by the system itself or are based on data external to it. What this classification then tries to assert is the provenance of the data" (Carvalhais, 2016, p. 180). Rule based processes create generative art, where all the data that the system utilizes is produced by the same computer, containing all processing within itself, via algorithms, effectively being a self-contained system. Data driven systems, whoever, create data without the use of internal algorithms or mechanics but by processing existing information - transforming image to sound, for example. The system takes data it has stored, can easily retrieve or is fed by input (camera, microphone, keyboard) and alters it via internal mechanics; there is, then, a large difference between data that is created via algorithms and that that comes from an algorithm-processed collections of externally produced information.

As we shall attempt to create a system with no responsiveness, we can fall into any category, or even construct a hybrid of the two, a system that utilizes both data captured by, for example, a camera, and internal algorithms to construct an output. This dissertation's project seems to fall more heavily into the *data-driven* category, as it utilizes both pre-recorded video files, where pseudorandomness was applied, that it directly outputs, but also a real-time processing of the images to generate sound. The size and amount of videos and the complexity within them, while being completely deterministic (recording a pseudorandom system turns the recordings into data, which is predictable and unchangeable), will provide the sense that the system is processing input, as if those images were being generated in real time by the inputs provided by the user which will, of course, not be registered by the system itself. However, there are many ways of designing a non-responsive system that utilizes different types of data generation.

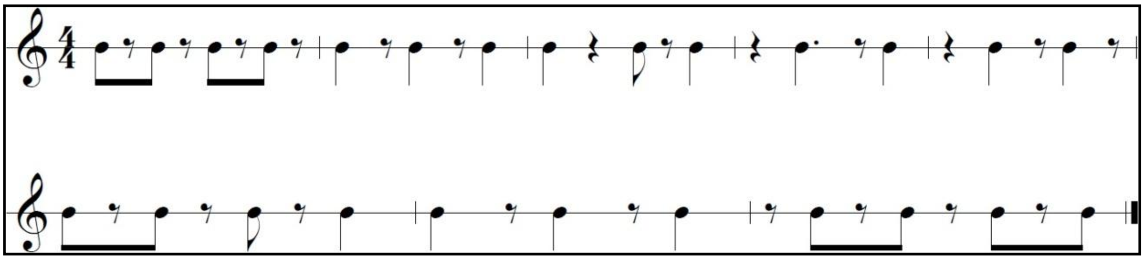
For a moment, it is important to come back to the working definition of interactivity, as we remind ourselves of a most imperative aspect of it - a result that feels mostly unpredictable. There is, then, the possibility to utilize *data-driven* or *rule-based* systems to store or generate data to be later processed and utilized in the course of the installation, as long as said information or processes are applied carefully and with intent. It is important, firstly, to define randomness, as well as pseudorandomness, to understand what we can or cannot do, particularly when the aim is to create randomness on request, as is often the case with systems that do not process input and have, therefore, no way of being sure what the user will do. We can utilize Lorenz's (1995) definition, as a sequence where "anything that can ever happen may happen next" (p. 7), which contrasts with the hard deterministic view that affirms that only one thing may happen next in a sequence, and that enough data about it would allow us to predict it. This is, in a practical sense, true for computers, which are deterministic systems, which therefore forces us to regularly speak of pseudorandomness within this medium. Pseudorandomness is, then, practical randomness in the sense that, if well constructed, a process can create sequences of data in a way that ensures that all tools at our disposal are unable to find patterns or signs of determinism on it. Since this dissertation aims to further the understanding of interactive systems through the perception of the user, we will work with the definition that a good pseudorandom process is created when its output is indistinguishable from absolute randomness to the audience's discernment. In this way, we can limit the amount of discussion on the nature of true randomness and determinism and focus on the task at hand by settling on a working definition that suits our needs in attempting to create the feeling of interactivity where there is none. Ignoring the discussion on whether determinism applies to all processes, we will focus only on computing processes, as those are demonstrably deterministic.

We concluded, in the previous section, that originality cannot be the only defining feature of creativity, but that it is needed in order to call a work creative. In a system that attempts to create the feeling of interactivity - and therefore creativity, as we will discuss - the creation of new and interesting data is paramount. Since, in the present project, no responsiveness is included, we must use or create information within our system, as no other systems or inputs are available for us to draw from.

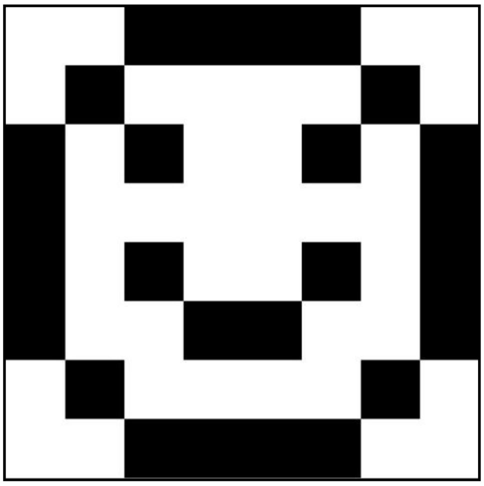
To create a *data-driven* system, we must collect and curate the data that we will utilize. This approach has a clear advantage over *rule-based* systems - we can choose data that is already recognizable as creative to jump-start that feeling in our user. Of course, the mechanisms that we use to transform that data into something new may change that nature dramatically but that advantage is still in our side, if we choose to use it; much in the same way a sound designer prefers high quality recordings, even if their intent is to create a *low-fi* or distorted effect, due to the increased range of opportunities that extra quality allows them to explore. As an example, consider



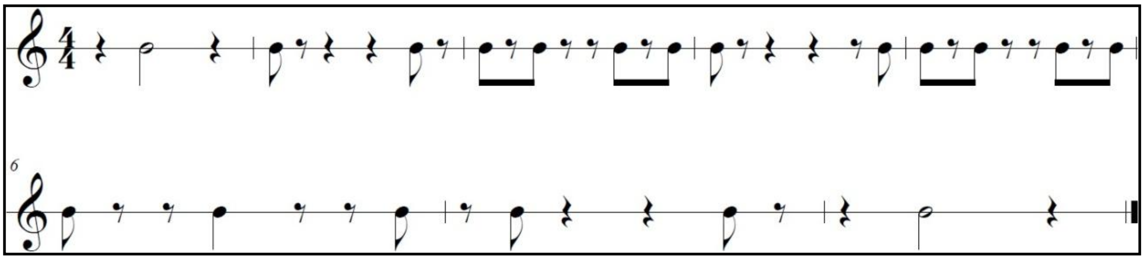
Img. 2 - 8 by 8 canvas of random 1 bit deep pixels.



Img. 1 - Musical representation of image 1.



Img. 3 - 8 by 8 canvas of purposefully picked 1 bit deep pixels.



Img. 4 - Musical representation of image 3.

images 1, 2, 3 and 4. 1 and 3 are 8 by 8 canvas of black and white *pixels*, the first image being created by random generation, while the second representing a smiling face. Following, is a rhythmic representation of those images, where a black pixel represents a note, while a white pixel represents silence. The first example can represent, then, a *rule-based* system, as it was the computer that created this pseudorandom result - an algorithm-based image - while the second is an image created by a *data-driven* system - an input of a human made image. Judging by the images alone, one would recognize the second image as more creative than the first, as it is possible to recognize the human hand in the creation of that sequence of *pixels*. Listening to the rhythmic result only, it would be hard to recognize a human hand in the creation of one example over the other, as the system of patterns function differently between visual and auditory cues - a smiling face's pattern is easily visually understood, while auditory patterns revolve around repetition. There is, however, an easier way to connect these two, particularly for a multimedia system, by displaying them at the same time or as the result of the other. We can establish coherence and extend the perception of creativity present in the smiling face image, to the auditory results of the processing of said image if we can show the user that these two are linked, granting the rhythm that would otherwise be overlooked a more clear creative origin.

Using a *data-driven* system that displays or processes what is seen as creative, like the smiling face, can be a useful tool when constructing an object that will suggest to the user the building of recognizable patterns. In certain settings, we can predict the wishes of the user and provide them with adequate output data at the correct times to create the feeling that they were the creators of said pattern. Utilizing a *data-driven* system has clear advantages towards this method, as all information is already planned and understood by the creator, allowing for a fine tailoring of the user's experience and expectations, something that could fail more often with a *rule-based* system, particularly a complex one. However, a *rule-based* system could potentially respond to unpredictable actions by the user, maintaining coherence throughout their experience, even if that comes at the cost of possible lack of control for the creator.

In order to create the most interesting and effective kind of data for our purposes we must, then, build a system where the user will follow predictable paths. To enhance the immersion by the audience, however, they must not feel led by this system, they must believe that their free will is being unrestricted, they must assume they are deciding by themselves and that they are unpredictable. One of the best ways of achieving this is by presenting a game, as this genre of interactive media often presents a final goal, an objective that all users much achieve to win the game (although it does not necessarily demand an end goal, as will be discussed in chapter 3.5).

As we discussed previously, creativity is a pillar of interactivity - the machine must be seen as capable of intelligence, of showing artistic intuition in its choices when processing or creating data. Since we do not have input in our proposed project, we must create or store that information for use in this hopefully creative output.

A *rule-based* system of immense popularity, due to its ease of use for digital machines, is randomness, or pseudorandomness. However, the creation of random data "by itself may very well be insufficient to achieve creativity and to produce interesting results" (Carvalhais, 2016, p. 95). As mentioned before, however, randomness, in this case the specific use of randomness in the creation of data "needs to be recognized and evaluated before it can be either psychologically or socially valuable", according to Carruthers (2011, p. 439), which ties in with our next chapter - how the organization of data into recognizable forms creates the "value" required for a system to be seen as creative and, therefore, capable of dialogue with a human user who attempts to interact with the machine. We can see that data is intrinsically linked to form; in fact, how we generate data is as important as form, as data is the organization of values. While we are discussing data, many of the points pertinent to this chapter will be important for the next, as the way data is created is connected to the way it is ordered.

2.3 The importance of form

Organizing complex sets of data into familiar and easily understandable collections gives the users a guide, an index, to the work, freeing them to delve into more specific interpretations and interactions with the possibly seemingly random data points. This marks the difference between a purely original data creation process and a creative one, as the audience can recognize elements which organize the data that they now assume as being equally deliberate.

The creation of data, discussed previously, while something important to the creation of an interactive (or apparently interactive) system, is secondary to the way this data is organized, the way it is presented to the audience and the user, or its form. While understanding the difference between *data-driven* and *rule-based* systems may be important to the creator, these distinctions will be less important to the audience, especially if the processing of such data creates indistinguishable outputs. What truly changes the perception the users have of the artistic piece is the way this data is organized.

We can see this importance in the study of the history of art, specifically music's history, as music was often used in connection with dancing. We have created terms like Chaconne, Gigue, and Sarabande to separate types of music differentiated by their rhythmic patterns, time signatures, position of strong and weak beats, as well as cultural use and significance. What distinguishes these pieces of music is, therefore, the organization of their musical notes, with a strong basis on repetition and predictability of rhythm, elements which were vital for dancing, particularly in those cultural contexts.

In fact, predictability is one of the most useful tools when controlling the levels of tension of a piece of music, and the use of said tool can create an interesting game of tension and release. The use of sets of data with patterns that are recognizable and predictable can lower frustration and give the user a sense of control, as we will see in following examples, along with the use of this technique in the creation of the prototype and installation, further on.

Predictable patterns can take two shapes, one of repetition and one of recognizable data. Image 3, the smiling face, is an example of the latter, as the organization of data into an object that the user knows, particularly in the context of an interactive piece where output is influenced by the audience, gives them a sense of control that is extremely important for the creation of the feeling of interactivity, our main goal in this dissertation. In this context, the use of repetition is less useful, as it is not a solely human characteristic - while only advanced artificial intelligence is able to create recognizable and familiar patterns, without assistance, repetition is something any machine excels at.

Returning to the example of genres of music with predictable organization, like the Sonata, if we can utilize the audience's knowledge and bias towards recognizable patterns, we can more successfully predict their actions towards our artistic piece; being able to give some guidance allows us to craft an experience knowing with more certainty the path of our audience. If we can suggest to the user that they are to, for instance, write a piece of music in a sonata form, we can possibly disregard their input and have the system craft this piece, which the user will assume is their creation, as their goal and expectations were met. The flaws in this prediction - we know only that the user is likely to want to create that suggested structure, not the musical notes, rhythms, length or any of the specific choices they make - fit with the feeling of interactivity we want to give to the audience as a goal, as a system that apparently does not respond to the input in a direct manner can be assumed to require some deeper interactivity and play. The user, facing this system, may regard the difference between their input and the machine's output as being the computer's hand in the creation of this hypothetical piece; reaching the end of the experience, they will recognize the organization of data as something they aimed towards, possibly attributing this recognized pattern to their own choices, understanding that the computer had some, but not complete, influence over this result.

Organization of data, then, can be the difference between a confused audience and one that feels in control. For the purposes of the creation of an interactive piece, or one that aims to create the feeling of interactivity, creating recognizable patterns is more valuable than giving the audience what can be seen as random data. While the generation of information can use pseudorandomness as a method, it is important that the audience does not feel like the output is fully random, as their choices in input will certainly have an aim and purpose.

Audience expectation and management of that expectation is, therefore, the priority when deciding not only what type of data creation methods to use, but also how that information will be processed and organized. We can use this organization to create a path for the user, allowing us to predict their choices and respond accordingly. In accordance with the theme of the installation *Behavioral Economics* (the practical project that was developed along this dissertation, the documentation of which will be present in following chapters), the audience is, then, unknowingly led by the decisions the creator had, following a controlled corridor of limited choices, suggestion and exploitation of human psychological mechanisms, while always feeling at least somewhat in control.

It is in this realm that the creation of installations has a clear advantage over other interactive media, as they belong in a context that jump-starts these bias and expectations into our audience. While a video-game may be played in various forms by many different people in many different contexts, installations are generally placed in more directly artistic or so called "serious" environments, where the audience's background is narrower than in other more so called "popular" contexts. Due to this somewhat elitist separation of works of art into groups of mainstream audiences and the selected few who have the will or privilege to engage in art that is more hidden and reserved to those who understand the coded language of the group, a "Great Divide" between high culture and low culture described by Andreas Huyssen (1986), works of art placed in this context give the creator an advantage, as they can understand the group's language and the performative ways they engage with the artistic object. Installations, however, are somewhat within the blurred line that separates these two cultural groups, which means that while a general path can be trusted to be followed by most audience, many will not engage with it as predicted.

In the case of installations, these are placed in this "high culture" area, to be consumed by people who have, generally, a deeper understanding of various forms of installations, and of diverse tools of interactivity. They are also more prone to accept an explanation of the inner workings of the installation, when provided, as this understanding holds cultural capital, being important in the standing of the user with the rest of their sub-cultural group. Simply placing a work of art in this context gives us considerable benefits over other environments, as a simple, if vague, explanation of the system's mechanics will be more readily accepted, not to mention how this group is generally more prone to engage with more unconventional works.

If the intended interactive media genre is closer to video-games, two groups stand out - the indie game consumers, who favor "walking simulators" and so called "art games" more heavily, and the mainstream, "AAA games" players, who hold more strict definitions of interactivity and demand mechanical clarity and high responsiveness. This second group will pose a bigger challenge to the creators of non-interactive media presented as interactive, as a basic feeling of responsiveness is mostly required for there to be acceptance of the pretend interactivity present in the system. The data created for or in this context must be carefully organized into recognizable forms, and levels of frustration must be lowered by using various methods discussed in this dissertation.

While these divisions are important when considering the shapes our data will form into when presented in different contexts, it is necessary to point out that these groups are not clear-cut. Many people from a group participate in events aimed at others, and even those in certain cultural environments will behave in unpredictable ways. One must always create a system that can stand scrutiny from every group, as one single unsatisfied user who suspects or discovers our artistic object's lack of real interactivity can share this dissatisfaction with everyone in the room and beyond. Any creator should strive to have their message understood (even if the aim is for the audience not to understand the real mechanisms in their work) by most, especially in the context of interactive media, as the notions of creativity and interactivity, as discussed, are always dependent of the audiences' acceptance and recognition of these characteristics.

In fact, the importance we place on form comes precisely from how necessary the audience's perception is, particularly for the proposed installation project that accompanies this dissertation. Form is used to organize data specifically so that the users can see some measure of creativity and therefore interactivity in the data it outputs as it relates (or apparently relates) to the input.

As previously discussed, randomness cannot solely be used to produce a feeling of interactivity. It needs to be organized into recognizable patterns so as to be seen as a coherent output instead of randomness that ignores user input. We can use the example of Mozart's *Musikalisches Wurfelspiel im C* to demonstrate this importance.

This piece presents the player with a score as well as instructions to roll some dice. The result of said dice will dictate the path that the player must take when playing the piece. Randomness is, therefore, clearly used in the form of the dice, yet the result is coherent, tonal and musical, "the pre-composed bars supply the system with order and form, while the throws of the dice inject it with randomness and novelty" (Carvalhais, 2016, p. 95). This order was achieved by limiting the effects of randomness, and by creating the data in such a way that any combination of pieces will result in a coherent output.

In this example, randomness was used at the organization level, arranging data that was purpose-built for that experience. We can see similar results if randomness in the creation of data is organized and restricted into our desired realm of possibilities - processing the results of a random note generator by organizing the notes into tonal harmonic structures and melodies, we can create a coherent piece of music recognized by the audience as such. If we were to do the opposite - create a coherent set of data, later to be organized into a random arrangement, there would be no, or little, output seen as creative or interesting, demonstrating the importance of form.

The audience must, then, understand the data they are presented with as an organized group and not as clearly and fully random (or even pseudorandom), as "messages that are totally random have no depth, although they may certainly be very complex" (Carvalhais, 2016, p. 95). This ties in with our previous example of the *Eliza effect* - even if the answers of said machine were random, if organized into grammatically correct and with understandable syntax, due to the context they could be perceived as having intent. In fact, giving that feeling of intent is the prime function of form, of organizing data sets into coherent outputs. If the users can see the system's output as having a clear objective, this intent will aid the perception of interactivity by reinforcing the expectations that the machine does communicate and interactive with its users.

However, full randomness in every step of the process can still create a feeling of intent, order, creativity and interactivity. By sheer chance a random placement of paint droplets can produce a painting recognizable as artistic and with intent. We can, then, instead of processing order into randomly generated data sets, create restrains that can, by manipulating probabilities, provide us with a similar result. "If randomness is not totally free and unrestrained but if it is limited by constraints or probabilities, then it can more easily produce structured results" (Carvalhais, 2016, p. 97), giving users the same feeling of intent as if we had organized randomness after it was created. This still falls into the *data-driven* system of data creation, as it is a result of algorithms, and it wouldn't use full randomness, leading to more predictable outputs.

