AN EXPLORATION OF THE INTERNET'S EMBODIED NARRATIVES THROUGH SOFTWARE DIAL-UP MODEMS: ATEMPORALITY, NEUTRALITY, IMMATERIALITY

Cyrus Lognonné Khalatbari

A Thesis
in
the Department of
Design & Computation Arts

Presented in Partial Fulfillment of the Requirements
for the Degree of Master of Design at
Concordia University
Montreal, Quebec, Canada

June 2021

CONCORDIA UNIVERSITY
School of Graduate Studies

This is to certify that the thesis prepared

By: Cyrus Lognonné Khalatbari

Entitled: An exploration of the internet's embodied narratives through software dial-up modems: immateriality, neutrality, physicality

and submitted in partial fulfillment of the requirements for the degree of

Master of Design

complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the final Examining Committee:

_____ Examiner
Rilla Khaled

_____ Examiner
Jonathan Lessard

_____ Supervisor
Pippin Barr

Approved by _____
Dr. Martin Racine, Graduate Program Director

June 2021 _____
Dr. Rebecca Taylor Duclos, Dean of Faculty of Fine Art

ABSTRACT

An exploration of the internet's embodied narratives through software dial-up modems: immateriality, neutrality, physicality

Cyrus Lognonné Khalatbari

My research-creation thesis is not about the internet itself. It is about the way we frame and understand that network. It is, more specifically about its narratives: metaphors and discourses that are developed and engineered by internet stakeholders in order to reinforce their position and, ultimately, gain control of our data. Starting from the ubiquitous metaphor of the internet cloud that depicts the internet as a non-tangible and harmless object we observe from far, my thesis triangulates between three sub-discourses emerging from this narrative. These are the illusion that our internet processes are 1) atemporal, 2) neutral and 3) immaterial. As a research-creation thesis, it moreover inquires into these beliefs by engaging with a specific technology that I argue as foundational for deconstructing these narratives: the dial-up modem that was used during the early internet era to create an internet connection. Contextualising this technology inside a web of artistic, theoretical and methodological references, my thesis guides the reader through four design projects where these analog modems are used in a critical and speculative way. In opposition to the way internet processes are crafted by engineers as purely operational, optimized and seamless, these projects serve as a way to reflect on the internet's materiality and embodied discourses. Moreover, they serve as frameworks to make explicit the temporal, political and material characteristics of the infrastructure.

Keywords: internet narratives and metaphors, applied media archeology, data flow, internet cloud, critical and speculative computing.

ACKNOWLEDGEMENTS

First, I would like to thank my thesis supervisor, Pippin Barr. Pippin, working with you has been an honour and a privilege. I started this thesis with a heavy dose of jargon and after a never ending void of Google Docs named as *Entire Thesis > Jam, V2 > RoadMap > Thesis, Master's Thesis Jam, Case studies + Future works + Problematics, Iteration 2 > Thesis, Master's Thesis Jam > PLANV3, Master's Thesis Jam > PLANV4 > Cyrus, 2_Thesis*...here is where we are. Thank you for your rigour and your precision, this really enabled me to give my work a direction. Thank you for the patience, trust and emotional support you provided me during these years, this has been crucial.

J'aimerai également remercier mes parents. Quelle chance de vous avoir...En plus de votre soutien sans faille, vous m'avez tous les deux donné l'envie de m'embarquer dans cette aventure, d'explorer les zones grises où théorie critique, art et technologie s'entremêlent...Azi: de par le journalisme et la philosophie des sciences, j'ai développé ce désir d'être curieux et d'écrire; de questionner notre rapport au monde et aux systèmes techniques qui nous entourent. Philou: de par la planétologie et la géophysique, j'en suis venu à faire des nouveaux liens qui m'étaient jusque là inconnus et qui me semblent maintenant ô combien excitants pour mes futurs projets artistiques et recherches.

I would also like to thank David (Jhave) Johnston, Rilla Khaled, Jonathan Lessard, Sabine Rosenberg, Fousse, and ma soeur Louisie.

This thesis is meant to be read while listening to the following: *Aphex Twin - Selected Soundcloud Works, Aphex Twin - Selected Ambient Works Volume 1.5*, *Aphex Twin - Selected Ambient Works Vol. 3 (2015) - user48736353001 compilation*, *Aphex Twin - Selected Ambient Works Vol. 4 (2015) - user48736353001 compilation pt2*, *Rain Sound and Rainforest Animals Sound - Relaxing Sleep*. *Happy reading.*

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

From a broad perspective, the research I present here emerges from the debate gravitating around the concept known as *network neutrality* (Wu, 2003). This concept, developed by the media law scholar Tim Wu in 2003, argues that the internet needs to stay a neutral and inclusive space for all its users at the level of its materiality - and how this materiality is being implemented on a daily basis. Moreover, Wu argues that Internet Service Providers (ISP) must treat all Internet communications equally and not discriminate against users or websites based on decided parameters - such as content, geographical location, type of equipment, and so on. A clear and infamous example of these types of practices is known as *bandwidth throttling* and happens at the level of the internet's protocols. Bandwidth throttling consists of restricting the speed of data transmission coming from server to a website in order to create a hierarchy of users accessing the website. Conducted in the context of streaming platforms such as Netflix or YouTube for an example, this behaviour enables firms to privatize the network and reinforce their capitalistic agenda.