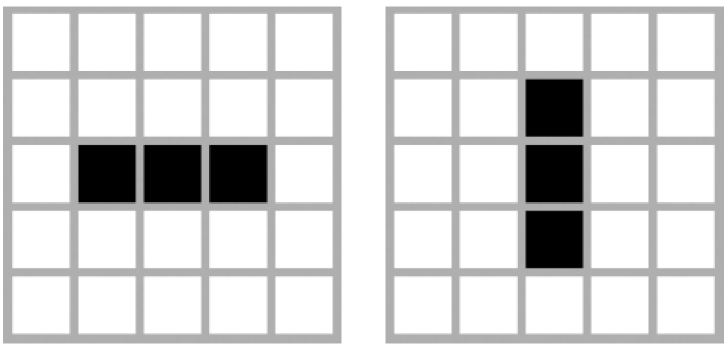
A great example of this organization via restraining randomness instead of processing already random data sets, using *comtivity* as well, is John Conway's *Game of Life*, a cellular automaton model that mimics population organization and spread in an abstract way; a player has only to set the initial conditions and the game's rule will continue forth.

The game has only four rules:

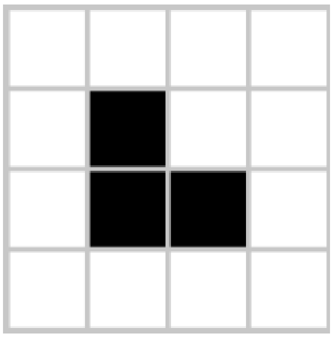
1. Any live cell with fewer than two live neighbours dies, as if caused by underpopulation.
2. Any live cell with two or three live neighbours lives on to the next generation.
3. Any live cell with more than three live neighbours dies, as if by overpopulation.
4. Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

From this, the *rule-based* system will take over whatever pattern the player has placed initially. Knowing these rules even a random initial point will organize itself into recognizable patterns and behave in a recognizable manner. The effort to create a parallel to life itself, to biological imperatives (death, reproduction) and population migration and growth aids the player to imprint meaning, as if the game was simulating life, providing a context that will enhance the experience.

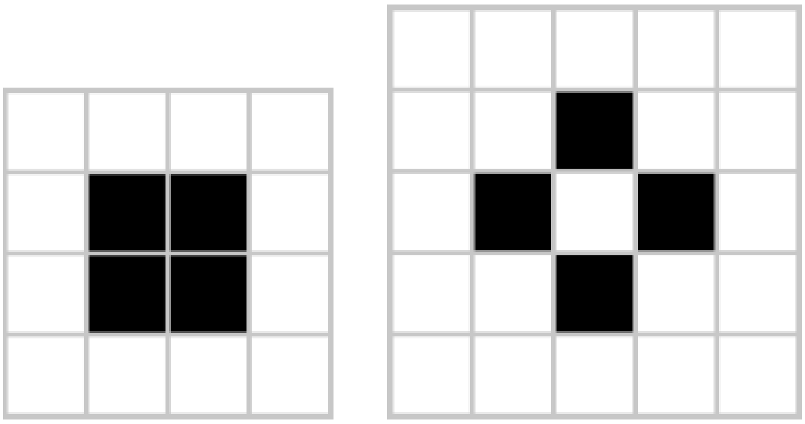
Knowing these rules and having experience with this system, a user may plan their own "world" by placing specific sets of longer lived structures. A line of three cells, for example, will create an oscillating pattern, unchangeable from its normal action as long as undisturbed. A group of four cells organized into a square will remain that way as long as undisturbed, while an L-shaped pattern will turn into a square and then remain unchanged.



Img. 5 - *Blinker*, a pattern that cycles between two positions.

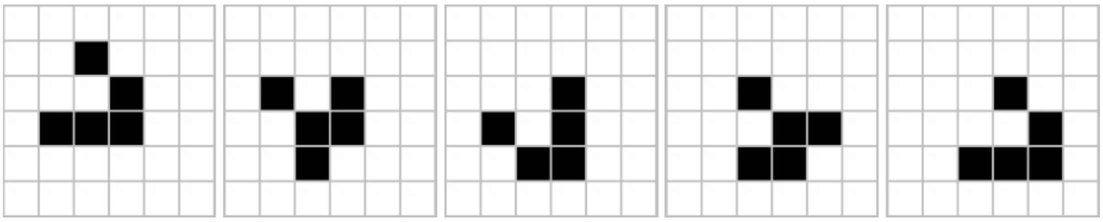


Img. 6 - Pre-block, a pattern that will always turn into a *Block* after one *step*.



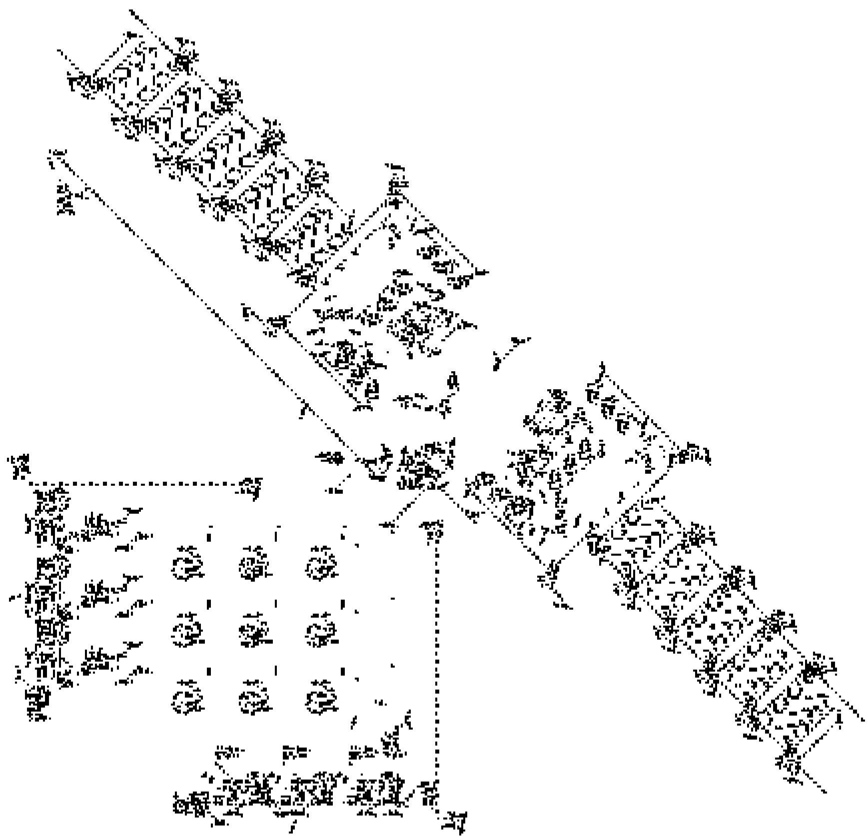
Img. 7 - *Block* and *Tub*, two fixed and unchanging patterns.

These groups will persist in the same place without evolving indefinitely, if they do not interact with other groups. Certain other patterns, however, will move indefinitely across this "world", using only the rules they were created with: in the case of the glider, each cell propelling each other by a five step pattern sequence, repeating itself and moving two blocks (one vertically, one horizontally) after each group of five.



Img. 8 - *Glider*, a pattern that cycles between five positions, moving in a direction after five *steps*.

Using some of these patterns, complex systems can be built within this system. Logic gates can be constructed, using *gliders* to send messages across longer distances and between gates. In effect, that means that Turing Universal Machines can, and have been, built using only John Conway's four rules.



Img. 9 - Universal TuringMmachine, designed by Paul Rendell (2010), accessible at: www.rendell-attic.org/gol/utm/

This shows that even simple rules can lead to complex systems. So long as we restrict the generation or organization of data, recognizable patterns may emerge, arranging even fully random data into understandable (even if possibly complex) groups and coherent output.

As we discussed in the previous chapters, form, the organization of data, is a pillar of creativity, or as Carruthers (2011) puts it, "while stochastic generation isn’t creative by itself, it would seem to be a necessary condition of creativity" (p. 439).

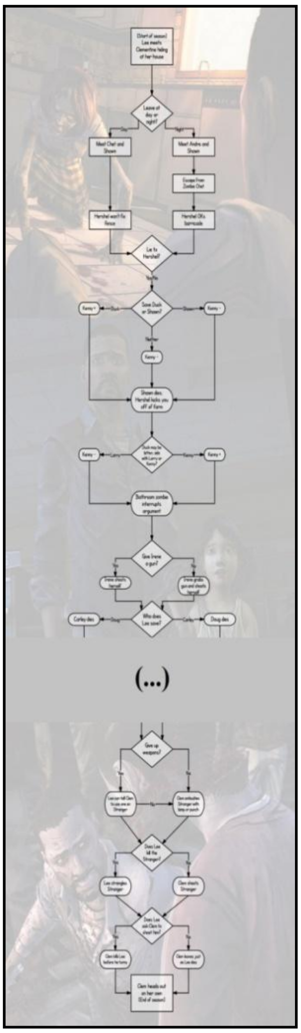
2.4 Does choice matter?

> "The choices you make (...) influence what that character becomes in your mind. Even if you will see little actually change, the act of choosing (or experiencing the illusion of choice) really does have an impact."
>
> - Anonymous (at *gaming.stackexchange.com*).

The inclusion of video-games where the player's actions have little to no real mechanical influence on the game or the progression of its story is still a hotly debated topic among video-game enthusiasts, players, developers and critics. It is easy to understand how such games can disturb our understanding of the genre itself and the expectations one forms of them; they shake the very foundations of how we define them.

Interactivity has been one of the hallmarks of video-game experiences, their selling-point. As, in defining terms, what something is may considered at least as important as what it isn't, this genre separates itself from books, movies, theater and even interactive film by the complexity of choices the user has in shaping their experience - its interactivity. Yet, video-games such as *Beyond: Two Souls*, *The Walking Dead*, *Kentucky Route Zero, Firewatch* and *The Beginner's Guide* are generally still considered games, despite lacking complexity of choice and consequence.

Beyond: Two Souls by *Quantic Dream* is certainly the closest, of the examples, to interactive movies. The game presents the player simple challenges (known as *quick-time events*) where precision and speed allow them to progress into the story. In this particular example, failing such challenges provides no in-game consequences, simply an infinite number of chances - the game and its story will not progress until such test is surpassed. After easily beating the challenge the game continues its story, with no real user choice, essentially stripping the player of essential aesthetics (as explained in the paper *MDA: A Formal Approach to Game Design and Game Research* (Hunicke , Leblanc , Zubek, 2004)), such as *Challenge*, *Expression* and, after understanding that most of the game consists of such events, *Discovery*, aspects the player expects from the genre *Beyond: Two Souls* is part of. In fact, the only aesthetics provided by this game are *Narrative* and *Fantasy*, which are also solely present in books and movies. *Beyond: Two Souls* also contains moments where the player is free to explore their



Img. 10 - Decision tree for the video-game *The Walking Dead,* by *Telltale Games*.

surroundings in a 3D environment, being given little to no challenge, choice or agency.

The Walking Dead, by *Telltale Games,* unlike the previous example, shows a non-linear story and presents the player choices on how to progress in it; depending on what the player decides, they will be taken through different paths (img. 10). "Various choices make one or two changes in dialogue and can alter how other characters treat you, but it does not change the main plot significantly" (Elise Favis -

gameinformer.com, 2015). However, those paths return to common points after diverging, resulting essentially in a linear story presented as a non-linear. We see, then, an issue similar to the first example - player's agency is removed, in a genre where it is expected. Like in the first example, *quick-time events* are common, although more challenges, similar to *first-person on-rails shooter* video-games, where the player has limited time to aim and shoot enemies in a fixed camera environment, are present.

In the *Kentucky Route Zero* example, by *Cardboard Computer*, no challenges appear, only a story and the means to follow it, which blurs the line between video-game and movies, interactive movies and books even more. The player follows a linear story, told by setting, *non-playable characters* (*NPC*s), and descriptions of their surroundings, and has no in-game control other than how much of the story they wish to engage with (by following alternate, hidden, paths), and the speed that the story unfolds in front of them. A main character is guided by the player in 3D sets, frames of action, moving in or out of those sets as the story commands. They can speak to *NPC*s to progress, or click on buttons to read a description of various items and characters. As the player picks which lines specific characters say, such choices have little to no influence in the inner workings of the game, but they may affect the player's perception of the characters and their situations, as show by this interaction where two characters watch an unspecified television program together and the player much choose the character Shannon's answer:

EZRA: What are they singing about?

- SHANNON: They're singing about travel.
- SHANNON: They're singing about going home.
- SHANNON: They're singing about hard times.

This is perhaps the example which most closely resembles theater, as intended by the developers, who inform the player of the story's divisions - acts and scenes. Tamaz Kemenczy, one of the developers, in the 2014 Game Developer Conference, demonstrates how his team took cues from and were inspired by theater, in his presentation "The Scenography of Kentucky Route Zero":

> *Since we're talking about a videogame environment and not a physical theater space, for us performer and spectator start to mean different things for us in KRZ* [*Kentucky Route Zero*]*, they kind of collapse and become one thing, simply the videogame player. Part of this collapse has to*

do how we observe, as spectators, theatrical events in a theater space and how we can observe a theatrical event in a videogame. So, in a conventional theater space, as a scenographer, you often design for the proscenium, which basically means the front of the scenery, but in a videogame. from a scenographic perspective. you can design for cinematic frame.

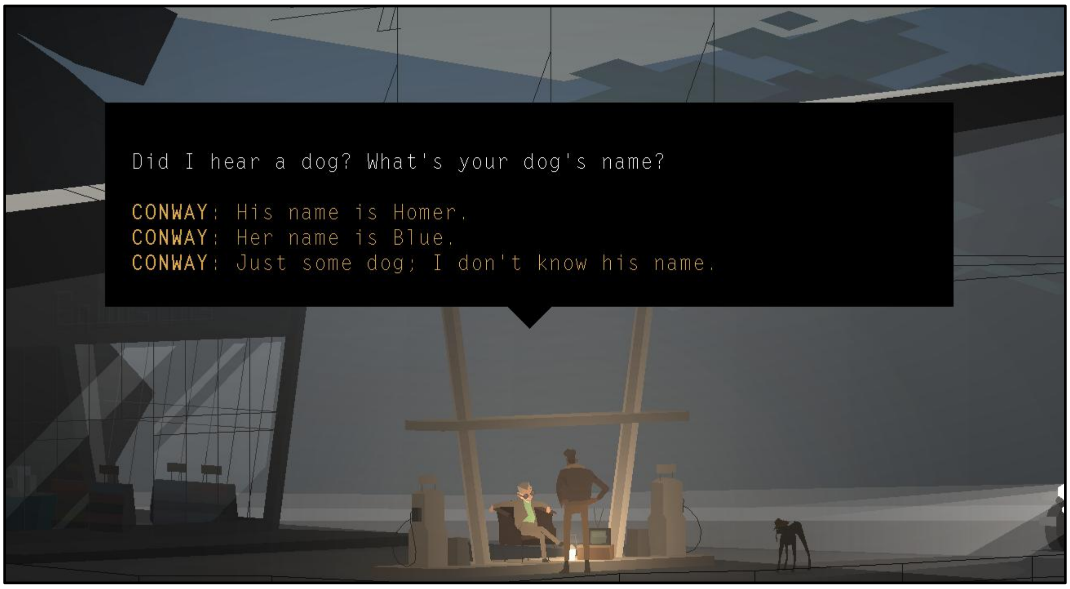
The spectator can be dislodged and lifted from the seat and can move in all directions, so the idea of a proscenium kind of changes or just drops away in some instances.

In the 2013 Game Developers Conference, Jake Eliott, one of the designers of *Kentucky Route Zero*, in his presentation "Designing For Mystery In Kentucky Route Zero", describes the process of creating this experience:

You're making software that is reactive to somebody, like how an installation is reactive to a viewer; in the context of performance it is reactive to the performer (you're doing instrument building) and in the context of a game it is reactive to the player and the simulation, and it all runs in real time.

(...)

You can see some of these similarities between these different practices kind of permeating the boundaries between game, performance and installation, like in recent games like "Proteus" or "Panoramical", you can see some of these borders kind of collapse, and in these old games like "LSD Dream Emulator" or "QQQ" or works of JODI, they start to collapse these performance videogames.



Img. 11 - Screenshot of the videogame *Kentucky Route Zero*, act I, scene I, demonstrating a dialogue bubble.

Jake Eliott even shows that his game has no, or limited, interaction, by saying that "a lot of games offer players great chances to be strategists, to be powerful strategists, but this game, *Kentucky Route Zero*, is about disempowered people and it's about not having that option of behaving strategically", which demonstrates how a lack of consequence (no opportunity to be "powerful strategists") can enhance the theme of a game.

In the case of *Firewatch*, by *Campo Santo*, the player controls one character, being allowed to explore a 3D open-world environment. In here, the story is also linear, and choices often do not create noticeable consequences. No challenges are present, only prompts by the character's one companion to explore in certain areas which allow them to progress through the story. The player simply follows a story, with no agency on how it develops, having, however, extreme freedom to explore the landscape without following the story.

In the last example, *The Beginner's Guide*, by Davey Wreden under the studio name *Everything Unlimited Ltd.* a narrator (the author, his voice and his presented *persona*) explains the user that he will take them in a journey through someone else's game, a friend named Coda, much like in a museum trip. The user walks through a short level of a game Coda allegedly created, while the narrator explains what is happening. The levels have no challenge, the user walks the path that is displayed to them, and nothing more. It is a story and a though experiment where no choice is given to the player.

With these examples in mind, we must ask why are these considered video-games? If they reduce player agency to very low levels, having their choices essentially ignored or outright refused, what still places them in a group whose defining feature is player agency and complexity of choice and consequence, if their choices do not matter?

A common argument for those who wish to expel low player agency story driven games from the video-game category draws on the importance of non-mechanical effects of choice. While one's decisions in a *Telltale* game may not have deep consequence on the in-game workings, they can shape our understanding of situations, scenarios and characters presented to us - choosing to downplay the character Conway's pain or admit its reality in the videogame *Kentucky Route Zero* may have no effect on the game character's movement speed, health or any future interactions, but it portraits him as someone who keeps things hidden for the sake of a quicker and smoother social play or as a man who admits how he feels and describes his situations with honesty. Given multiple similar choices, the player's mental representation of Conway can have surprising diversity and complexity. In this sense, the typical person-machine interaction processed at the machine level is replaced by a person processing of character traits, scene setting and problem framing.

Following this path, these games, while still incredibly close to movies, interactive film, theater or books, can be defined by how the interaction is processed not primarily by the machine, but by the player, allowing the standard video-game definition to remain intact and allowing this genre to subsist inside the label. However, one can transport this definition over to, for example, movies. In a film, viewers often attempt to guess the character's choices, as they are engaged in their story and interested in seeing it go through; in this way, the movie invites the viewers to process information in similar ways that low interaction video games do, by creating mental representations of the character's personality. Still, unlike videogames, movies collapse into a reality - the character does or doesn't do what was predicted, they answer in one way or another. In videogames, the choice, even if it has no effect (and precisely because it has no effect), remains open - the developers did not answer the players' expectations, so they're allowed to keep them. In this way, the inclusion of low-interactivity games in the videogame category seems to be, at least, plausible and effective.