This debate, resurfacing frequently in the media for the previous five years, has been foundational to crystallize my will to explore the internet infrastructure from a critical perspective and inside an academic context. Being interested in architecture as well as crossovers between design and political theories of the built-space, understanding design as *normative* (e.g: imposing norms on us and on our behaviours) has already been an important aspect of my thoughts and research. However, this debate has been foundational for me, in the sense that it connected my perception of the design activity with digital infrastructures. As a digital designer and programmer working with technology, this concept of network neutrality led me then to question the underlying power structures embedded inside programming. In other words, engaging with this debate has been critical to kickstart my research on the internet's protocols and on the power structures and narratives these pieces of code

embody.

In dialogue with a network of artists, scholars and designers, my thesis questions this concept of network neutrality. More specifically, it examines the technical concept and metaphor of *cloud* computing, a data transmission and hosting infrastructure where the content is served to the user from external servers and third-parties. In dialogue with this infrastructure, I argue that the analogy of the *cloud* serves a capitalist agenda and is used by ISPs as a narrative that obfuscates the complexity of the network and over-simplifies the way it works. In this thesis, I break down the *cloud computing* narrative into three smaller narratives that are developed by the internet's engineers and reinforced by its privatized stakeholders. These narratives are the illusions that the network is atemporal, neutral and immaterial. More specifically, it is first the illusion that data transmission (inside the network) does not have a temporality and that data *flows* instantaneously; without interruption or friction. Then, it is the belief and illusion that the internet - since it appears as intangible and ephemeral - is neutral and that its materiality does not affect data as well as how it is being transmitted. Finally, it is the narrative that the internet does not have a physicality and only appears as digital. As a research-creation project, I question these narratives in dialogue with the work of artists, designers and scholars; as well as with the technology I use in my projects that contradicts these narratives: the software dial-up modem.

From this perspective, I ask through my thesis the following research questions:

- How can we use the software dial-up modem as a counterexample to deconstruct and critique the metaphors and illusions of the flow and the cloud?
- Using this technology in order to contradict through design these narratives, how can we create situations and experiences where users will critically reflect on these illusions and beliefs?

Moreover, how can we make explicit the fact:

- That the internet materiality and protocols - even though optimized for reinforcing this illusion of connectivity and flow - manipulate time as well as our perception of time?
- That these protocols are not neutral but are normative and define a specific way for us to communicate?

Finally and in a more speculative manner:

- How can we create design situations to speculate and reflect on the connexions between the earth and the internet's data transmission processes?

Starting with the first narrative at the top level of my thesis, I review artworks that explicitly explore the temporal characteristics of the network. Drawing from the net.art current that uses the affordances and restrictions of the internet's materiality to create art, I argue that the internet is temporal and that this temporality emerges from the internnet's protocols. In dialogue with net.art projects where foundational internet's protocols (such as the HTTP/IP or the DNS) are detoured outside of the purely operational and used to generate crashes, delays and unexpected user interactions, I argue moreover that this *atemporality* is an illusion that has been crafted and engineered. Moreover, with the research of internet media scholars, I expand on the concept of micro-temporalities which is central in understanding how temporality operates inside *distributed* infrastructures such as the internet. In dialogue with these artists and scholars, I finally expand on my rationale for using the software modem as a means to subvert this narrative of data transmission atemporality through the creation of critical design projects and interactions.

Still within the context of net.art, I then critically explore the second narrative I seek to deconstruct: the belief that the network is neutral because it appears as intangible and digital. In

opposition to this illusion reinforced by the analogy of the *cloud* as a harmless object, I argue that data transmission happening inside the internet's material infrastructure is modulated; and that this modulation happens at the level of the internet's protocols. Starting from an analogy with our built-space and road infrastructure, I argue that inside the internet these protocols take the form of internet *routes* that have an impact on the transmission process as well as on its final output based on what their materialities afford and restrict. In dialogue with software studies scholars and net.art projects focusing on making visible these power-structures embodied inside the internet's digital or physical protocols - whether Application Programming Interfaces (API) or packet radios - I circle back to my rationale on engaging with software modems. Through the realisation of critical games, engaging with software modems becomes thus a way to make visible and reflect on the politicality of these protocols inside our data transmission processes.

Finally, my thesis questions the third and final illusion emerging from the *cloud computing* narrative: the belief that the network does not have a physicality and does not emerge from the earth's raw matter. More than arguing that the internet is, at its foundational material base, an entire infrastructure of routers, modems, radio waves, electric currents, undersea cables and others, this seeks to deconstruct this narrative by taking a speculative and geophysical turn. More specifically, what I am interested to explore here is the intersection between the internet's infrastructure and the raw matter that constitutes it, between the internet's platform (and interfaces we interact with) and the internet's infrastructure geophysical context of execution. Using this approach, I argue that the internet's materiality is not limited to hardware but needs to take into account what Bratton defines as "the earth layer" (Bratton, 2015). In dialogue with internet scholars as well as media arts practitioners intertwining land art with computational processes, I expand on two design provocations I have designed in dialogue with software modems that serve my critical reflection on the matter.

From this perspective, my thesis expands on how dial-up modems are foundational to my critical technical practice deconstructing the metaphor of the cloud and challenging its sub-discourses of atemporality, neutrality and immateriality. Drawing from this primitive and analog data

transmission platform, I assert that dial-up modems have significant potential to detour our seamless data transmission processes and reinforce these processes' temporal, political and material characteristics.

OVERVIEW OF CHAPTERS

During my master's degree, my research questions and problematics shifted and evolved in the light of conversations, readings and artists I have discovered. As a result, this thesis is not composed of a single problematic but a body of research questions that are intertwined together and from which my research practice emerges. However, there is a constant inside these research questions: exploring through art and design projects the materiality of the internet. In particular, I have sought to tackle how this materiality embodies three dominant narratives about data transmission: neutrality, atemporality and immateriality. As an exploration of the internet's data transmission processes happening inside the internet, my thesis follows the structure of the Open Systems Interconnection model (OSI model), the conceptual model that characterises and standardises data transmission as a succession of layers going from the interface (Application layer) to the hardware (Physical layer). Following this model, which I will review in detail in § 2.6, this thesis proceeds as follows:

First chapter:

The first chapter is dedicated to introducing the theoretical and artistic network of ideas and projects from which my work emerges. These clusters are:

1. *The interface/Application layer.*

   This section focuses on works tackling the idea of the internet as political and of data transmission happening inside our platforms as regulated, controlled and temporal. From this perspective, this § seeks to explore the false narrative of internet atemporality and immateriality. In these sections, I introduce the key concept of protocols and platforms, two frameworks that I use as starting points to explore how

the internet (and all technologies) embody a set of rules and discourses inside their materiality and design. From an artistic perspective, exploring these concepts of network and infrastructure politics leads me to the analysis of projects from net.art. The net.art movement becomes valuable because it acknowledges the internet as a political environment with affordances and constraints; it subverts elements of web interfaces and data transmission processes and uses them as a medium for making art. In dialogue with this artistic current and the work of scholars concerned by politics and temporalities embodied inside the internet, I introduce my object of study: the dial-up software modem technology. Moreover, in dialogue with three net.art projects exploring different facets of the internet's protocological nature, I expand on my rationale behind working with software dial-up modems.

2. *Hardware layer*

   Whereas the previous § aims to deconstruct false narratives of internet neutrality and atemporality, this § explores through art and design projects the belief that data transmission and the internet is purely digital and does not depend on physical characteristics. In this section, I expand on works of artists and engineers that do not focus on the user interface but on protocols and data transmission processes that are analog and whose physicality is explicit, such as packet radio. As in the previous section, I create a dialogue between these projects and software modems as my own object of study.

3. *From the Hardware layer to the activity of the earth.*

   Shifting from interfaces to hardware and from digital data to analog signals, I have been finally interested in opening my research to problems related to the intersection between data transmission and the activity of the earth. Drawing from narratives of

the internet's atemporality and neutrality I debunked in the first and second section, I connect my work on modems with the work of artists and scholars approaching media from an environmental and geophysical perspective.

Second chapter:

In the second chapter of my thesis, I connect my work with a broader context of *research through design* frameworks as well as the body of methods I actively engage with. This chapter goes as follows:

1. *What is research-creation and where does it come from?*

   Designing my research within an interdisciplinary frame that crosses multiple disciplines, I first introduce the reader to the historical context and key problematics of *research-creation*. Research-creation is the foundational paradigm within which my work operates. I situate research-creation inside a larger context of academic ideas and approaches in order to make it intelligible for the broader audience reading this thesis. These contexts are the emergence of design as an academic discipline, concepts of the "wicked problem" (Rittel and Webber, 1973) and discursive practices conducting research *through* making.

2. *Research-creation frameworks*

   In dialogue with this research-creation paradigm and the theoretical and artistic context I have introduced in the previous chapter, I expand on the concept of critical technical practice that is specific to technology making. Operating from a critical technical practice standpoint becomes a way to situate my work inside a broader network of practices that question technology *through* making outside of the market incentives: critical making and critical engineering. In addition, I also connect my

research with media archeology, a research framework that builds on top of critical technical practices. Inspired by Foucault's *archeology of knowledge* (1969), media archeology seeks to question discourses and values embodied in media by searching for (and shedding light on) counter-narratives, noises and accidents of media history. In dialogue with media history, I expand on modems and connect these inquiries with my object of study.

3. *Design methods*

   In relationship with these research-creation frameworks, I then walk the reader through the body of research methods I engaged with during my thesis. From prototyping to the method for design materialisation and analysis (MDMA) and speculative sketches. I have used these methods in order to quickly embody my ideas and assertions in design while materialising and keeping a trace of my process in order to produce meaningful data and insights, reframe on my research trajectories and use these to build my research rationale. This § concludes with my investigations into the creation of new methods that better suit my projects, expanding on MDMA in order to find new ways to materialize my design content and trajectories that are site specific to developing critical software.