We can establish a parallel with the ideas in Jorge Luis Borges' short story "Pierre Menard, author of the quixote", where it is suggested that authorship comes from the reader at least as much as from the writer. As Howard Ginskin puts it (2005, p. 1):

> *It is a deeply profound revisioning of how meaning is created through the interaction of man and text. Through Menard's recreation of the Quixote in a different time and place from Cervantes' original, Borges implies the simple yet disturbing supposition that the meaning of literary works is entirely dependent on the varying historical and social contexts in which they are read.*

As "meaning is created through the interaction of man and text" (Ginskin, 2005, p. 1), the choices a player makes in a videogame, even if they do not alter the game mechanically, do create a relation between the reader's interpretation of the story and the author's code, images and text, in much the same way a mechanically significant choice creates an interaction between the author's work and the player's decisions.

"Pierre Menard, author of the quixote" also explores the idea that perceived authorship (and perceived inclusion in specific genres) can also alter the way someone reads a work of art, which is explicative of the importance of calling these non-interactive experiences videogames, as calling them something else would certainly change the ways they are perceived, used and experienced.

In fact, if we do a more sociological analysis of the cultural roles of these types of videogames, we see that they are played and experienced as games, - they run in computers, with a hands-on active engagement by the player, with some expectation of the presence of interactivity - as opposed to, for example, a movie - a more passive engagement by the viewer, with no interactivity. One could even forget the analysis we did firstly and focus on the way users utilize these low-interactivity experiences to classify and categorize them - an analysis not by semantic definitions but by use an cultural significance.

This situation is comparable to the one we face when discussing the public perception of interactivity; as it has become a buzzword, what we could describe as merely reactive is, in fact, interactive in the eyes of many, who are not aware of these differences. We face the dilemma, then, of defining terms by their more useful, technically correct meaning - reactivity as a system that responds to input in a predictable manner, creativity as a system that responds to input in an unpredictable and apparently creative manner - or by the socio-cultural standing, by how the word was shaped by forces such as marketing efforts - reactivity and interactivity as one, as a system that responds to input. The best solution is unclear.

It is clear that this separation of objects into distinct sub-genres or even full genres behaves likes an in-group/out-group situation, where individuals define what they see as "games" by their own experiences and personal taste, often relying on semantics secondarily. A *gamer* may proclaim that a game like Proteus is not a game but a "walking-simulator" (term often used to describe games whose main and sometimes only mechanic is simple and minimalistic - like walking through a virtual world for the sake of exploration or progression through the story only) or an interesting artistic piece devoid of importance to those who play games with "deeper" mechanics; this semantic rationalization often falls flat, in these cases, as the cultural element was primordial in its creation, as they often consider objects with similar minimalistic approaches games. When a certain sub-cultural group tries to culturally exclude various low-interactivity video-games, their platonic essentialist ideal of a "video-game" is not the only factor influencing why they think the way they do.

There is another interesting comparison to make with the genre of music, where interactivity may be matched up with silence. In John Cage's famous *silent piece*, *4'33"*, the composer has given the audience, theorists and historians pause, as the implications that silence is extremely important were ground-breaking, at the time. Much in the same way we do not think pauses in a piece of music are not music, which would create an odd understanding of most music created so far, demanding from videogames a high level of interactivity, particularly if it has to be constant and ever-present, would remove many works of art currently, and without controversy, considered video-games from that label.

Analyzing the cultural significance of the label of "video-game" alone, in relation to the use of interactivity, reminds us to consider not only the semantic, creator-based sense of the term, but also the cultural significance that may come from the narrowing or enlarging of the label, as lesson to apply to "interactivity" as well.

2.5 Defining interactivity

> *The concept of a traditional acoustic instrument implies a significant degree of control, repeatability and a sense that with increasing practice time and experience one can become an expert with the instrument. Also implied is the notion that an instrument can facilitate the performance of many different compositions encompassing many different musical styles. Interactive systems blur these traditional distinctions between composing, instrument building, systems design and performance.*
>
> (Drummond, 2009, p. 124)

Taking all the knowledge we gathered so far, we can present, then, a more complete definition of interactivity. It will have to be useful and applicable to most scenarios, while being supported by a strong theoretical background. It is important to note that the choices made in defining such a complex topic were made with awareness of the current context where the audience's perception of creativity and interactivity are more important than strict definitions for labeling purposes only.

Going step by step, starting with the smallest, most obvious elements of interactivity, it is clear that an input is required, or there would be no contact with the user, as referred previously. There also must be some process that utilizes that input, be it *data-driven* or *rule-based*, "whether the system's behaviours, choices. and ultimately its creations are generated by the system itself or are based on data external to it" (Carvalhais, 2016, p. 180), or we'd be simply repeating the user's input, creating a responsive system which holds no surprise to the audience. We need an output, or the user would not be aware of any work done by the program.

We can be more specific by calling on examples where this definition falls a bit short, particularly as we require a separation between a responsive system and an interactive one. Instrument building, as opposed to installation building, for example, creates responsive works, as instruments must be predictable and non-creative - they are an augmentation and an instance of the user's gestures and choices. An electric piano, for example, requires little to no latency between the user's key presses and the output, and the timbre and amplitude must respond, for instance, to the pressure to the key (the *velocity*, in MIDI terms) in predictable and repeatable ways, otherwise the user would be surprised with every key they press, and would not be able to utilize it to play a piece of music in a reliable way (there is, of course, space for instruments with surprise built into them, made by or by request of the composer, for their specific works). Of course, there is a degree of pseudorandomness in playing an instrument, as neither the user or the creator of the system can control for every single variable. Nevertheless, it is inconsequential, as there is an unspoken agreement between the creator, the user, and the audience, to dismiss these factors and accept, for example, the C3 note of a piano as the same every time it is pressed, despite minute differences between each iteration.

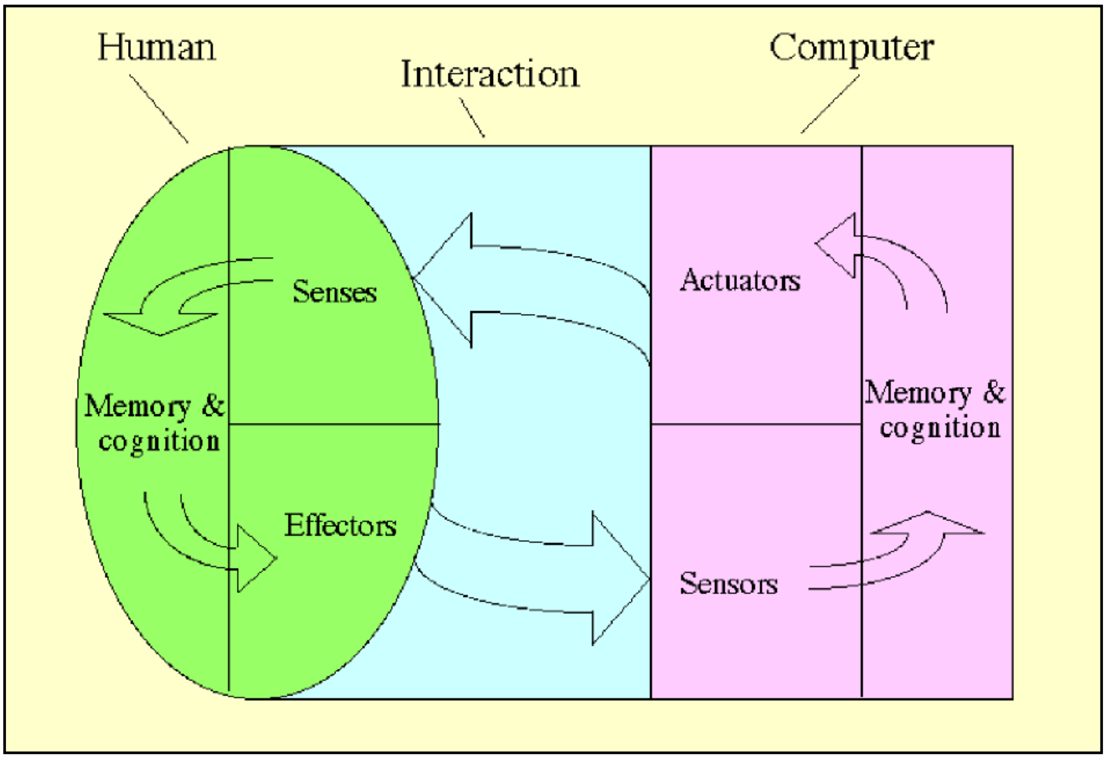
Rowe (2001) defines interactive computer music as systems "whose behavior changes in response to musical input" (p. 1). As we unpack this phrase we understand that "behavior changes" must apply to the core mechanics of the system, not just the higher level responses (or it would be merely responsive - repetitive and predictable), but the way it processes input.

To achieve a perception of a system as something that creates unpredictable and creative objects, we can utilize Boden's (2004) notion of *machine creativity*, useful when creating "computational systems that are, or appear to be, creative to some degree" (p. 1). We will, then, require our previously discussed notion of "creativity", as we need it when creating interactive (not merely reactive) pieces of art. Boden (2004) defines it as "the ability to come up with ideas or artefacts that are "new, surprising and valuable" (p. 1). As discussed before, we have to, as well, separate creativity from originality, as the latter is something that computers easily create when utilizing randomness (or pseudorandomness) to create new objects; if we were to make a system create only randomness it would quickly lose its surprising attribute, as human perception blurs the comprehension of data when it present us with constant objective novelty; we turn a series of individual random and novel events (or even non-random events presented in a quick or hard to analyze way - if we were to speed up Varèse's *Ameriques* by 2000%, for example) into a single collection of randomness, much like we do with "white noise". For Boden (2004), the creative process "must involve decision processes and aesthetic criteria. In this sense, purposeful behaviors should be more common than random processes and any randomness that is integrated in the process must be constrained by the creative domain and the contexts concerted" (p. 163). We achieve, then, a perception of random processes as creative when their randomness is constrained by familiar structures (be they organizational, musical scales, color palettes).

We can then augment our definition to a system that (1) receives input, (2) analyses and processes or otherwise utilizes input (3) outputs the result, in a way that is (4.1) mostly unpredictable, (4.2) creative and (4.3) valuable. We see, then, that the added points are user-oriented and object-processed, but not object oriented; psychoacoustics come into play, as well as computer-human interaction and even artificial intelligence.

The notion of "value", while a common term in the study creativity and interactivity, may more correctly be described as allowing the audience to imprint meaning and intent to the output, mostly through the context on which this interaction takes place or through the organizational methods, or the form, we employ before outputting to the user. However, what audiences can recognize is dependent on context and even the personal choices of the creator; as Drummond (2009) puts it, "for a system to respond musically implies a system design that meets the musical aesthetic of the system's designer(s)" (p. 126). It may be necessary for a creator of an artistic object that aims to create a feeling of interactivity on its audience to understand said audience and to cater to their notions of what is "valuable" or what patterns can be recognized as creative and interactive.

Bongers (2004) describes the process of interaction with a system as follows, providing as well as a graphic visualization of the specific processes that create human-machine interaction (44 - 45):



Img. 12 - Representation on the processing methods involved in interactivity with a system.

Interaction between a human and a system is a two way process: control and feedback. The interaction takes place through an interface (or instrument) which translates real world actions into signals in the virtual domain of the system. These are usually electric signals, often digital as in the case of a computer. The system is controlled by the user, and the system gives feedback to help the user to articulate the control, or feed-forward to actively guide the user. Feed forward is generated by the system to reveal information about its internal state.

An interaction-'loop' may start when the user wants to activate the system. The system is controlled by a user through its inputs, it processes the information, and displays a result.

(...)

The systems [sic] *communicates with its environment through transducers, devices that transduce (translate) real-world signals into machine-world signals (sensors) and vice versa (actuators).*

Sensors are the sense organs of a machine. Through its sensing inputs, a machine can communicate with its environment and therefore be controlled. A sensor converts any physical energy (from the outside world) into electricity (into the machine world). There are sensors available for all things perceivable by human beings, and more. For instance, kinetic energy (movement), light, sound, but also properties unperceivable for human beings can be sensed such as electromagnetic fields and ultrasonic sound.

(...)

Machine output takes place through actuators. Actuators are the opposite of sensors, i.e., they convert electrical energy from the machine world into other energy forms for instance those perceivable by human beings. For instance, a loudspeaker converts electricity in changes in air pressure perceivable by the human ear, a video display shows images perceivable by the eye, motors or vibrating piezo elements may address the sense of touch. The interaction usually takes place by means of an interface (instrument). Following the definitions of the diagram, the interface is part of the system or machine and consists of the sensors and actuators.

It is also important to note the importance of reactivity to the creation of a feeling of interactivity. While our goal with this dissertation is to remove as much of it as can be done, it would be remiss not to point out the aspects where it is unavoidable and where it adds to the experience of interactivity. A distinction between reactivity in the system or merely in its sensors must be also pointed out, separating it between *active* and *passive* system feedback (Bongers, 2000, p. 46). Taking the example of the *Behavioral Economics* installation, built in the context of this dissertation, the constructed input table makes ample use of reactivity at the sensor level by employing mechanical on/off switches and several discreet dials (where different fixed positions can be switched between, as opposed to a smoother analogue rotation). The mechanical *clicks* provided by these buttons, as well as the LEDs that turn on when the button is on the *on* position, give the user immediate and direct feedback. This distinction is more clear when we consider that "the device can even be turned off and still the feedback is perceived" (Bongers, 2000, p. 46).

Lastly, in order to effectively engage with the task of creative the feeling of interactivity in the practical examples that follow, we must gather this knowledge and settle on one working definition of interactivity.

A major issue that must be decided upon is the divide between a cultural or a technical and practical approach to this definition. As discussed previously, the term "interactivity" has lost the meaning within mainstream circles that the creators of interactive works more generally use. We must decide, then, if we accept the merging of the concepts of interactivity and reactivity or if we stick to a strict separation between these two.

Since this dissertation, so far, has focused immensely on the perception of the audience over the technical faculties of the discussed systems, a more immediate thought may place us on the mainstream "side" of the argument - if the understanding of a system as creative, for example, is our working definition of creativity, one could reason that when speaking of interactivity the same logic would apply. During chapter 2.5, there was a stronger leaning towards a cultural approach to the definition of video-games and the inclusion of non-interactive experiences into that genre if the creator felt it was the adequate area to place their system, understanding the context. Why would, then, the working definition of interactivity deviate from this more common thought?

Clarification is, therefore, necessary. The imperative nature of the audience's perception was explored and deemed important to the definition and to the achieve of creativity, partially due to this decision leading to a smoother understanding of the mechanisms of interactivity when in the context of a creation of the feeling of interactivity where there is none. While one can argue that a system can be, in itself, creative or not, regardless of the audience's perception of its internal mechanics - must in the same way a sonata will still be a sonata despite some audience's ignorance of the term and how to spot such a form. That position, while interesting and worth exploring in more detail, may be immensely less useful than the alternate position - of a larger importance of the audience's understanding, even if goes against the inherent qualities of the system.

Since our objective is to deceive users, the inner workings of a system that will remain, for the most part, hidden from the audience would create ineffective discussion - whether or not said machine is creative, if the users feel it is creative then our objective is complete, regardless of the true nature of the work.

Why, then, it is suggested that the definition of interactivity not follow this process precisely?

Another important aspect of our attempt at creating the feeling of interactivity where there is none in the system itself relies on the distinction between reactivity and interactivity - we attempt at producing these results without or with minimal reactivity. A deviation from this pattern was purposeful - we found it more useful to separate these terms, so as to more thoroughly explore these mechanisms.

It is clear, then, that we must divide these two terms for the purpose of discussing the intricacies of interactivity and its application on non-reactive contexts. While the more common definition may possibly be explored when discussing interactivity with, for example, our testing volunteers, for the purpose of clarity and ease of understanding this dissertation must separate reactivity from interactivity, and define it as follows, where the forth points clearly divide this meaning from the one of reactivity:

A system that (1) receives input, (2) analyses and processes or otherwise utilizes input (3) outputs the result, in a way that is (4.1) mostly unpredictable, (4.2) creative and (4.3) valuable.

3. Application

3.1 Introduction

To apply the knowledge we have acquired in the previous chapters, we will present an example in the form of a non-interactive interactive sound installation. We will study how to apply the techniques we have discovered in an effective way, in a complete way, so we can understands the challenges and solutions that present themselves when applying theory to practice.

Firstly, we will present a group of examples of already created systems, some discussed previously, that present themselves as interactive while having none or very little amounts of interactivity. These examples come from a wide range of media, in diverse genres and each provide a different method and execution, as well as challenge, if we apply the context where they are included; in this way the reader will be exposed to a great array of perspectives, being informed of the various way to analyze and apply the techniques exposed in the theoretical framework of this dissertation.

We will then document the design, creation and construction of the prototypes, detailing the reasoning behind each decision, basing choices off the previously presented theoretical framework. Detailed explanations of the programming and construction techniques will be given, however, the reader may find most of the code as it was used in the annexed materials section. Since there is an attempt at simplifying the execution of the ideas previously discussed, so that replication and exploration is more accessible, it is recommended that the full code is analyzed if the reader pretends to comprehend the functioning of the prototype installations more easily.

Since both the prototype and the full installation were publically displayed and tested (although the sample size is too short for a confident generalization of results), reactions and experiences have been recorded and questions asked to the users, so as to more accurately discover what worked best and what failed in its objective.

3.2 Deceiving an Audience

Various forms of media have examples of perceived but ultimately inexistent/limited interactivity to engage with their audience, presenting us with an interesting body of work for us to analyze and discover mechanisms of interactivity and user expectation. We will focus on the analysis of video-games and interactive installations, as these are closest to the project's genre and may provide valuable insight into how interactivity functions and how we can imitate its effects efficiently.

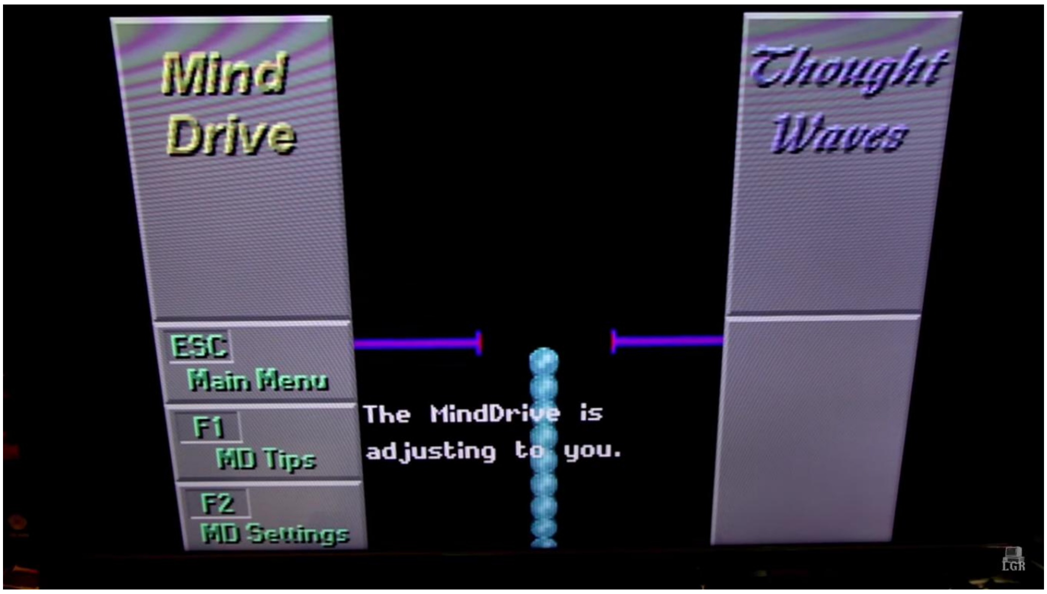
We will start by drawing examples from selected works, so we can ask appropriate questions and develop a framework on which to build the installation; before we tackle the project, we must know how to construct it, how to exploit the mechanics of interactivity.

We will start with the example of *Mind Drive*, a product of *The Other 90% Technologies* company, created by Ron Gordon, a gaming console with accompanying video-games that claims to operate by reading the user's mind. Mechanically, it utilizes a galvanic skin responses sensor to read the skin conductivity of the user's finger, which would be related to their emotional state. As explained in the product's box:

> "Our various thoughts and emotions produce bio-electric signals which can be precisely measured through our fingertips. (...) The patented Minddrive programs on the PC analyze the unique signal patterns and provide an ongoing indication of the type, size and emotional quality of our thoughts -- thereafter translating them into a myriad of software application commands."

The *Mind Drive*'s sensor, however, is extremely limited, measuring only binary responses - yes/no, left/right, etc.. Even after this simplifications of the reactions of the human mind via skin conductivity, the result is not very precise or effective, as it fails frequently at what it claims to do - attempting to think in yes/no, left/right terms in order to control the equipment or simply not looking at the screen will achieve similar results.

Yet, the console's failures are not instantly clear. During early experiences, a less skeptical user may believe that the sensor is effectively reading their mind, only starting to doubt this claim after a few attempts to "break" it, by using the sensor in ways not intended by the creator, by not thinking in binary ways or by not focusing on the game. The *Mind Drive* deceives the user, possibly, by altering the way their games work, something more clear in the game *Thought Waves*, included in the



Img. 13 - *Mind Drive*'s game *Thought Waves*.

package, which asks the user to guide a string of circles through the indicated spaces without touching the obstacles, by thinking left or right to control the horizontal movement of the string's top end.

The user's level of attentiveness will not dramatically change the outcome of the game - they may try to seriously play the game or even just look away. They will, in most cases, win. Their victory does not come from their skill or the sensor's ability to read their mind, but possibly from the game itself, which may utilize the phenomenon of confirmation bias in which the user will ignore the system's failures and focus on the times (even if they were sparse) when it apparently followed their wishes.[1] This is, of course, dependent on the user's expectations, which is why it is incredibly effective when the goal is very clear. In *Thought Waves*, the player's objective is only one - to reach the end without touching the obstacles, something the game designers know very well. Having such a clear objective, with little variation in play, allows the creators to craft an experience that will be much the same in most play-throughs.

[1] It must be made clear that these are assumptions, mere possibilities, as a deeper research on the real mechanisms at play in this device was not possible.

Publicity is also a very important aspect. Informing the user that the console does read their mind effectively, that they will be able to control its systems, places the player in a mindset where they can be convinced (and will convince themselves) of this, even if the system has little to no responsiveness to player input.

This is, then, a system that, technically and mechanically, has very little responsiveness, and therefore interactivity, yet, for more trusting users, it presents a level of apparent response and interactivity. It is, therefore, a non-interactive interactive system, something very similar to this dissertation's project.

We take, then, two important lessons from this product - that advertisement is paramount and that the input should be vague in its response. The fact that the *Mind Drive* presents itself as capable of interactivity aligns the user with the mindset the game designer chooses; they will play the system's games accepting that they are games, assuming that the box is honest in its portrayal of the system's capabilities. We also gather that having a vague and ineffective input allows the player to forgive its inaccuracies, as being unsure of what and how the device registers input leaves the user open to effects with dubious (or inexistent) causality. Due to the effects of confirmation bias, they will take agreeable results as proof of the machine's accuracy, and will ignore less desirable effects. The ambiguity in the relation between input and output, while dangerous in high amounts, can provide the user with an explanation as to why levels of responsiveness are low - the system seems complex due to a less accurate sensor or, perhaps, because it is complex beyond the user's current understanding. The vagueness created by this less than ideal sensor can be exploited, as it is a natural psychological phenomenon to create meaning from even ambiguous data, depending on the current context, as explained by Minsky (1988, p. 207):

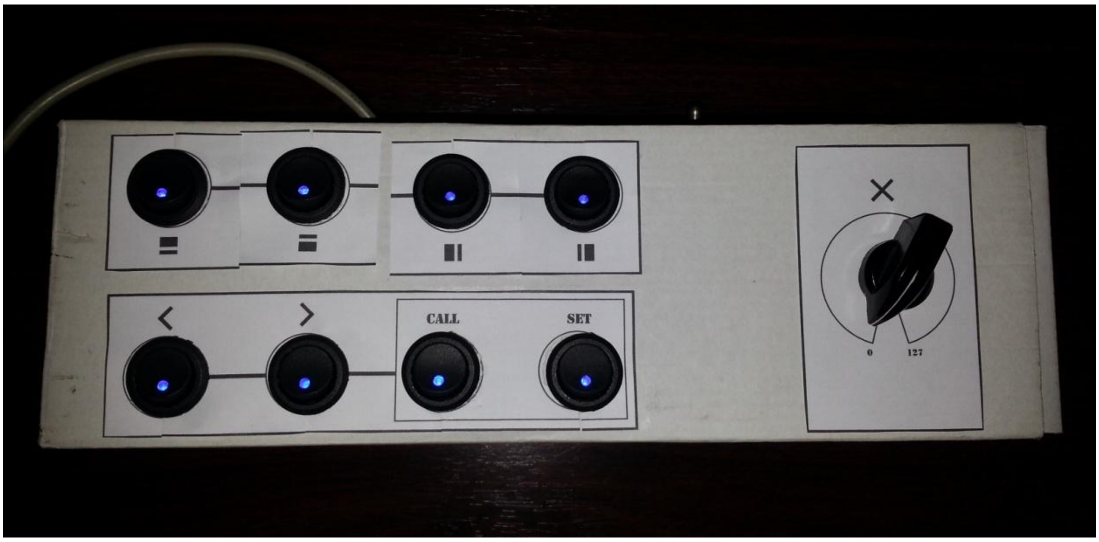
> *You understand "I wrote a note to my sister," despite the fact that the word "note" could mean a short letter or comment, a banknote, a musical sound, an observation, a distinction, or a notoriety. If all our separate words are ambiguous by themselves, why are sentences so clearly understood? Because the context of each separate word is sharpened by the other words, as well as by the context of the listener's recent past.*

Previous examples can help as well, after analysis. In *The Walking Dead* we learn that clear internal cause and effect is important - the world, its settings and physics must be coherent, with effects driven by cause, even if said cause was mechanically internal and had little relation to the user, which lets them focus on their input while showing that the experience has a recognizable form and characteristics. The in-game mechanics must be clear, they must offer no surprise, or the user will question the effectiveness of the whole system, including its input. We understand this due to the game's mechanics having little space for a lack of coherence or failure, as they are simple, relying extensively on the story to "hook" the player, rather than in complex AI systems or obtuse input structures.

In another preceding example, *Kentucky Route Zero*, we see that an interesting or active experience distracts the user from their failing input, as long as said experience isn't too reliant on input precision or its mechanical mastery, as that would cause the opposite intended reaction - the user would focus too heavily on the controls of the systems. In games like *Super Meat Boy¸* by *Team Meat*, while the experience is incredibly active and frenetic, it places a huge amount of importance on the player's skills and reaction times, which demand responsive and clear inputs, negatively impacting the user if their input isn't received in a timely, uncorrupted and predictable manner.

Lastly, in an example similar to the installation *Behavioral Economics*, there is Lucas Werthein and Jason Aston’s *Boom Shakalaka*, an installation based on Rube Goldberg machines, which provides the audience with a vast room with diverse objects and contraptions that, when engaged with, affect what happens on screen; the results of interacting with the objects are vague and require the use to spend some time understanding how they work.

3.3 Prototype



Img. 14 - First prototype, front side capture.

There is a known mantra for creators that summarizes the perspective one must have to build something successful - "fail faster". Daniel Floyd, from Extra Credits, explains it, in their video towards video-game designers:

> *Fail faster, because, without testing and without exposing your thoughts to others and embracing how many horrible mistakes and egregious failures you made in your last pass, you will never create a good game.*

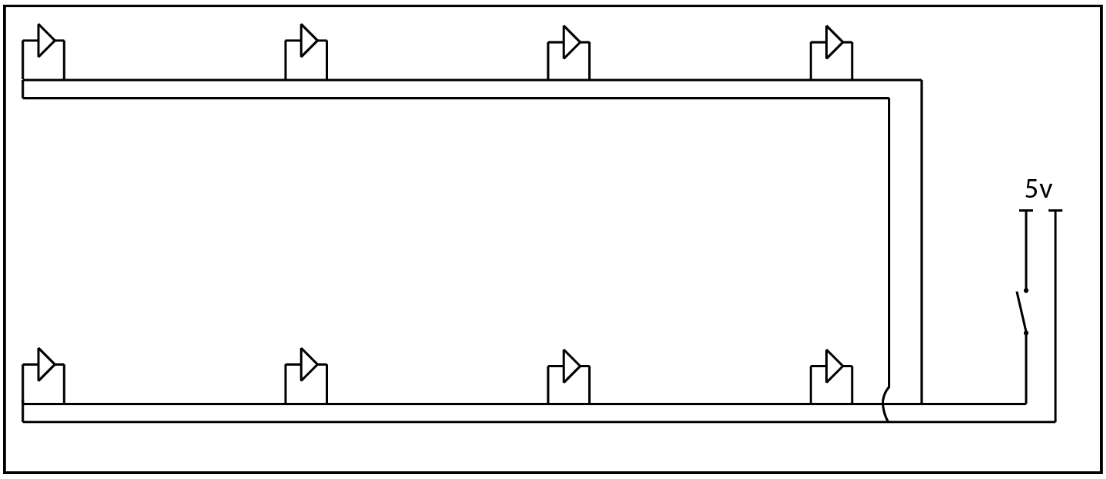
This thought portrays a key aspect in creating, in this case, a successful installation with daring odds. While one's theoretical framework helps immensely and is the starting point towards such a creative act, the fact is that every artistic object is unique, and each creator faces different challenges and solves different problems in their work. The best way to polish out the inevitable unpredictable errors in the design of the artistic piece is, without a doubt, by testing.

The development of prototypes, of creating a smaller, simpler, cheaper version of a final design, is something understood as immensely helpful by groups from small independent creators of interactive media to large companies with budgets in the millions. Few big products, videogames or installations are now finished without testing, and with the advent of the digital distribution platform Steam and its Early Access space for in-development videogames, games in years-long public alpha or beta stages are fairly common. For the designers of those products, their audience's feedback on their mechanics or found bugs is invaluable, allowing for the better polishing of the creation before the end of its development.

It was important, then, to create a prototype of what the *Behavioral Economics* installation was to be. This prototype would utilize the same base mechanics planned for the finished installation, but at a much smaller size; that way we could catch the inevitable mistakes a purely theoretical analysis of interactive mechanics can't predict.

In order to cut on costs and complexity of build, it was decided that the whole (pretend) input device would be placed in a small cardboard box, a found object at no cost. This box, while sturdy enough to hold the electronics we would fit inside, required extra structure so as to be safely handled by multiple people during testing; for that purpose polystyrene foam was cut and fitted into the available and most fragile areas - a plate covering an unimpeded wall of the box, as well as a board to sustain force to the rotary dial and a long pillar in between the on/off buttons.

The input device was fitted with 8 on/off buttons (with LED) and a rotary dial, as well as an on/off switch to turn the power off and on of the whole machine. A USB cable, to be connected to a laptop computer, was connected through a wall to the main on/off switch, giving 5V power to the whole 8 buttons assembly. A simple schematic image follows, for clarification:

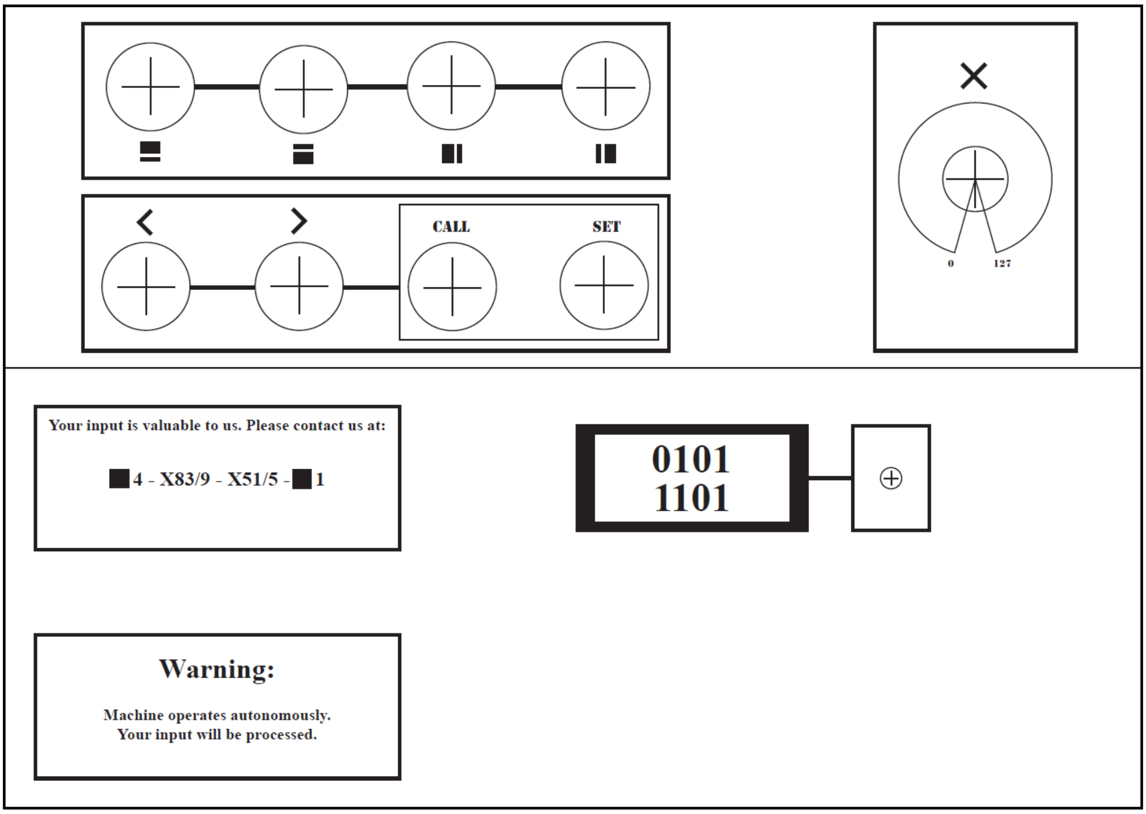


Img. 15 - Simplified electronic schematics of the first prototype.

The USB cable would provide a physical suggestion to the user that the input device is connected to the computer to transmit information of the pressed buttons and current dial position, something reinforced by the buttons only turning on if the cable is connected. This approach was added after an initial iteration using batteries, which would not give this benefit. While the current audience can be expected to assume some sort of wireless transmission of information, using this physical suggestion can help the user confirm their expectation that the input device connects to the computer.

On/off buttons with LEDs were chosen so as to increase coherence and ease of understanding within the input device itself. At a glance the user can see what buttons are in the *on* position and what buttons are turned *off*, quickening their understanding. Physical buttons are also an important addition, providing the user with extra sensorial information. As Bongers (2000) describes, "this is an important source of information about the sound, and the information is often sensed at the point where the process is being manipulated (at the fingertips or lips). This can be described as articulatory feedback" (p. 43); this feedback is a measure of responsiveness that is present only at the input response level, not reaching the system.

Evidently, this input object does not relay information to the computer - the LEDs switch on and off as the user presses them, and no part of the system has any information about the on/off state of these buttons or the current position of the rotary dial.



Img. 16 - Labels placed on the first prototype.

Various labels were also added to the input device, giving suggestions, hidden tips and other information surrounding the buttons and around the box, presenting itself as a puzzle (img. 16).

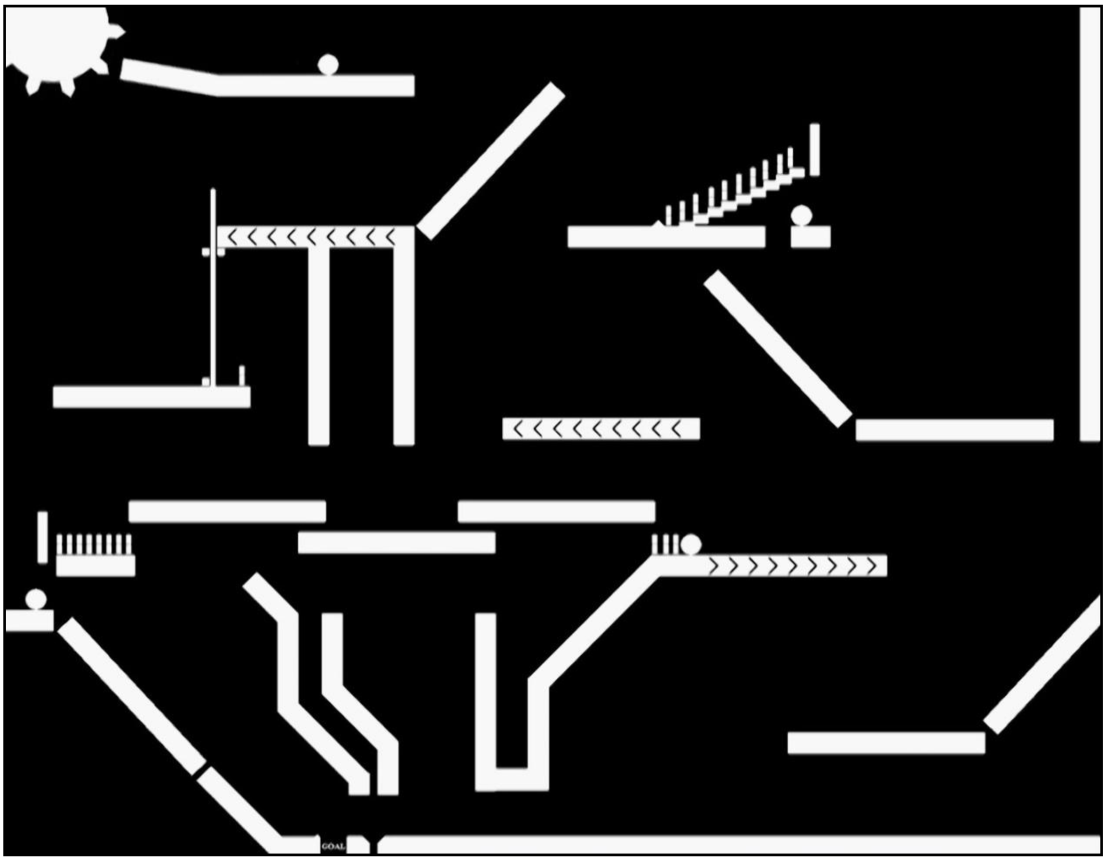
Here we face one of our first problems. In order to create a good puzzle, some experience in game design, level design and puzzle design is necessary, so as to create a challenge that is not too hard or frustrating. Lacking such skills, the thought process to create these labels was not ideal, focusing on what the user should see, rather than all the possibilities these signs could suggest. As an example, we take the "phone number" label, particularly the sections "X83/9", which suggested to various testers some sort of division was to take place. The "/" symbol was intended as a separator only, telling the user that two "X" areas required input - an 83 and a 9 (in binary). The puzzle was, therefore, created with the solution in mind, not the user's journey in deciphering the cryptic messages.