Third chapter:

The third chapter is where I expand on my design projects while connecting these with the network of ideas and practices that influenced my research and determined my object of study. Developed in an iterative format and following the shift that occured in my research problematics I introduce in the first chapter, I have separated this chapter into the following three clusters of projects:

1. *Foundational work: debunking connectivity inside digital platforms*

   This cluster is foundational to my work with modems. Moreover, it contextualises my modem work with the OROBOROGRAM (§ 3.2) project. This work tackles the central narrative of data transmission flow from where my modem works originate. Through this software bot project, I moreover question and deconstruct how connectivity (and the illusion of a seamless browsing experience) is crafted through the network at the level of its interface and protocols. This engineered process, creating in turn the illusion of an atemporal and effortless browsing time experience, serves as the entry point of my research-creation projects. Drawing from this, I expand on my work engaging with modems inside our seamless data transmission circuits. These are:

2. *Temporality of data transmission*

   In this cluster, I expand on the MODEM_BROWSER (§ 3.3) and the 2X (§ 3.5) projects. This cluster proposes to use the modem as a frame to critically address and deconstruct the narrative of data transmission atemporality. By doing so, it uses modems to stretch and make explicit the temporality of data transmission that we usually perceive as flowing and instantaneous when we browse on the internet. I contextualise these works in dialogue with the artists I introduced earlier whose work tackles the concepts of platforms, protocols' disruptions, and embodied micro-decisions. In addition, I create a dialogue between my work and those scholars whose ideas assert that data does not flow freely inside the internet's circuit of transmission but is operated and transmitted through a circuit of micro (and disconnected) temporalities. Zooming in to the level of the modem technology, I reflect on this perspective inside my modem inquiries. Using the primitive modem platform and protocol whose temporality is explicit inside a digital context becomes therefore a way to hijack this embodied narrative of atemporality and explicitly turn data transmission into a temporal process.

3. *Political agency of protocols*

   In this cluster, I expand on the MODEM_GUESSR (§ 3.4) and the 2X (§ 3.5) projects. This project uses the modem to make the normative role (and political nature) of protocols explicit. Where the distributed protocols of our actual internet are based on logic of modulations with each of these nodes having an impact on the data transmission output, I zoom into the level of the modem's protocol to amplify this characteristic. Moreover, I use the modem's protocol *baud rate* as a frame and metaphor to assert that, even though our modern internet is optimized to enable this illusion of neutrality, it still governs and controls our data at the level of its distributed protocol nodes. In dialogue with this research angle, I connect the MODEM_GUESSR to works produced by artists and scholars that critically engage with this narrative.

4. *The physicality of data transmission*

   In this cluster, I expand on the 2X (§ 3.5) and the EARTH_MODEM_GUESSR (§ 3.6). Taking a more speculative and fictional turn, I explore how the modem can be used as a catalyst for questioning the internet's materiality beyond its infrastructure; exploring the intersections between its processes and the activity of the earth itself. Inside this frame, I consider moreover the material nature of the earth as defining a protocol which has agency on the internet's platform at the level of its hardware infrastructure, disrupting our data transmission processes and altering its illusion of connectivity and flow. Contextualising these projects inside a body of artistic and academic inquiries, this cluster gives the reader an overview of my future research directions.

Conclusion

In the conclusion, I first guide the reader through two research clusters that shape how the thesis can be interpreted and read. The first cluster inquires into the internet's narratives. Drawing from the foundational Open Systems Interconnection (§ 1.7) model in which the internet is structured into seven layers - from the interface and application to the physical and hardware - I expand on my three core research questions about the atemporal, neutral and immaterial narratives of the internet. The second research cluster relates to the epistemological framework of research-creation and the desire to bridge gaps between critical design and internet theory. Bridging infrastructural hacking (§ 1.8), media archeology (§ 2.7 to § 2.10) and critical technical practices (§ 2.5), I reflect here on frameworks and methods of inquiry into the internet's materiality outside technology's purely operational and market-driven incentives. Finally, I expand on my thesis key contributions to the academic community and introduce my plan for future works.

CHAPTER 1: ARTISTIC AND THEORETICAL CONTEXT

1.1 - INTRODUCTION

My research explores the internet from a critical design perspective. From this standpoint, it echoes what has been labelled as a "wicked problem" (Rittel and Webber, 1973), a type of design-related problem I will expand on in § 2.3 of this thesis. Wicked problems are problems emerging from the intertwinement of design objects and human practices. Because they are deeply rooted in our human practices and therefore are characterized by different facets and contexts, wicked problems need to be explored through the lens of interdisciplinary research frameworks.

Mirroring the internet's infrastructure, my research is interdisciplinary. Drawing from this research context, my research intertwines different research scopes and angles, borrowing from disciplines such as design and media studies, critical theory, art and engineering. By building a critical discourse on the internet's narratives through these different angles, my research seeks moreover to borrow from all these different research-angles nodes I argue as interconnected in order to support my research rationale. Inside these artistic and academic works and inquiries, there is a common ground: approaching design infrastructures (and therefore the internet) as apparatuses that are not neutral but embody specific rules. Moreover, challenging our perception of the internet that emerges from the market and its status quo, these research projects propose to extend the materiality of the internet beyond the purely technical and to use it as a playground for critical reflection and art.

Through this section, I will connect these inquiries to the three narratives that are foundational for my thesis. Moreover, I will contextualise my research and will to engage with dial-up software modems in dialogue with these projects. § 1.2 to 1.7 tackle infrastructures in the light of the political and argue that it is crucial to zoom in to the level of the materiality of design objects and infrastructures in order to understand how they embody specific structures of power. § 1.8 to 1.10 are dedicated to the framework of platform studies and serve as a theoretical foundation for art practices subverting infrastructures. Going deeper into the internet's materiality - from the interface to the

protocol, from the protocol to the hardware, from the hardware to the earth's raw matter - § 1.11 to 1.26 contextualise the three narratives I challenge through design (atemporality, neutrality, immateriality) in the light of net.art and critical theory projects and inquiries.

1.2 - WHAT IS AN APPARATUS?

In order to tackle this online built-space we use on a daily basis known as the internet, we need to start with the foundational concept of the apparatus. Giorgio Agamben defines an apparatus as "anything that has in some way the capacity to capture, orient, determine, intercept, model, control, or secure the gestures, behaviors, opinions, or discourses of living beings" (Agamben, 2009, p.14). Later, he argues that our world is composed of two classes: "living beings (or substances) and apparatuses" (Agamben, 2009, p.14). If design is the activity of planning, directing and building experiences and therefore behaviours then designed objects are clear examples of these apparatuses. Governing our actions, trajectories and opinions inside the variety of spatiotemporal contexts constituting our built space, design is not a neutral element but an embodied system of logics, values, and procedures; or, as Slavoj Zizek would say, the "materialization of ideology" (Zizek, 2006).

1.3 - ROADS AS APPARATUSES OF CONTROL

Echoing Zizek's analysis, the political agency of objects is explicit in two trivial yet important components of our urban landscape: freeways and residential roads. These objects are clear examples of the power structures and relationships embodied through design objects. From these apparatuses of the built space, one main characteristic differs: their form, and therefore the behaviours they afford. On the one hand, residential roads are characterized by narrow widths, soft borders (pavement,

painted lines...) that drivers can easily transgress, and often a set of structural failures and specificities scattered on the road surface: speed bumps, cracks, potholes and others. On the other hand, freeways are larger and more linear, with multiple lanes of traffic, separated by hard borders (median strips, concrete barriers...) and paved by smooth and seamless asphalt.

These materialities are not neutral. These roads impose on us specific behaviours and restrictions. Through their designs, roads embody specific rules and ways to operate and regulate. On these roads, an interesting example borrowed from the internet scholar Alexander Galloway is the case of speed bumps used for speed regulation. Among others, two key strategies are used by policy makers to regulate drivers' behaviours on the road: signage (such as traffic signs) and devices inherent to roads (such as speed bumps). While traffic signs rely on a driver's decision-making, speed bumps have a different operating mode. Because speed bumps are inherent to the form of the road itself, users must follow their "rules" in order to avoid any inconvenience. In other words, they *force* users to slow down, submitting drivers to the embodied values they represent. The parkways of Robert Moses (figure 1) are a clear example of objects embodying a specific ideology and values. Located close to beaches and residentials areas, these parkways have been designed to exclude poor and lower-middle-class families who did not own cars. By making these objects too low for buses to cross beneath, it becomes then explicit that the designer seeks to embody politics (and a political discourse) through the built-space itself.

Figure 1: Robert Moses' parkways.

Source: https://www.bloomberg.com/news/articles/2017-07-09/robert-moses-and-his-racist-parkway-explained

More information about this case can be found in this bloomberg article.

1.4 - AN ASSEMBLAGE OF ROADS

On a larger scale, road networks also direct the ways we interact with their territory. Enacted by their components, road networks are an assemblage of embodied (through road designs) practices and rules; where each of the components have agency relative to the others and contribute to the spatio/temporal characteristics of the system. If someone needs, for example, to traverse a territory using first a freeway and then a number of residential roads regulated by speed bumps, the gain of time delivered by the (uncongested) freeway affording higher speed will be reduced by the rules embodied in the speed bumps. If, moreover, someone needs to traverse a space but the path of the road forces the driver to make a detour, this will have an important impact on the rest of the driver's circuit. As a result, each of these roads alter and define the networks' spatio/temporal characteristics through their locations, forms and ongoing events (crashes, traffic congestion...). Converse to an immutable and disassembled structure, road networks are an ecosystem of procedures enacting specific behaviours, regulating our trajectories through their space.

1.5 - MODULATIONS OF THE BUILT-SPACE

Aside from speed bumps used at the level of the road network, another example of these regulation systems is the case of traffic lights. Traffic lights are representative of what Gilles Deleuze described in his “Postscript on the Societies of Control” (Deleuze, 1992) as a shift between two modes of organisation and control: disciplinary societies (modernity) and societies of control (end of the twentieth century). Whereas disciplinary societies take the form of decentralized structures driven by “discrete sites of confinement” (Williams, 2015) such as schools, hospitals, factories, or prisons, societies of control are based on distributed and dynamic “logics of modulation” (Galloway & Thacker, 2007). On top of fixed strategies (such as speed bumps) used to regulate speed, traffic lights are defined by an ensemble of “micro-scaled modulations” (Williams, 2015), operated by computing and feedback mechanisms, thus allowing more control and flexibility.

From speedbumps to traffic lights, the built-space is regulated by an ensemble of both fixed and dynamic procedures. Paraphrasing Keller Easterling, it acts moreover as a form of “spatial software” that, just like an operating system, makes certain things possible and others impossible (Easterling, 2014). Following on the analogy with computers, our built space can be seen as a *platform*, meaning that it is, essentially, a foundation “for other entities, artefacts, and processes to be built upon” (Williams, 2015) and modulated.