Following the messages in the way they were intended to be understood, the user would receive a tip that binary was in play by the above "0101 1101" label, which also indicated which of the 8 on/off buttons would be used. They would also be able to compare the "X" symbol to the two "<" ">" icons over two on/off buttons below and on the right. They'd apply the same thought to the top row of 4 buttons, combining them to form a black square, present in the label under the box, allowing them to read the instructions "square 4" and "square 1". 1 and 4 would be, of course, in binary, suggesting to the user that they are to set the buttons in the 4 position - 0100. They would then set the rotary dial to an estimated value close to 83, as indicated by the next instruction, followed by a 9 in the bottom row of on/off buttons - 1001. Next, following a similar tip, they would set the dial to 51 and the bottom row to 5 - 0101, ending the instruction with a 1 - 0001 - on the top row of on/off buttons. The user was expected to understand these instructions in two minutes, suggesting that they won because they understood said instructions.

The projection was developed on the Game Maker Studio engine, due to its ease of use and understanding, aiding at the recreation of this prototype, and the sound that accompanies the prototype was programmed in Pure Data, a simpler, visual programming language of quicker and more intuitive comprehension than text-based alternatives.

It presented the audience a Rube Goldberg type system, where momentum must be maintained to drive an object into the *goal* area. Four tilting platforms and three speed boost platforms were added whose values of speed and position changed, moving the platforms between two states (+45º and -45º) and altering the enhancement of the speed of any ball that touches the speed boost platform.

More details about this projection may be found on the next chapter, describing the construction of the *Behavioral Economics* installation, which utilized the code created for this prototype, expanding upon it.



Img. 17 - Visual projection of the first prototype.

During testing, this puzzle proved too difficult and vague, and was not solved in under 2 minutes; in fact, many testers did not give importance to the symbols, preferring to focus on the relation between their button presses. This goes in accordance to the findings of Luís Eustáquio (2012, pp. 62 - 63), who noted that:

> *This mindset towards testing starts by an analysis of the physical properties of the device, in an attempt to understand its function based on its general shape and specific*

elements like buttons or screens. It is during this time that the first questions appear, particularly about functionality: what it is, what it does, what is it for. We observe that the type of construction, using used packaging and buttons, suggests a state of doubt and drives the users into structuring their approach in phases, systemization (repetition) and verification. First, the available controllers are experimented upon one by one, in an attempt to identify specific mechanics and effects on the results. After the experimentation is systemized in combinations and sequences of actions, in a search to instrumentalize the device and detect patterns of behavior. Finally, the device itself is used as a controller, altering parameters with movement through space. Verification is constant in every step, in the comparative reading of actions and results. In this phase, the user's actions have a specific objective in sight, testing the predictability of results. Once a satisfactory level of mastery is achieved, the user's self-confidence is manifest in challenges to the operational limits of the device.[2]

This text clearly explains the downfalls on the prototype's approach to puzzle design - the users would not follow the intended path, as they were interested in learning how the machine works before they could tackle the puzzle. It would, then, be necessary to suggest to the user that the mastery of the device would come through the solving of the puzzle, or simply by creating the sensation of some understanding of the input device's mechanisms and responses on screen, so that the user can be comfortable enough to tackle the puzzle.

Another small issue came from a lack of control of the surroundings. Testing was made in public places; surrounding people created a distracting atmosphere.

---

[2] Original in Portuguese: "Esta postura de teste começa por um levantamento das propriedades físicas do dispositivo, tentando intuir funções a partir da sua forma geral e elementos particulares como botões ou ecrãs. É nesta altura que surgem as primeiras perguntas, especialmente sobre a funcionalidade: o que é, o que faz, para que serve. Observamos que o tipo de construção usada, com recurso a embalagens e botões reutilizados, inspira um estado de dúvida e conduz os utilizadores a estruturar a abordagem em faseamento, sistematização (repetição) e verificação. Primeiro os controladores disponíveis são experimentados um a um, na tentativa de identificar funções específicas e efeitos sobre os resultados. Depois a experimentação é sistematizada em combinações e sequências de acções, na procura de instrumentalizar o dispositivo e detectar padrões de comportamento. Por fim, o próprio dispositivo é usado enquanto controlador, variando parâmetros com o seu deslocamento no espaço. A verificação é uma constante em cada passo, na leitura comparativa de acções desempenhadas e reacções obtidas. Nesta fase, a actuação do utilizador tem já um objectivo específico em vista, testando a previsibilidade dos resultados. Uma vez conseguido um grau satisfatório de domínio, a auto-confiança do utilizador manifesta-se em desafios aos limites operacionais do dispositivo."

Testers seemed to want to solve the puzzle more quickly, missing steps in the analysis, jumping rapidly into trying to understand the direct connection between their button presses and the screen's reactions. Often they did not turn the device to find the extra labels on the top and bottom walls, as they did not try to solve the puzzle in the device itself.

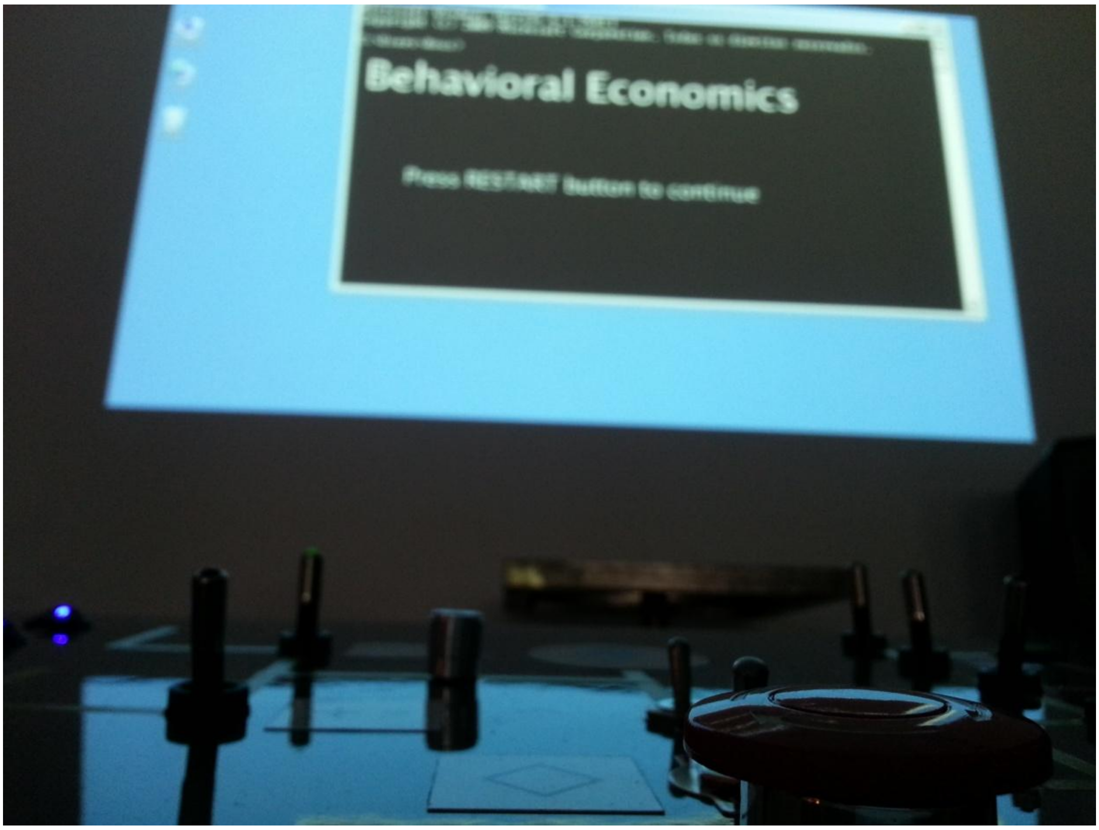
Yet, the results were positive in a number of ways. Often users would recognize some response by the system for their button presses, aided by coincidence and their own confirmation bias, attaching meaning to the random movements of the images, as predicted. About half of them recognized some interactivity in the design, and most felt engaged with the system until they won. Understandably, the users that reported this feeling of interactivity were more often satisfied with the end result, attributing the puzzle's completion to their influence and button presses.

This prototype, then, gave us insight in how to construct the full installation. The puzzles would have to be simpler, the complexity of the displayed images would have to increase so as to obfuscate the relation between buttons and movement, as well as to increase the chance of coincidence when the using of a button or dial coincides with the movement of a piece in the projection. A wider array of buttons, with a simpler puzzle, as well as a bigger and more complex projected image would aid the user into the desired feeling of interactivity that wasn't always felt in the prototype.

3.4 Behavioral Economics

Propaganda is to a democracy what the bludgeon is to a totalitarian state.

(Chomsky, 2002)



Img. 18 - *Behavioral Economics* installation.

Like in most works of art, there is a theme, a meta-text that justifies the creation of the piece. That is the case with *Behavioral Economics*, the installation that comes from this dissertation. We will start by describing it, to place the whole work in its context.

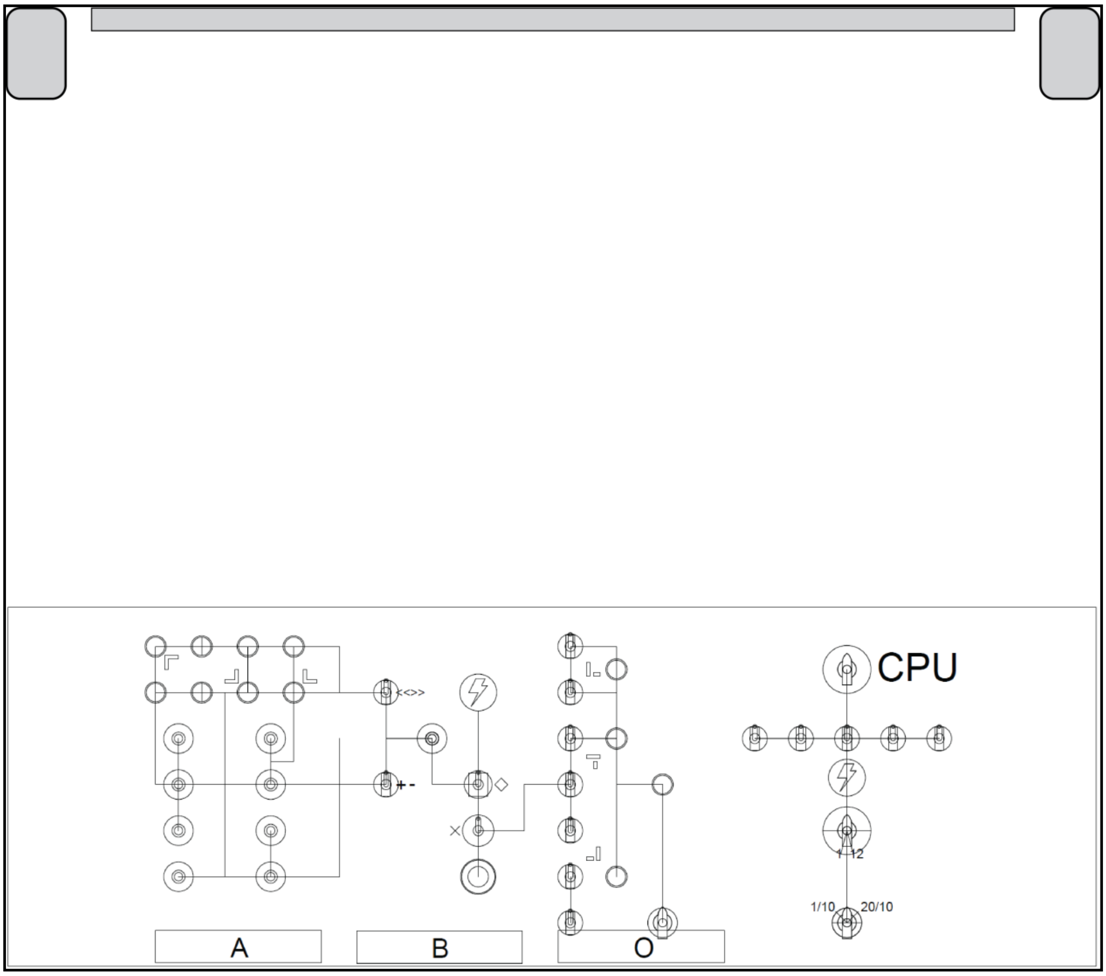
The installation, through its (perceived) mechanics, will work as a metaphor for an analysis of the world and, particularly, the State, common of the political left/far-left. We will utilize mostly the view of Noam Chomsky, a man famous for his work on linguists, but also for his political views, as he aligns with the left anarchist examination that Capital and the State control our lives far more than most know, using propaganda and the atomization of the workers through neoliberalism's focus on individualism and order over collectivism and justice. They also see suffrage and representative democracy as ultimately ineffective in providing equality or leading the people into socialism, as little more than a distraction. As he put it (Chomsky, 2002, p. 17):

> *Then, there is the bewildered herd, and they have a function in democracy too. Their function in a democracy (...) is to be 'spectators,' not participants in action. But they have more than one function than that, because it's a democracy. Occasionally they are allowed to lend their weight to one or another member of the specialized class. In other words, they're allowed to say, 'We want you to be our leader' or 'We want you to be our leader.'*

When a consumer is presented with apparent choices when buying products, or when a voter is presented with two or more candidates or parties, their choice will not be fully theirs. A great amount of time, money and effort is made to display the products (including the candidates) in the best light possible to the widest amount of viewers possible, focusing always on a target audience. In the same way, this installation will provide people with the feeling that their choices mattered, that they had an influence in the path the installation took when, in reality, that choice was made before them and what little input they had was ignored or ineffectual.

Mechanically, the installation was built using the tools we learned to from our theoretical framework. We achieved a clear cause and effect world, with coherent physics, as well as an active experience, by displaying a projection of a Rube Goldberg type machine. These machines are pure causality, where one object, when set in motion, will cause others to move in predetermined ways into a goal. There would be, then, no doubt when predicting the next movement of most elements of the projection. Certain objects, however, move in a technically random way, hiding the lack of real creativity in *comtivity*, which allows the audience to imprint a measure of intent and meaning, as well as a relation between input and these movements, into the choices the computer is assumed to make when receiving the user's decisions.

The display shows a movie, presented as a real-time process of player input, of a ball rolling down a path, at the start, interacting with various objects to keep the momentum going; the previously mentioned set of videos. After five minutes, it will play a last video where the user achieves the goal, as, in the random selections of paths, it will have missed it every time. The user, during those five minutes, is prompted to control these selections of paths and guide the momentum to the end goal, reaching that final objective after five minutes have passed, so as to limit the time the player has to discover how non-interactive the installation truly is. This time limit will, of course, not be told to the player, providing them with the idea that they themselves reached the end by sheer skill and understanding of the system before them.



Img. 19 - Top-down view of the schematics for the *Behavioral Economics* installation.

The input, or the feeling of it, is provided by a large board with a great amount of buttons, dials and switches, with drawn lines, symbols, phrases and codes scattered along it. This suggests to the player that the solution could be found by breaking this puzzle, by discovering the relations between buttons, which allows them to activate the correct ones in the correct time and win the game. On the far-right the user will see a panel giving them *Technical Info*, as well as a *Maintenance Code* written in *pseudocode*, inspired by python and java. Similarly to the initial prototype's suggested solution label, this *Maintenance Code*, if understood, provides the correct group of buttons and dials to activate in order to win the game, if the input table was only connected to the computer in the way the user assume it is.

Maintenance code:

O	A	B
1	1010	T1.1
1	1010	T3.1
1	11.126	L2.0
1	13.47	┛2.1
	21.47	
	23.47	

CPU

```
hand = 1; head = 0; time = 1; talk = 0; see = 0;
if(movement.b_t1 == true){
      cpu.clock++;
      }
if(cpu.clock == 'too fast'){
      choose(cpu.volt--,cpu.ticks--);
}
```

Img. 20 - Section of the far-right label from the input table of the *Behavioral Economics* installation.

Utilizing another tool gathered from our technical framework, context will not be the sole mechanic to create expectation on how the installation functions. The following text is presented on the far-left side of the input table of the installation Behavioral Economics:

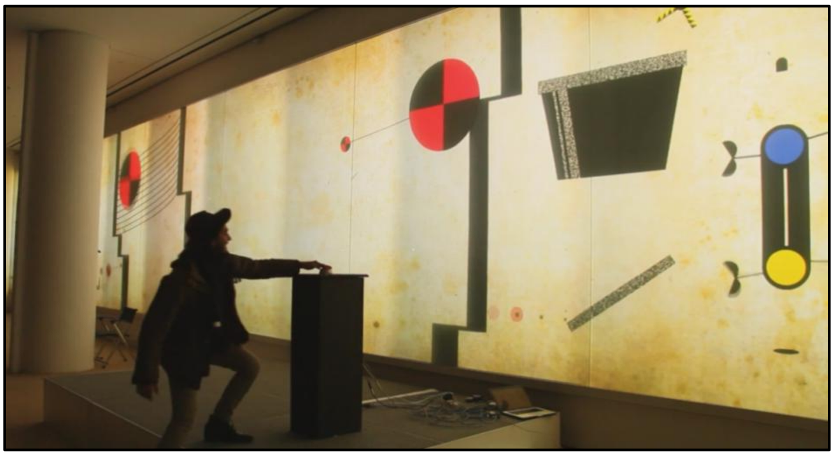
This installation will measure the user's level of commitment and persistence when faced with a complex challenge where they aren't in full control.

The machine will mediate the user's input, and the user will have to create a dialogue with this intermediary.

This will increase our understanding of the way the masses respond to loss of agency and to outside influence, which will give new insight into acceptable economic policies, marketing efforts, and consumer cooperation.

Not only is the installation presented as an artistic object and as presumably interactive, this short text present on the installation itself drives the user's assumptions about the piece's purpose and functions. It also suggests to those who use it that their "level of commitment and persistence" will be the key data point and its analysis is the function of the installation. The section reading "when faced with a complex challenge where they aren't in full control" further suggests to the user that they will not be the sole processor of the puzzles they will face, preparing them and giving them a reasonable, if vague, explanation on the reason why their input will not necessarily or at least immediately or predictable match the output - there will be another system that will "mediate the user's input", and a "dialogue [must be had] with this intermediary".

Regarding the general aesthetic choices for the Behavioral Economics installation, we draw elements from other works as well. The visuals of this installation are of a digital hardware display of exposed circuits and wires, close to a *cyberpunk* style. The display draws inspiration from works such as Fred Penelle, Yannick Jacquet and Matthieu Safatly's *Mécaniques Discursives* installation, and Lucas Werthein and Jason Aston's *Boom Shakalaka* interactive installation, both pieces that work with the Rube Goldberg machine archetype, both in their visual presentation and mechanical inputs. The videogame *Please, Don't Touch Anything* was also highly influential, this dissertation's project being heavily inspired in its large board with cryptic buttons, strange symbols, lines and codes that form a puzzle and a display showing the effects of the user's choices.



Img. 21 - *Book Shakalaka,* by Lucas Werthein and Jason Aston.

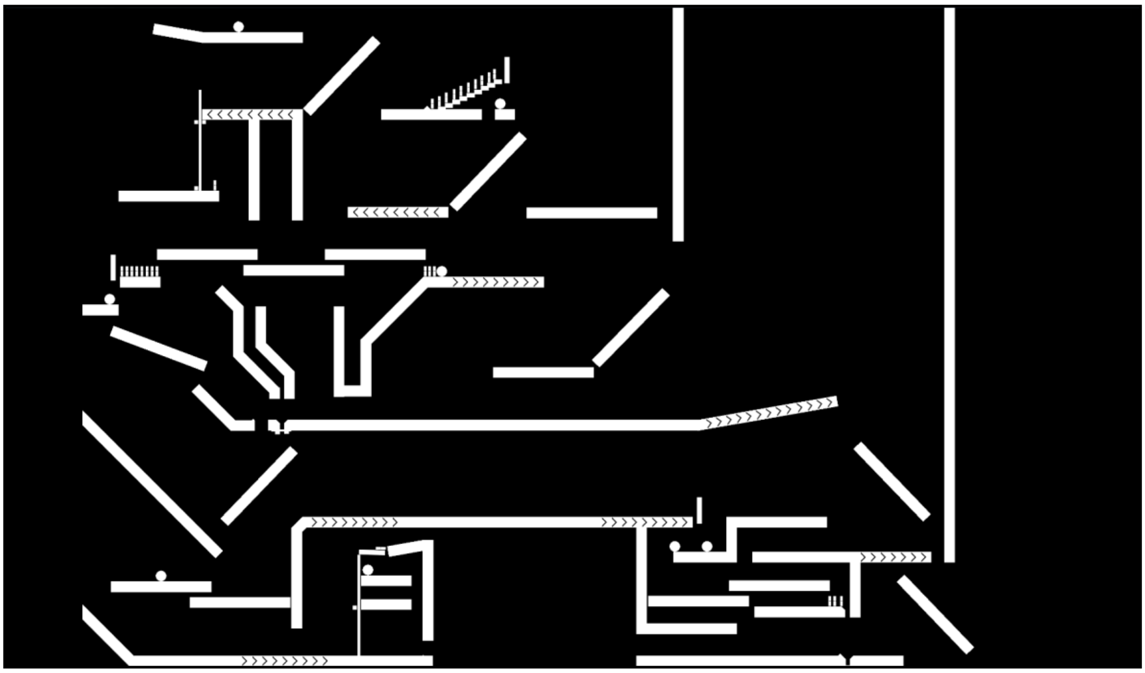
Img. 22 - *Mécaniques Discursives*, by Fred Penelle, Yannick Jacquet and Matthieu Safatly.

Img. 23 - *Please, don't touch anything*, by Four Quarters.

During the creation of this prototype, the developed theoretical framework was utilized, putting in practice all the lessons learned through the study of the state of the art and discussed mechanisms of interactivity. While not a priority, there was care so to limit the complexity of this build so as to showcase all aspects of it as clearly as possible, and to facilitate the recreation of this installation or elements of it, which should aid creators of similar installations to understand and utilize the same or similar methods.

The process of creation of the visual projection of this installation was developed with the previously explained rules in mind - a coherent world was, then, the priority. For this, an established physics system was utilized, to limit the amount of errors a creator could fall into, the game engine Game Maker Studio being chosen to create the systems that would then be recorded and displayed. This software has a built in physics engine which is easy and intuitive to work with, being the system chosen by many amateur game developers or indie developers; this high-abstraction, while facilitating understanding, has the downfall of hiding from sight a lot of the inner workings of the engine, limiting the options of more advanced users. For the purposes of this installation, however, it was the indicated engine to work with.

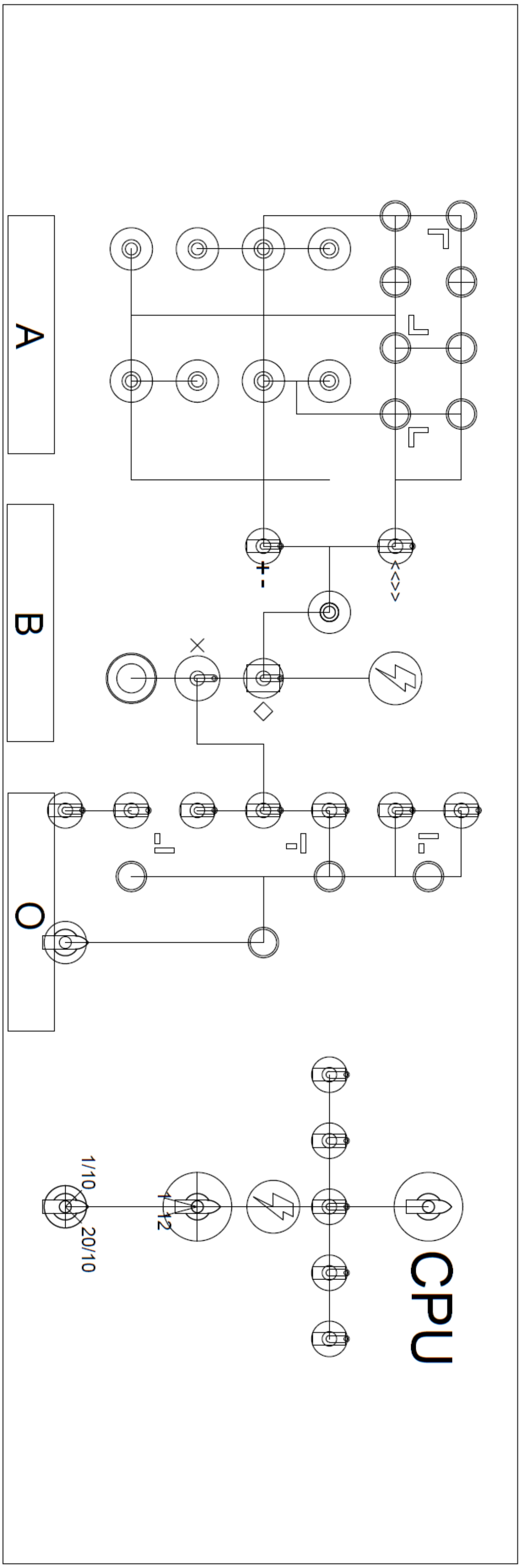
Perceived interaction with the system works by suggesting to the user that they can control the moving platforms, as well as the momentum given to objects that interact with the "speed boost" blocks. The amount of objects to control, as well as the complexity of the possible solutions of this puzzle, meant it was not necessary to include various distinct objects with perceived interaction, as that could increase the level of difficulty of the understanding of the puzzle, as well as lowering the cohesion of this world, which required apparent mechanical simplicity - while being complex in the number of possibilities, each object works in a simple way, leading the user to quickly understand how the world works while allowing them start understanding the solution to the puzzle as quickly as possible. The visual imprint of the different platforms and objects was also designed to be simple geometric forms, painted white against a black background, speeding up this understanding of the world.



Img. 24 - Visual projection of the *Behavioral Economics* installation.

The input table was designed with some of the same rules in play. The buttons are organized in a clear way, with lines connected to important groups and symbols attached to said groups which aided the quick indexing of button sets by the user.

The table is divided in four main areas - the "speed boosts", the "main menu", the "platforms" and the "CPU". The leftmost group suggests control of the "speed boost" platforms in the visual projection, both by selecting which are active or not and how much momentum do these platforms give to objects that touch them. To the right of that panel is the "main menu", where the user starts the system to begin playing, having access to buttons that control the flow of information towards the "CPU", having buttons that control the two panels surrounding this, as well as two more buttons that control the power to the top row of selector switches and the bottom area of rotary dials. The following panel suggests the user can control the turning of the rotating platforms, giving another set of buttons for access to the "CPU", adding to the complexity while providing a clear explanation via the lines drawn into the surface. Lastly, the "CPU" is named that way as it suggests some sort of master control of the system, namely, the clock, as well as possibly the level of distortion and other mechanisms the system uses to process input, which suggests to the user that merely pressing buttons will not suffice - they must "play" with the machine, interact with it, to finish the game.



Img. 25 - Schematic of the input table.

Of course, none of these buttons transmits any information to the computer, where the system's programs are assumed to be running. Under the table, wires connect different buttons, switches and dials, giving them power via a 5V USB connection to the computer which, like the prototype before, should give the audience reassurance that the input table is connected to the computer to convey information back and forth.

The projection was initially created in the Game Maker Studio engine, due to its ease of use and beginner friendly design. Two groups of predictable responsiveness were created - tilting platforms and speed boosts.

Seven platforms tilted between +45º and -45º, switching between these two positions in random moments where one of the two possibilities would be chosen, with equal chance that the next position would be the same as the previous, keeping the platform in its current state. The following code is applied in every *step* or *tick* of the system to the object *ob_wall_rand1*:

```
global.counter1 = global.counter1+1
if global.manual = false {
   if !place_meeting(x,y,ob_ball){
      if global.counter1%global.rand1==0 {
         physics_apply_torque(1000000*choose(-1,0,1))
         global.rand1 = choose(20,30,84,109,124);
      }
   }
}
else{
  if keyboard_check(ord('Q'))  physics_apply_torque(1000000)
  if keyboard_check(ord('A'))  physics_apply_torque(-1000000)
}
```

The variable *global.counter1* was numbered according to the number of the object so as to make sure that all tilting platforms moved independently. A manual control was also added (*global.manual*) so as to control the movement of the object by pressing, in this case, "Q" and "A", in order to record the final video where the goal is reached. A locking section of code was added to prevent movement while in contact with other objects, specifically *ob_ball*, seen in the *!place_meeting(x,y,ob_ball)* area.

The eight speed boosts' code would run only when in contact with an *ob_ball*, choosing a random multiplier to apply to the current speed of the object, effectively propelling it in the direction it followed previously with more intensity. These objects were separated into adding speed to the left (*ob_speedL*), and to the right (*ob_speedR*), and a manual selection set the multiplier as a fixed amount that guaranteed the best solution to the puzzle, as seen by the following lines of code for the left leaning boost object:

```
if(global.manual == false){
  mult = choose(-10,-15,-20,-30)
}
else{
  mult = -10
}
physics_apply_force(x,y,+phy_speed*mult,0);
```

All other moving objects utilized the engine's physics systems.

The results of these simulations were recorded and edited so as to be displayed in video form during the installation's presentation. This cut unnecessary processing requirements off the computer, without any ill results to the experience, as enough recordings were made so as to provide every user with new material.

The video files were selected and displayed on screen using Processing 3, utilizing the *processing.video* library, as well as the *Open Sound Control* protocol enabled by the *oscP5* and *netP5* libraries.

A main menu was added, so as to provide the user with some evidence of the connectivity between input and system. This was done by the lowest red button on the "O" area of the input table, that would press a button on a keypad placed below it, linked to the computer. By pressing the required button, described on the right side of the input table as the "Restart button", the number six would be sent to the computer, starting up the rest of the system, as seen by these lines of code:

```
if(keyPressed && key=='6'){
  selection = int(random(num)+1);
}
```

The variable *selection* held the current video file, multiplying it by 100 when said file was in use, so as to only begin the display once. We can also see in the following exemplifying lines of code the section that makes the variable *selection* choose the winning video file (*selection = 10;*) after a certain amount of seconds passed (variable *secs*, multiplied by 30 due to the 30 frames per second frame rate, so as to be set as seconds for easier understanding):

```
 if(selection==1){
 mov1.play();
 selection=100;

(...)

if(selection==100){
 image(mov1, 0, 0, width, height);
   if(mov1.time()>=mov1.duration()){
    mov1.stop();
    if(counter>30*secs){
      selection = 10;
    }
    else{
      selection = 1;
      while(selection==1){
        selection = int(random(num)+1);
      }
    }
  }
 }
```

The OSC capabilities were utilized so as to establish contact between the visual and the auditory signals. Two groups of lines of code gathered data from the video file in play, while two others sent it to the program Pure Data to be processed into sound. The first analyses one out of every 20 pixels from left to right, jumping 20 pixels horizontally, returning to the first one after reaching the end of the screen and jumping 20 pixels vertically. The second group gathers the average of all pixels in the screen. Since the video files contained mostly black and white, only the red color was checked, so as to save processing power and to limit the amount of data sent towards Pure Data. The described lines of code, having the *pixel* variable for the first case and the *avg* for the second, can be analyzed here:

```
pixel = pixels[pixelX+(pixelY*width)];


(...)


for(int i = 0; i < pixels.length; i++){
  avg = avg + (pixels[i] & 0xFF);
}
avg = avg/pixels.length;
```

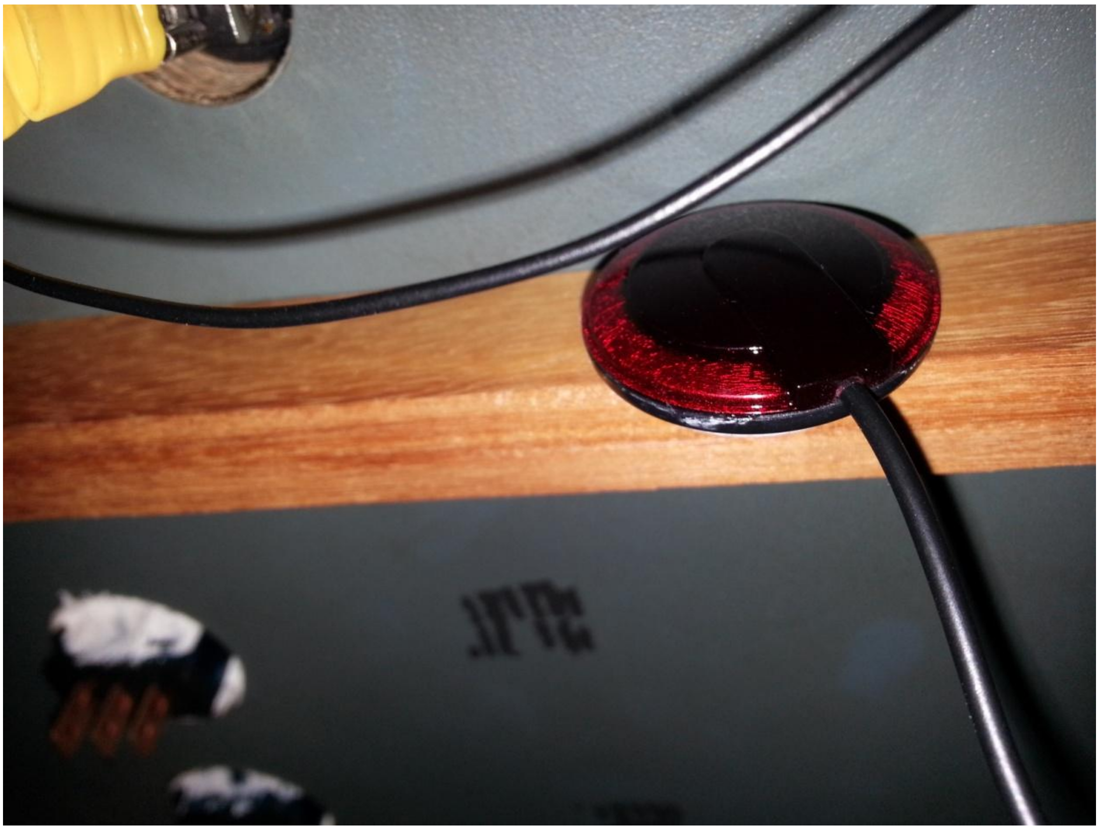
This information is sent to Pure Data via OSC, being received and processed in distinct ways.

The data at the *pixel* variable is firstly softened, so as not to create extremely quick jumps from a white pixel to a black pixel and vice-versa. If the pixel is white and, therefore, being represented by a number above 100 (255 for white, 0 for black), the smoothing blocks of code will trigger the *select 100* object, sending a random number to be added to the incoming data. The resulting number will be the lower frequency allowed by the *high pass* filter *hip~*, creating a window of filtered noise of 100 hertz, as the following *low pass* filter *lop~* stops frequencies above the previous resulting number plus 100. This number commands a simple sine wave oscillator at a much lower volume, so as to simulate high resonance of the filters.

At the same time, the variable *avg* goes through a smoother similar to the previously described one, 100 is added to the data that is then processed by a filter group similar to the last. This time the oscillator is slightly louder, as to compensate for the lower frequencies this set outputs, due to the lack of a randomizing section that was present in the first area.

A contact microphone was added to the input table, capturing the mechanical noises produced by the switches and dials, processing them as follows:

Firstly, the input from the microphone is made 15 times louder, so as to compensate for the inherent low volume from the capturing device. It is then modulated with an oscillator whose frequency is determined by random chance, with the selection of new frequencies being separated in time directly by the last outputted frequency (if the output is, for instance, 1000, then the timer will take 1000 milliseconds to choose a new output). This result is further modulated by a *phasor~* whose frequency is the same as the oscillator in the previous area. The output of this processing is then delayed and feedback is created.