1.6 - FROM TRAFFIC LIGHTS TO THE INTERNET PROTOCOLS

My research does not address speed bumps or traffic lights but the internet. However, in a similar manner to the (offline) built space, the internet is composed of a variety of modulated components that alter (based on their design) the data they carry with their affordances and restrictions. Like speed bumps forcing their users to behave according to their embodied rules and

logics, the internet's routes of data force the information being transmitted to follow their specific procedures. As with traffic lights modulating the built-space and its spatio/temporal characteristics, the internet takes the form of an assemblage of modulations, with each of its modulated nodes part of a system that "regulates flow, directs netspace, codes relationships, and connects life-forms" (Galloway & Thacker, 2007).

1.7 - THE INTERNET AS A PLATFORM: THE OPEN SYSTEMS INTERCONNECTION (OSI) MODEL

In the context of the internet, the map of the network where routes *transporting* our data are made visible is known as the *Open Systems Interconnection* (OSI) Model. This model is organised following seven layers that proceed from the interface to the hardware, from our input to the hardware that serves as the (visible) material infrastructure enabling all our communications to take place. As with road infrastructure in which a network of traffic-lights, speed bumps and other protocols act as *apparatuses* regulating our behaviours in the built-space, between each of the layers of the OSI model are various protocols that direct the way data is transmitted and encoded inside the internet's *territory*.

1.8 - INSERTIONS INTO IDEOLOGICAL CIRCUITS

As a starting point for my research, I have been inspired by the work created by the Brazilian's conceptual artist Cildo Meireles called "Insertions into Ideological Circuits" (Meireles, 1970). This work has been foundational for my research. Meireles' work is situated between art and activism and has been created in response to the repressive climate imposed by the Brazilian military

government in Brazil during the seventies. The concept behind these *insertions* is simple yet quite powerful: poetic (and often agonistic[1]) messages are written by the artist on Coca-Cola bottles using white ink (figure 2). Once these messages are written, these bottles are put back into circulation in Brazil, rather than being isolated from their context inside art galleries and venues. By choosing white ink to produce these messages on glass, this action has in turn the effect to only make these messages visible when bottles are filled and outside of factories. When these bottles are empty and sent back to factories, these messages written using white ink on glass will be then hard to decipher and notice, avoiding as a result the "control of the censor" (Meireles, 2014).

Figure 2: Cildo Meireles, Inserções em circuitos ideológicos: Projeto Coca-Cola. 1970.

Source: https://www.tate.org.uk/research/publications/performance-at-tate/perspectives/cildo-meireles

On the left, the bottle is full and we can see the "YANKEES GO HOME!" inscription. When the bottle is empty and sent back to the factory (on the right), the same inscription becomes harder to detect, therefore escaping the control of the firm's employees and the censors.

[1] This word refers to the work of the political theorist Chantal Mouffe. Mouffe defines agonism as the "condition of forever looping contestation" (DiSalvo, 2012) that is crucial inside our democracies. As a pillar of our democracies, agonism becomes the situation in which "the facts, beliefs, and practices of a society are forever examined and challenged" (DiSalvo, 2012).

With messages such as “YANKEES GO HOME” (Meireles, 1970), Cildo Meireles’s project is explicitly political. Inscribing such messages on Coca-Cola bottles becomes a way to acknowledge that these bottles - part of a broader *ideological circuit* - convey specific values and meanings, such as the American cultural hegemony the artist positions himself against. By actively using the materiality of these bottles, Meireles’ insertions are then a form of hacking, the activity of subverting the meaning and embodied values of a network (or object) through its design and materiality and using it for other reasons than what it was first intended to be. Inside Meireles’ insertions, the political object being subverted is then the Coca-Cola bottle and the network in which the object (or product) is distributed. By writing such messages on bottles, the Coca-Cola bottle network becomes no longer neutral but rather its (hidden) messages are revealed. From this perspective, Meireles’ project echoes with the definition of *exploits* as explained by Alexander Galloway and Eugene Thacker. Exploits, coming from computer hacking culture, are actions resulting in the discovery of holes in existing technologies and “the projection of potential changes through these holes” (Galloway and Thacker, 2007, p.81). Exploits take advantage of bugs, vulnerabilities, or other specific material conditions and use them critically to penetrate networks and alter how these networks function. These bugs, features and vulnerabilities are located at the infrastructural level of these networks.By closely looking at the shape and form of the networks hackers intend to penetrate, hacking is therefore concerned with the materiality of objects, acknowledging first that every designed entity and network - whether the internet, the Coca-Cola bottle infrastructure (figure 2) or telephone lines (figure 3) - embodies specific values in our world and that these values can be bent and subverted by changing the performing context of these objects.

Going back to Meireles’ insertions, this “vulnerability” of the network *exploited* by the artist starts at the level of the translucent glass of the bottle, embedded inside a broader infrastructure of distribution and packaging. By creating a system where, using white ink, inscribed messages will only be visible by customers outside of the factory (and will be returned invisible), the artist exploits the materialy of the network to turn it against itself; against the main ideologies the network embodies.

Meireles' insertion body of work is, consequently, turned toward the investigation of the infrastructure of designed things and how these designed things (systems, objects...) impose their values on us through their material condition. Meireles' work is also foundational for my research because of the way it proceeds: hacking the infrastructure with tiny gestures, creating a set of micro-disruptions from the inside (of the network) and turning consumers into active agents of the project and the hack.

Figure 3: Blue box prototype.

Source: https://512pixels.net/2018/03/woz-blue-box/

Subverting the infrastructure to generate a discourse going against the values it embodies is also explicit in the context of phone phreaking, from where this "Blue box" emerges. By replicating with these hardwares the in-band signaling tones generated by private telephone operators to route phone calls across the telephone infrastructure, phreakers were then able take control of the network and place free long distance phone calls.

1.9 - RESEARCH ROUTE: FROM MEIRELES TO THE OROBORO

This work of Meireles is foundational to my thesis because of its reference to the Greek Mythological concept of the *Ouroboros*, which I have used extensively in my research. This concept is represented by a visual image: a snake or a dragon eating its own tail (figure 4). With this cyclic and

recursive approach, the Ouroboros' figure echoes with our surrounding systems operating with feedback loops: where the output generated by the system is given recursively as an input to the same system, which in turn changes the system's characteristics.

Figure 4: Ouroboros figure. Engraving made by Lucas Jennis. Dated from 1625.

Source: https://www.britannica.com/topic/Ouroboros

This analogy resonates with the work of Meireles as well as net.art projects I will explore in § 1.12 to 1.17, grounding my rationale for working with modems. Connected to practices of hacking and critical engineering I will expand on later (§ 2.5), this artistic strategy asserts therefore that designed systems are not neutral but, following Meireles' terminology, take the form of *ideological circuits* that embody specific rules at the level of their materiality. Drawing from this approach and in dialogue with the auto-destructive characteristic of the *Ouroboros (*e.g: eating its own tail) these projects seek then to use the materiality of infrastructures against the main ideologies they embody, actively using these infrastructure's materialities to build a critical discourse on the way these works. With a desire to critically explore the internet's infrastructure narratives through working its materiality (e.g: physical computing and software), this artistic strategy has been at the core of my research. Moreover, in dialogue with Meireles, my will has been to *insert* subversive values into the cloud's *ideological* circuit: embodying through its materiality these three narratives that are central to

my thesis. This means that where the cloud appears as atemporal and instantaneous, my will has been to insert into this materiality an apparatus whose temporality is explicit in order to reframe the infrastructure itself. Operating within the same logic for narratives of neutrality and immateriality, I have been interested in hijacking this infrastructure (as well as these narratives it embodies) by itself: using the software modem apparatus into its materiality. I will expand on these modem *insertions* in § 1.14, 1.16 and 1.18.

1.10 - COMPUTATIONAL PLATFORMS AND PLATFORM STUDIES

By subverting the infrastructure of the Coca-Cola bottle and building its micro-disruptions on top of what the infrastructure affords and restricts, Meireles' work is in direct relation with the concept of *platforms* and *platform studies*. Bogost and Montfort (2009) define platforms as foundational systems upon which other systems, applications and interactions are built. These systems are, for example, our cities, language, or the internet: used as a foundation for the design of protocols and conventions regulating our interactions. In the context of computation, platforms are foundational systems that can be "reprogrammed and customized by outside developers and in that way, adapted to countless needs and niches that the platform's original developers could not have possibly contemplated" (Bogost and Montfort, 2009, p.3). Whether using Application Programming Interfaces (APIs), directly uploading code in a runtime environment or making external additions to existing hardware, platforms allow users to create new and innovative cultural forms and interactive systems involving computation. Often built on top of each other, platforms can take the form of programming languages (such as *BASIC*), virtual computers (*Java*), physical circuits (*The Atari VCS*) or a combination of both hardware and software (such as the *Wintel* technology: a portmanteau standing for *Windows* and *Intel*).

Drawing on this definition, platform studies inquiries into how platforms have agency and influence on artistic work being done by artists (on these systems); and how, in turn, these artists

actively use the technical limitations of platforms in their artistic practice. In reaction to *hard* technological determinism (Misa, 1988) stipulating that technology directly influences human behaviours without social mediation (Bogost and Montfort, 2012), platform studies explore how computational media artists negotiate with technology and creatively *exploit* what technology offers and restricts. From this standpoint, *platform studies* deconstructs our false assumptions on design and argues that all designed platforms (and technologies) are not neutral but embody a set of hidden (embodied) rules, conventions and protocols which creators build upon. Just like Meireles' *insertions* project, these platforms are then, from this perspective, *ideological* in the sense that they convey specific design decisions, affordances and restrictions.

Inside the artistic current of net.art I will introduce soon (§ 1.12), this artistic gesture is explicit, such as in the work of Alexei Shulgin (figure 5). This project proposes to turn a 386DX microprocessor running on a Windows 3.1 into a platform to create "the world's first cyberpunk band", playing covers of well-known songs that are distorted by the limitation of the sound card and the built-in speakers. This project echoes Bogost and Montfort's concept in the sense that, here, the technology is displaced from its purely functional realm and the artist actively embraces the limitations that define the platform as an artistic input.

Figure 5: Alexei Shulgin, 386DX . 1998 - 2013.

Source: https://anthology.rhizome.org/386-dx

More information on the project can be found here: https://anthology.rhizome.org/386-dx

1.11 - WHAT IS A PROTOCOL?

These platforms are ideological because - as with the Coca-Cola infrastructure or our road networks - they are composed of protocols. The concept of protocols paves the way for what Gilles Deleuze defines as our s*ocieties of control* in which our behaviours are modulated in the built-space. Defined in the broadest terms, protocols are rules imposed for behaving in specific ways: driving your car (traffic regulations), interacting with people in the street (handshakes, politeness) and so on. Applied to spatial architecture and the built-space, protocols are embodied conventions that direct the way we interact with the built space. Emerging from social constructs and habits, these protocols are crafted by designers embodying conventions and values through their design. Going back to road designs, speed bumps and traffic lights, these ubiquitous objects are clear examples of protocols. Embodying a set of rules to follow, these objects direct the flow of bodies inside the environment (Galloway, 2004), forcing us to slow down or stop when needed.