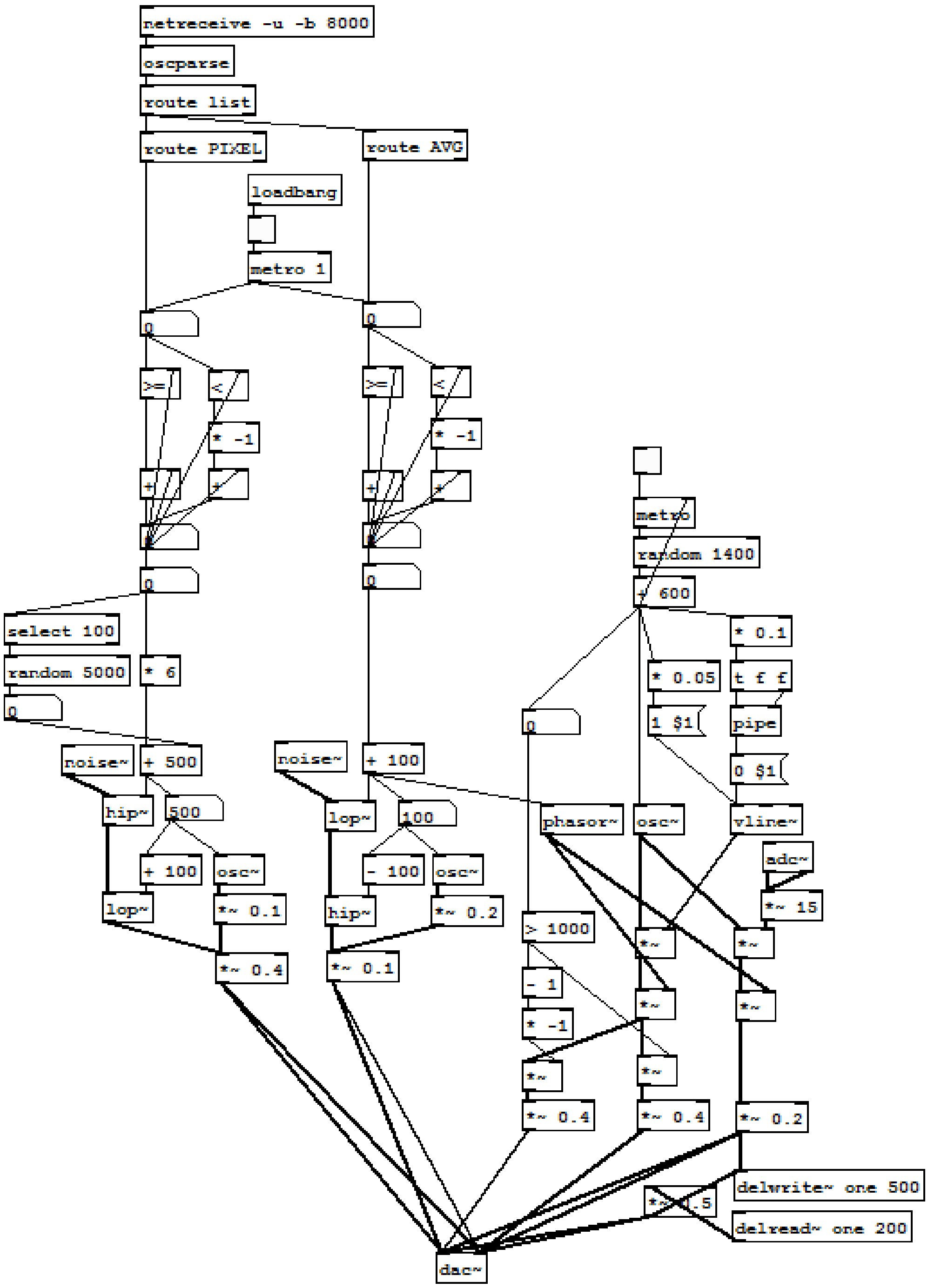


Img. 26 - Placement of the contact microphone in the *Behavioral Economics* installation.

This can be seen in the following image 27.

The theoretical framework discussed in previous chapters was, once again, the basis of these design choices.

The projection's simplicity and clear physics model aimed at demonstrating a clear and coherent internal system, so as not to distract the user from the solving of



Img. 27 - Pure Data *patch* that processes sound in the *Behavioral Economics* installation.

the puzzle, as well as to convey a sense of order, masking the disassociation between input and output, presumably due to the system's vague, hidden, internal processes and increasing the intuitive transference of the projection's clear mechanics into the complex assumed processing of input.

The input table provided the user with a complicated puzzle, applying the notion of *comtivity* so as to obscure the lack of responsiveness between input and output, presenting the user with a more feasible explanation of this apparent disconnection - their present inability of solving the input's puzzle. This also guides the user into trying to work out the relations between input and output, so as to complete the projected puzzle. *Comtivity* was also applied in the creation of the system's processes, utilizing randomness to guide the moving platform's movements. It's mechanical switches and dials also provide some measure of reactivity, of *passive* feedback (Bongers, 2000, p. 46). The *clicking* sounds the user hears when using these devices, and the visual cues provided by the LEDs, provide the audience with a feeling of responsiveness that acts only at the sensors level, not reaching the system itself.

Some part of this *passive* feedback turns into *active* feedback, however, by use of a contact microphone attached to the underside of the input table, picking up the mechanical clicks and processing them in Pure Data, as described previously.

Testing was done at the Faculty of Engineering of Porto University, the institution that provided the Master's degree in Multimedia and the creation of this dissertation. During one day a total of six people, divided into three groups (group A with one person, group B with three people and group C with two), voluntarily tested the installation, providing consent at the use of their image, as well as this analysis of their experiences.

During testing, some issues were made clear by the testers direct opinions and by their behaviors. While most felt some degree of interactivity, particularly during the first minute of experimentation, some reached the end with some certainty that their input was not important to reach the goal. Some specific problems were noted or pointed out by the testers themselves:

Firstly, it was clear that the academic context, as well as the familiarity between the creator of the installation (present at the public exhibition, while also taking notes) and the testers provided an unwanted distraction. Nearly all guests turned to the creator in search of help or deeper explanation when they felt the task was too complex or obtuse (all after the first minute of experimentation), with one tester in group C even feeling like a "lab monkey". This misunderstanding of the intended context of artistic exploration without pressure could have been prevented with a public exhibition where the goals where more clear and obvious for all. This negatively reinforces the importance of the environment the artistic object is placed in - a testing context created pressure to succeed, and the familiarity with the researcher and creator of the installation suggested to them that their victory could be helped by a more informed person, factors that would not be present in a public exhibition with a more exploratory nature, surrounded by interactive systems and artistic objects.

The level of *comtivity* also proved problematic. The tester of group A described the existence of a dialogue with the system as possibly present if "the computer is so advanced that I don't [understand] it", further adding that "too much was happening". Another, on group C, described the experience as "an enigma", despite the time for the automatic conclusion of the experience being lowered from 300 seconds to 180 seconds for group C. Due to the limited amount of voluntaries, no sufficient data could be gathered to suggest an improvement of the experience if the time of engagement with it is lowered.

Another issue was detected that can possibly be attributed to a slower experience than expected. During several occasions, testers found the time during the transference of momentum between slower moving objects useful in analyzing the relation between input. While during more active moments testing of these assumed characteristics of the system was more inconclusive, the less eventful moments gave the users an opportunity to engage directly with the input table in search of clear results on the screen. While in some specific tests coincidence boosted the user's confirmation bias towards believing that the input was being processed by the system, these moments were too rare to provide them with definitive proof.

Img. 29 - Group B of testers of the *Behavioral Economics* installation.

Img. 28 - Group C of testers of the *Behavioral Economics* installation.

A more detailed account of the processes of the testers follows:

Group A:

One tester was part of this group. He began confused as to the purpose and functioning of the installation, followed by experimentation with the input table's buttons. By chance, the "Restart" button is pressed, beginning the visual projection's actions. At this moment his attention moves towards the projection, losing focus on solving the puzzle in the input table. After some experimentation he comments "too much is happening", saying as well that the visuals were "too *trippy* for my taste".

After three of the five minutes of experimentation, the tester backs away slightly from the input table, watching the visuals from a distance without providing input. He notes that "looking up and down is sort of confusing", and ends the experience without reaching the goal.

Away from the input table, he remains attentive at the installation moving without his say. He comments that "it is very hard" and that "a lot of things [are] happening". The reactivity of the "Restart" button was understood - "the big red button does a restart (...) it is the most responsive thing". Afterwards, while still watching from a distance, the game won by itself, as planned.

Group B:

For this test, as well as for the following, the time until an automatic victory was shortened from 300 seconds to 180 seconds.

This group was made of three people who, unlike the previous tester, approached the installation in a very methodical manner. They began by reading the two side panels of text, separately, trading places when their section was finished. Understanding the purpose of the installation, as well as having read the instructions, the first tester pressed the "Restart" button, beginning to play with the buttons. Due to the layout, the buttons she happened to use were disconnected from power; the third person having to find the two power buttons on the "O" section for her to continue experimenting. Meanwhile, the second tester re-reads the "Maintenance code" section and comments "The point of this is to stray us away"[3]. The first tester then takes the lead and does a more thorough exploration.

Due to random chance, three video files where the momentum followed similar paths were selected in a row, prompting the third tester to say "This looks like a *gif* [animated image file, used often as a short loop]"[4]. Another glitch focused all tester's attention, due to its more text based nature - a command line window that appears for fractions of a second. The second and third tester discussed this appearance while the first tried to recreate it. Eventually they assumed the glitch was caused by the projecting device - a real glitch, as opposed to a planned one.

At this stage the first tester has exhausted many possibilities during her exploration of the input table's relation to the output. Like all the other testers, she turns to the creator of the installation in search for answers, saying "I don't get any of it"[5]. After no response was given, she then looked under the input table, while the other testers discuss how to proceed. She did not understand the inner workings of the installation, continuing to experiment more calmly until the automatic victory was reached.

Group C:

This group had two testers who, without any suggestion as to how to proceed, decided to test the installation both at the same time. The first tester immediately commented, comparing the input table to an airplane's cockpit. While the second person read the side text detailing the installation's presented purpose and instructions, the first began experimenting with the buttons. Like in the first group, the "Restart" button was pressed by chance, prompting the visuals to begin displaying the video files. Due to aesthetic choices, glitch-like effects were added to recorded images, causing the second tester to ask the first "where do you click to show those glitches?"[6], followed by "this is an enigma"[7]. After a few more minutes

[3] Original in Portuguese: "A ideia é despistar."
[4] Original in Portuguese: "Parece um *gif* a correr."
[5] Original in Portuguese: "Não percebo nada disto."
[6] Original in Portuguese: "Onde é que clicas para aparecerem o glitch?"
[7] Original in Portuguese: "Isto é um enigma."

of experimentation, the first tester stopped and said "maybe if I do nothing..."[8], prompting the second tester to inspect below the input table; they were testing the autonomy of the machine. The second tester noted that the wire layout would not provide input to the system, saying "Ah! They do nothing"[9]. Suspecting the real inner workings of the system, both turn to the creator of the installation in search of answers; none were provided, so as to mimic the appropriate context correctly. After some more experimentation, the second tester begins using the input table, while the first one compares their situation to one of "lab monkeys"[10].

Eventually, after the planned 180 seconds of testing, the installation concluded by itself. The first tester seems happy with the conclusion, while the second tester appears unaffected.

After each group finished their tests, some questions were posed, particularly regarding specific behaviors they had demonstrated during testing:

Group A:

To the question of how he would define interactivity, the tester in this group followed a description closer to reactivity. After some thought, however, he added that "having unexpected things can be interactive". He also added, when asked about the relation between the input and the output, that he felt some dialogue with the system at times, but that he couldn't be sure, saying "only if the PC is so advanced [that] I don't get it". He also added that the audio was "annoying" at times. Finally, when asked about if he felt some degree of interactivity, the answer was "a bit, especially the red button ["restart" button].", adding that "the LEDs helped" but that he "[has] doubts, but [thinks] the PC may receive something".

Group B:

The first tester of this group, when asked about her focus on the "A" area of the input table, responded that she believed it controlled the whole visuals, being confused as to the purpose of the other sections.

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[8] Original in Portuguese: "Se não fizer nada..."
[9] Original in Portuguese: "Ah! Não fazem nada."
[10] Original in Portuguese: "Macacos num laboratório."

When asked about how they would define interactivity, a clear position towards reactivity was clear. All felt some dialogue with the system was present at the start, although the first tester was more doubtful about the relation between input and output. They, however, defined the input table and its buttons as interactive.

Group C:

All testers in this group defined interactivity as reactivity, with the second tester making the comparison of videogames (interactive/reactive) and film (not interactive). The first tester did not feel interactivity in their experience with the installation, while the second tester felt some at the start.

4. Analyzing findings

4.1 Introduction

The results of this analysis and various applications of the mechanisms explored in this dissertation must be analyzed, not to discover if these practical examples failed, but to see where they failed, where they succeeded, and to understand the mechanisms that led to these results, what to change and what additional tools were examined as possibly helpful for the creators of interactive media and non-interactive media that creates a feeling of interactivity.

We will analyze the results gathered by the study of the state of the art, its various examples, and the practical applications of mechanisms discovered in this theoretical framework.

Firstly, the specific tools extracted from the building of the prototype and the installation that accompany the creation of this dissertation must be fully understood, explained and applied to various examples and contexts. The public presentation and testing of these artistic objects also contributed important data on what to do and what not to do when creating a feeling of interactivity where there is no mechanical interactivity. The results from the public tests will be analyzed qualitatively, exploring and understanding the various reactions to these systems and comparing them with the hypothesis and goals stated at the start of the creation of these installations.

Then we must discuss the findings of the theoretical framework that was presented. A purely theoretical approach provides valuable insight, as previous works, books, dissertations, and thesis hold more scientific validity, as they approached this problem from a more specifically design or psychology oriented standpoint.

These methods aim to clarify and systematize the specific mechanisms of interactivity, as well as the tools discovered to exploit psychological biases of the audience that engages with artistic objects they believe are interactive.

It is clear, then, that these methods provide us with less scientific validity than could have been gathered via a full-scale study of these specific tools and mechanisms of interactivity. It must be clear that the aim of this dissertation is not to provide data that can be generalized to all corners of human experience, it is simply a starting point for creators who aim to create this feeling of interactivity in their works. The practical applications of the theories explored in this dissertation are not perfect or flawless, - in fact, I repeat, they face serious problems - and should not be applied with full confidence of their completely effective results. It is hoped that, while reading and analyzing this dissertation, basic guidelines will be understood and applied, although more extensive testing and study should be used to provide the creator of interactive media with more certainties.

It would be nearly impossible to create a perfectly interactive feeling for everyone, equally. These projects tried to reach a serious and difficult goal - the deceiving of all audience into believing in the interactive characteristics of these artistic objects, even where there is no real interactive mechanisms - in order to fail, purposefully, or at least predictably, so as to more effectively find the common flaws in the overtaking of this task. As previously explained, while an installation with clear reactivity would be easier to be portrayed as interactive, mostly due to the lack of separation between reactivity and interactivity by most people, who would judge a purely reactive installation as interactive due to lack of this particular knowledge or semantic position and not the installation's good use of mechanics of interactivity, the goal of this dissertation to create the feeling of interactivity in an installation with limited reactivity would, predictably, encounter more challenges while providing more valuable insight that could, possibly, be applied to reactive installations with more effectiveness. The difficulty of this task would provide more answers, even if less successful.

The study of the state of the art and already known mechanisms of interactivity, especially those that can be transposed to our context, provided us with the theoretical framework that allowed us to apply some techniques to the building of example practical applications. The results of this study and the difficulties in creating the prototypes, as well as the reactions to their public exhibitions, can give the reader suggestions as to what to apply when creating their own artistic objects, be they interactive, reactive or non-interactive.

4.2 Findings

Initially, a study of the state of the art and known mechanisms of interactivity was made, presenting us with interesting tools to apply to artistic objects that aim to deceive their audience. While they have been explored more thoroughly in the previous chapters, the creation of the prototypes allowed a more practical discovery of more common issues and successes of this theoretical framework - where it fails and where it works best when applied to artistic objects that will be presented to an audience.

We can sum up these found mechanics of interactivity as follows:

1. Publicity;

Audiences must believe the experience will be fully interactive before they even see it or experience it. This can be achieved by direct communication, by describing it as interactive in explanations, the title, or accompanying descriptive texts, or indirectly, by presenting the experience in a context where the users can assume a level of interactivity is present.

2. Make it a game;

Not only will placing a challenge and a goal help to keep the audiences engaged, it will also favor some prediction of their actions, making the task of suggesting the processing of input in a creative way more easy, leading to some perceived communication between the user and the system.

3. Vague and puzzling input suggestion;

The user's input, even if not processed, can be a challenge as well. Making sure that the user must spend time solving not only a problem presented possibly at a screen but also by their own attempts at communicating may increase engagement and mask some lack of responsiveness.

4. *Comtivity;*

The perceived vagueness between input and output must be masked. The user must believe this lack of responsiveness comes from a complex system that processes input, without understanding that said system is not even receiving that input.

5. Clear internal cause and effect;

While the relation between input and output may (possibly necessarily) be, vague, the system's inner workings must be clear and predictable. When a user doubts the internal coherence of the machine and the output it presents, if the rules and algorithms that process information change without understandable reason or predictability, frustration may increase to the point that the user's illusion will be shattered.

6. Context;

Somewhat tied in with the first tool, context initiates expectations on the user. If the artistic object is placed in an environment where all or most outputs have meaning and truly interact with the audience, this feeling of interactivity will be projected into the system's output.

7. More immediate suggestions of dialogue;

While a dialogue, even with a system that does not "listen", is the main objective of these projects, some suggestion of a real conversation may be created by correctly predicting the decisions the user will take. Assuming, for instance, that they will fail often before finding or apparently stumbling into a solution, a more immediate comment on this fact in the form of written language may aid the projection of intent and meaning in the perceived decisions the system takes when receiving and processing input.

It must be added that these are tools, not requirements, to create the feeling of interactivity. The reader may use all of them or only some, and may apply these suggestions towards reactive or fully interactive experiences, as a way to enhance the engagement with the medium. In fact, this dissertation was created to provide creators of non-interactive, reactive, and interactive experiences alike with interesting tools and avenues.

The discoveries gathered while building and presenting the two prototypes that accompany this dissertation have also been discussed in a more complete fashion in previous chapters, but can be summed up for a more effective understanding and easier understanding:

1. Context;

While, as we've seen previously, context is described as a powerful tool to jump-start expectations and projections of feelings of interactivity into artistic objects that are placed in the correct environment, the prototypes failed in positively testing this hypothesis. Presenting them in an academic setting, as well as having the presence of someone taking notes on the behaviors and comments of the users, caused the testers to feel like "lab monkeys", often searching for validation in the creator of the installations instead of focusing on solving the puzzle. This, however, negatively shows the powerful effect of context - these behaviors may be attributed to these less than ideal surroundings, showing that, at least, the lack of proper context is a distraction and detracts from the desired experience.

2. Extreme *comtivity*;

As mentioned in the adequate chapter, *comptivity* must be used with care[11]; calibrations to its effect must be properly tested before any public appearance outside of a test context. Levels of frustration during the use of Behavioral Economics, as well as the smaller prototype, were more elevated due to a more intense complexity. Analyzing the provided code, as well as the scrutiny of these specific conditions in chapter 3, may give the reader a more effective guide at adjusting the levels of complexity of their creations.

3. Slow experience;

While an active and interesting experience betters the intended experience, this must be balanced with the clarity and coherence of the internal systems of the machine. This balance proved to be another area where more intense testing must be done. Behavioral Economics leaned too heavily on the internal mechanisms of the

[11] Drummond (2009) explains this situation as follows, "the way an interactive music system responds to its input directly affects the perception and the quality of the interaction with the system. A system consistently providing precise and predictable interpretation of gesture to sound would most likely be perceived as reactive rather than interactive, although such a system would function well as an instrument in the traditional sense. Conversely, where there is no perceptible correlation between the input gesture and the resulting sonic outcome, the feel of the system being interactive can be lost, as the relationship between input and response is unclear. It is a balancing act to maintain a sense of connectedness between input and response while also maintaining a sense of independence, freedom and mystery; that the system is in fact interacting not just reacting. A sense of participation and intuition is difficult to achieve in designing interactive systems and each artist and participant will bring their own interpretation of just how connected input and response should be for the system to be considered interactive" (p. 128)

system, giving users time to experiment with the input and sometimes more quickly discover their true workings.

However, the tests made to the prototypes, if small, did provide positive suggestions towards the validity of the hypothesis, notably:

1. Tactile feedback;

Bongers' view of tactile feedback as important, adding another layer of sensory responsiveness to the use of the installation, seemed to improve the experience of all testers, who enjoyed the mechanical movements and clicks provided by the on/off buttons and dials.

2. Auditory feedback;

The addition of a responsive feedback of button clicks, processed and played by the systems speakers, increased the satisfaction already present in using the buttons.

3. Some responsiveness is necessary;

While there was an attempt at minimizing the level of responsiveness present in the prototypes, the inevitable sparks of it resonated with the testers. While little user-system responsiveness was present in the installations, the input table provided tactile and visual feedback by itself.

4.3 Improvements and future work

One aspect of this dissertation, presented project prototype installations and testing of said prototypes, that lacks substance in an academic and scientific setting is the case of its scientific validity.

Without deeper work into creating a controlled testing of prototypes, followed by improvements, if minute, to several elements where the current installation and analysis failed due to insufficient data, the findings gathered by the study of the state of the art and the creation of practical examples cannot be generalized with confidence. As stated before, limitations were consciously placed on the scope this dissertation would work with, and there is an awareness of the lack of scientific validity.

Therefore, in future work regarding the topic of this dissertation and its installations, a longer, more robust study must be conducted, including an immensely wider testing demographic as well as sheer number of participants in the evaluation of the prototypes. Many smaller studies would have to be conducted in order to calibrate elements such as the balance between internal coherence and complexity; the more iterations and testing the prototypes can go through, the more accurate and predictable their results will be.

A research team would also provide these studies with a wider range of knowledge that lacked the current one; the fields of psychology and game design were particularly lacking, as an analysis on the psychological mechanisms that create the feelings of interactivity we aimed to cause, as well as a more engaging and just design of the game part of the installation would increase its chances of success and lower the amount of iterations the prototype would have to pass through. This suggestion was described by Drummond, as follows (2009, p.125):

> *Critical investigation of interactive works requires extensive cross-disciplinary knowledge in a diverse range of fields including software programming, hardware design, instrument design, composition techniques, sound synthesis and music theory.*

If possible, an exploration of not only non-reactive and non-interactive installations should be made, including research and the creation of prototypes of reactive but not interactive pieces, as well as fully interactive artistic objects where our findings can be applied so as to exemplify their wider use. So far, with the present dissertation, results cannot be generalized, and applications beyond non-reactive and non-interactive approaches would be even less predictable and consistent.

Without question, the problems presented in the previous chapters, where we analyzed the building and testing of the prototype installations, would have to be fully explored, replicated and fixed. A presentation on a public setting with a less invasive documentation technique could potentially change the perception of the installations by itself, although other issues like their obtuse design, extreme complexity and less than active experiences would require further study and application of knowledge and tools both better than presented and built in these examples or, as well, different and new.

5. Conclusion

This dissertation has grown from a wish to explore the phenomenon that deceive audiences into feeling interactivity where there is none, to a gathering of important mechanisms, as well as analysis of the cultural contexts, that provide this feeling, demonstrated by the construction and presentation of a prototype and an installation.

Due to the lack of a larger and more controlled study, the results of this project should not be generalized or taken as infallible. The creation of this feeling of interactivity where there is none has mixed results, as cultural backgrounds and knowledge of the study area, among many other decisive variables, may vary wildly from audience to audience, and user to user. As discussed in chapter 4, this project was developed as a way to show a practical application of the methods collected during the study of the state of the art. A choice was made, when designing these projects, to take the more troublesome and complex path, so as to give the reader a better sense of where their own attempts may fail and what decisions work the best.

Nevertheless, this dissertation's goals were mainly completed. An analysis of the state of the art was made, providing many real examples where the feeling of interactivity exists despite a lack of technical interactivity, as well as explorations on the topics of creativity, form, generation of data and, of course, interactivity, so as to define them accurately so the resulting theoretical framework could be applied to practical examples. The first prototype and the *Behavioral Economics* installation, however, did not meet expectations. Lack of testing and of a proper amount of volunteers provided less than ideal chances to find and fix areas where the practical application did not succeed. However, most of these issues negatively reinforce the presented hypothesis, notably on the importance of context and on the existence of a fine balance between coherence and complexity.

6. References

Bibliography

- Boden, M. (1990). *The Creative Mind* (2nd Edition - 2004). London: Routledge.

- Bongers, B. (2000). Physical Interfaces in the Electronic Arts: Interaction Theory and Interfacing Techniques for Real-time Performance. M. M. Wanderley and M. Battier, *Trends in Gestural Control of Music* (pp. 41-70), Paris: *Ircam - Centre Pompidou*.

- Carruthers, P. (2011). Creative action in mind. *Philosophical Psycology,* 24(4), pp. 437-461, Routledge.

- Carvalhais, M. (2016). *Artificial Aesthetics*. Porto: U.Porto Edições.

- Chomsky, N. (2002). *Media Control*. New York, NY: Seven Stories Press.

- Chomsky, N. (2003). *Understanding power: the indispensible Chomsky*. London: Vintage Books.

- Cope, D. (2005). *Computer Models of Musical Creativity*. Cambridge, MA: The MIT Press.

- Drummond, J. (2009). Understanding Interactive Systems. *Organised Sound,* 14(2), 124-133, doi:10.1017/S1355771809000235.

- Eustáquio, L. (2012). *Uma exploração de open hardware no campo da imagem* (Master's degree dissertation). Retrieved from Repositório Aberto da Universidade do Porto (http://hdl.handle.net/10216/70332).

- Eustáquio, L. (2017). *Interaction under interference* (unpublished paper).

- Giskin, H. (2005). Borges' Revisioning of Reading in "Pierre Menard, Author of the Quixote". *Variaciones Borges,* 19, 103-123.

- Hall, S. (2006). Encoding/Decoding. In Meenakshi Gigi Durham and Douglas M. Kellner, *Media and Cultural Studies - Keywords* (pp. 163-173). Hoboken, NJ: Blackwell Publishing.

- Hunicke, R., LeBlanc, M., Zubek, R. (2004). *MDA: A Formal Approach to Game Design and Game Research*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.79.4561

- Huyssen, A. (1986). *After the Great Divide*. Bloomington, IN: Indiana University Press.

- Minsky, M. (1988). *The Society of Mind*. New York, NY: Simon and Schuster.

- Rowe, R. (2001). *Machine Musicianship*. Cambridge, MA: MIT Press.

- Sawyer, R. K. (2012). *Explaining Creativity: The Science of Human Innovation.* New York, NY: Oxford University Press Inc.

- Searle, J. (1990). Is the Brain's Mind a Computer Program?. *Scientific American*, 262(1), 26–31, Springer Nature.

- Searle, J. (1980). Minds, Brains, and Programs. *The Behavioral and Brain Sciences*, 3, 417-457, Cambridge University Press.

- Searle, J. (1984). *Minds, Brains, and Science.* Cambridge, MA: Harvard University Press.

- Weizenbaum, J. (1976). *Computer Power and Human Reason: From Judgment to Calculation*. San Francisco, CA: W.H. Freeman and Company.

- Weizenbaum, J. (1983). ELIZA: A Computer Program for the Study of Natural language Communication Between Man and Machine, *Communications of the ACM* 26(1), pp.23-28, Association for Computing Machinery.

Referenced works

Quantic Dream; Beyond: Two Souls, 2013.

Lucas Werthein and Jason Aston; Boom Shakalaka, 2010.

Campo Santo; Firewatch, 2016.

Cardboard Computer; Kentucky Route Zero, 2013 (unfinished (2017)).

Asmik Ace; LSD Dream Emulator, 1998.

Fred Penelle, Yannick Jacquet, Matthieu Safalty; Mécaniques Discursives, 2013.

Finji; Panoramical, 2015.

Nullpointer; QQQ, 2002.

The Other 90% Technologies; Mind Drive, 1997.

Borges, J. L. (1939). *Pierre Menard: autor del Quijote*. Retrieved from: www.genius.com/Jorge-luis-borges-pierre-menard-author-of-the-quixote-annotated

Four Quarters; Please, Don't Touch Anything, 2015.

Team Meat; Super Meat Boy, 2010.

Telltale Games; The Walking Dead, 2012.

Araújo, J. T. M. (2015). *TV Grotesque*. Available at: https://youtu.be/cWoffJBgBfI

Referenced internet links

p. 30 - Anonymous; Do choices matter in Beyond: Two Souls? - Arqade - https://gaming.stackexchange.com/questions/134004/do-choices-matter-in-beyond-two-souls

p. 31 - Elise Favis; Opinion – Your Choices Don't Matter In Telltale Games - http://www.gameinformer.com/themes/blogs/generic/post.aspx?WeblogApp=features&y=2015&m=02&d=03&WeblogPostName=why-your-choices-dont-matter-in-telltale-games&GroupKeys=

p. 33 - Tamas Kemenczy; The Scenography of Kentucky Route Zero - https://youtu.be/nh_o8JEmVdw

p. 33 - Jake Elliott; Jake Elliott - 'Designing For Mystery In Kentucky Route Zero' - https://youtu.be/XLYAxYGzhBw

p. 49 - Extra Credits; Fail Faster - A Mantra for Creative Thinkers - Extra Credits - https://youtu.be/rDjrOaoHz9s

Annexed Materials

The following is the entirety of the code for Processing for the *Behavioral Economics* installation. It includes a debug function that can be turned on or off by changing the value at the boolean variable *debug* to *true* or *false*:

```
import processing.video.*;
import oscP5.*;
import netP5.*;


//DEBUG
boolean debug = true;
String txt1;
String txt2;
String txt3;
String txt4;
String txt5;
String txt6;

Movie mov1;
Movie mov2;
Movie mov3;
Movie mov4;
Movie mov5;
Movie mov6;
Movie mov7;
Movie mov8;
Movie mov9;
Movie win;

//Variable init for OSC
OscP5 oscP5;
NetAddress pd;
```

```
//Diferent info check for OSC
int diffmess;

//Init of current file
int selection;

//Number of lose video files
int num = 9;
color pixel;
int pixelX;
int pixelY;

//DEBUG image
PImage image;

//Counter - Current frames
int pxcounter;
int counter = 0;

//Win - seconds until auto win
int secs = 300;

//Average
int avg;

void setup() {
  //fullScreen();
  fullScreen(P2D);
  frameRate(30);

  //Selection - MENU
  selection = 0;



  //List of files to load
```

```
  mov1 = new Movie(this, "lose1.mp4");
  mov2 = new Movie(this, "lose2.mp4");
  mov3 = new Movie(this, "lose3.mp4");
  mov4 = new Movie(this, "lose4.mp4");
  mov5 = new Movie(this, "lose5.mp4");
  mov6 = new Movie(this, "lose6.mp4");
  mov7 = new Movie(this, "lose7.mp4");
  mov8 = new Movie(this, "lose8.mp4");
  mov9 = new Movie(this, "lose9.mp4");
  win  = new Movie(this, "win1.mp4");

  // OSC
  // Listening Port
  oscP5 = new OscP5(this, 9001);
  // Sending Port
  pd = new NetAddress("127.0.0.1", 8000);

  //MENU image
  image = loadImage("introbox.jpg");
}

void draw() {
  //Play order for file
  //If selection = x*100, x=file, selection changes so play occurs once and image occurs
always
  if (selection!=0) {
    counter++;
  }

  if (selection==0) {
    //MENU
    background(0);
    image(image, 0, 0);

    //Title name
    textSize(80);
```

```
  textAlign(CENTER);
  fill(255);
  text("Behavioral Economics", width/2, 250);

  //Instructions
  textSize(40);
  textAlign(CENTER);
  fill(255);
  text("Press RESTART button to continue", width/2, 450);

  if (keyPressed && key=='6') {
    //START button
    selection = int(random(num)+1);
  }
}

if (selection==1) {
  mov1.play();
  selection=100;
}
if (selection==2) {
  mov2.play();
  selection=200;
}
if (selection==3) {
  mov3.play();
  selection=300;
}
if (selection==4) {
  mov4.play();
  selection=400;
}
if (selection==5) {
  mov5.play();
  selection=500;
}
```

```
if (selection==6) {
  mov6.play();
  selection=600;
}
if (selection==7) {
  mov7.play();
  selection=700;
}
if (selection==8) {
  mov8.play();
  selection=800;
}
if (selection==9) {
  mov9.play();
  selection=900;
}
if (selection==10) {
  win.play();
  selection=1000;
}

//Video visualizer
//mov1
if (selection==100) {
  image(mov1, 0, 0, width, height);
  if (mov1.time()>=mov1.duration()) {
    mov1.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 1;
      while (selection==1) {
        selection = int(random(num)+1);
      }
    }
  }
```

```
}

//mov2
if (selection==200) {
  image(mov2, 0, 0, width, height);
  if (mov2.time()>=mov2.duration()) {
    mov2.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 2;
      while (selection==2) {
        selection = int(random(num)+1);
      }
    }
  }
}

//mov3
if (selection==300) {
  image(mov3, 0, 0, width, height);
  if (mov3.time()>=mov3.duration()) {
    mov3.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 3;
      while (selection==3) {
        selection = int(random(num)+1);
      }
    }
  }
}

//mov4
if (selection==400) {
```

```
  image(mov4, 0, 0, width, height);
  if (mov4.time()>=mov4.duration()) {
    mov4.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 4;
      while (selection==4) {
        selection = int(random(num)+1);
      }
    }
  }
}

//mov5
if (selection==500) {
  image(mov5, 0, 0, width, height);
  if (mov5.time()>=mov5.duration()) {
    mov5.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 5;
      while (selection==5) {
        selection = int(random(num)+1);
      }
    }
  }
}

//mov6
if (selection==600) {
  image(mov6, 0, 0, width, height);
  if (mov6.time()>=mov6.duration()) {
    mov6.stop();
    if (counter>30*secs) {
```

```
      selection = 10;
    } else {
      selection = 6;
      while (selection==6) {
        selection = int(random(num)+1);
      }
    }
  }
}

//mov7
if (selection==700) {
  image(mov7, 0, 0, width, height);
  if (mov7.time()>=mov7.duration()) {
    mov7.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 7;
      while (selection==7) {
        selection = int(random(num)+1);
      }
    }
  }
}

//mov8
if (selection==800) {
  image(mov8, 0, 0, width, height);
  if (mov8.time()>=mov8.duration()) {
    mov8.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 8;
      while (selection==8) {
```

```
        selection = int(random(num)+1);
      }
    }
  }
}

//mov9
if (selection==900) {
  image(mov9, 0, 0, width, height);
  if (mov9.time()>=mov9.duration()) {
    mov9.stop();
    if (counter>30*secs) {
      selection = 10;
    } else {
      selection = 9;
      while (selection==9) {
        selection = int(random(num)+1);
      }
    }
  }
}


//win
if (selection==1000) {
  image(win, 0, 0, width, height);
  if (debug == true) {
    if (keyPressed && key=='5') {
      win.jump(75);
    }
  }
  if (win.time()>=win.duration()-5) {
    win.stop();
    print("restart");
    counter = 0;
    pxcounter = 0;
```

```
    selection = 0;
  }
}


//Fills space
pxcounter++;
if (pxcounter<width*height) {
  pixelX += 20;
  if (pixelX>width) {
    pixelX = 0;
    pixelY += 20;
  }
  if (pixelX+(pixelY*width)>height*width-1) {
    pxcounter = 0;
    pixelX = 0;
    pixelY = 0;
  }
}

loadPixels();

//Aimed at Pixel
pixel = pixels[pixelX+(pixelY*width)];


//Finds average of all pixels
for (int i = 0; i < pixels.length; i++) {
  avg = avg + (pixels[i] & 0xFF);
}
avg = avg/pixels.length;

//OSC
if (counter%5==0) {
  oscP5.send(new OscMessage("/AVG").add(avg), pd);
  println("OSC AVG message sent");
```

```
}
if ((pixel & 0xFF) != diffmess) {
  oscP5.send(new OscMessage("/PIXEL").add(pixel & 0xFF), pd);
  diffmess = (pixel & 0xFF);
  println("OSC PIXEL message sent");
}



//DEBUG visualizer of chosen pixel
if (debug==true) {
  fill(pixel);
  noStroke();
  ellipse(pixelX, pixelY, 20, 20);
  rect(pixelX, 0, 1, height);
  rect(0, pixelY, width, 1);
}

//DEBUG visualizer of files' time data
if (debug==true) {
  textSize(20);
  textAlign(CENTER);
  fill(150);
  txt1 = "DUR 1: "+str(mov1.duration())+" 2: "+str(mov2.duration())+" 3:
"+str(mov3.duration());
  text(txt1, width-300, 100);
  txt2 = "4: "+str(mov4.duration())+" 5: "+str(mov5.duration())+" win:
"+str(win.duration());
  text(txt2, width-300, 150);
  txt3 = "TIME 1: "+str(mov1.time())+" 2: "+str(mov2.time())+" 3: "+str(mov3.time());
  text(txt3, width-300, 200);
  txt4 = "4: "+str(mov4.time())+" 5: "+str(mov5.time())+" 6: "+str(mov6.time());
  text(txt4, width-300, 250);
  txt5 = "7: "+str(mov7.time())+" 8: "+str(mov8.time())+" 9: "+str(mov9.time());
  text(txt5, width-300, 300);
  txt6 = " win: "+str(win.time());
  text(txt6, width-300, 350);
```

```
    text("Counter: "+str(counter/30), width-300, 500);
  }
}

void movieEvent(Movie mov) {
  mov.read();
  mov.volume(0);
}
```