In the case of the World Wide Web (WWW), these are explicitly known as protocols. Located at every layer of the OSI, these bits of code have been moreover engineered to regulate how data is transmitted (or modulated) over the platform. From the regulation of the speed of transmission to the orchestration of the graphic and interactive design aspects of the browser and how this data is rendered online, these protocols can therefore be seen as our internet's online roads, speed bumps and traffic lights. Going back to Agamben (2009), these protocols are therefore the internet's *apparatuses* that impose on us specific ways to make things through their materiality and design. Drawing from

Galloway's *Protocol* (2004) essay, these regulating agents are then responsible for making infrastructures and platforms such as the internet political and regulated while at the same time distributed and with many layers of complexity.

1.12 - NET.ART: A QUICK INTRODUCTION

As an artistic movement that explicitly uses (and subverts) the internet infrastructure and its protocols, I have been interested in exploring the artistic field known as net.art. As a movement that is site specific to the internet (and more specifically to the World Wide Web), the conceptual foundations of net.art were developed on early online mailing lists, such as *Nettime* founded by Geert Lovink in June 1995. These mailings were meant to provide artists, critics and curators a space for debating and fostering new forms of critical discourses about the internet and its affordances for art and poetry. However, more than simply using the internet as a way to distribute artworks, these discussions engage with the materiality of the internet itself and how this materiality can be used as a *medium* for creating site-specific artworks: artworks that depend on the materiality of the internet to exist (figure 6). Approaching the internet as a medium with its own affordances and restrictions, artists of this mailing list started to explore data transmission processes and the use "delays in transmission-time, busy signals from service providers, crashing web browsers" as artistic gestures (Galloway, 2004, p. 216). Inside this frame, I have been interested to explore three foundational net.art projects that had a significant impact on my research: Olia Lialina's *Will-n-Testament* (2000), Heath Bunting's *_readme* (1998) and Cornelia Sollfrank's *net.art Generator* (2003).

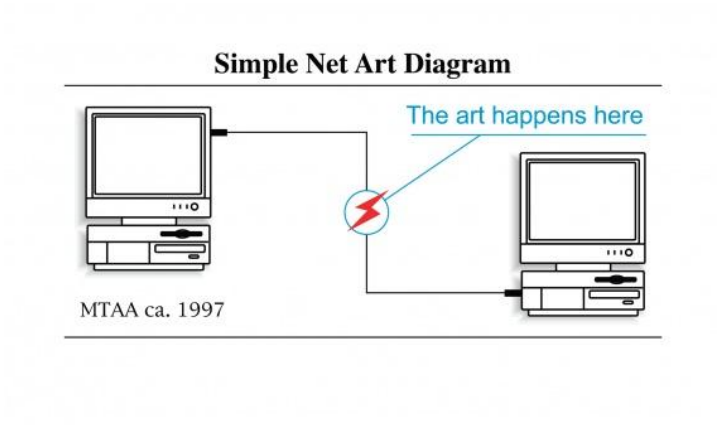


Figure 6: MTAA, Simple net.art Diagram. 1997.

Source: https://anthology.rhizome.org/simple-net-art-diagram

This diagram acts as a visual manifesto for the net.art movement. With this inscription - "The art happens here" - that sits between these two computers, it becomes explicit that net.artists are interested to actively investigate computational processes and engage with network protocols and the network of technologies that orchestrate data transmission processes. This means therefore that net.art does not focus on the production of static content but on actions and performances happening within these processes of transmission.

1.13 - NET.ART: HTTP

The *Will-n-Testament*, made by the pioneer net.artist Olia Lialina, takes the form of a webpage with the artist's last will and testament displayed. At first sight, the project is fairly simple: a black and blue text is displayed on the screen with no images and no animation. However, each letter in this text is in the GIF format rather than in standard text encoding. Because images involve larger file sizes than HTML text, this has an important impact on the loading speed of the webpage, forcing the page to be rendered slowly and irregularly depending on the size of each letter's (GIF) image (figures 7).

This project actively engages with Berner Lee's Hypertext Transfer Protocol (HTTP). The HTTP, the ubiquitous internet software used by computers to communicate with each other over a

network, corresponds to the handshake between *client* computers (requesting the content of a webpage) and *server* computers (hosting the content of webpages). This technical standard, acting as the rule that controls the exchange between these two entities, is responsible for parsing and transmitting data following its own rules such as the obligation to transmit content in binary. It is because this content is transmitted in binary (and GIF formats are more data-intensive than encoded text) that Lialina's images will take more time to render.

From this perspective, Lialina's project actively *exploits* the material conditions and behavior of this protocol and the temporality it enacts, using this temporality as an artistic gesture. While the act of writing a testament gives *a priori* a serious and solemn tone to the project, the performativity of the HTTP through the rhythm of files loading and the irregular and chaotic display of the images contradicts this seriousness. With this gesture that makes the temporality of the protocol (and the platform) visible and breaks our false assumption that data flows seamlessly inside the network, the materiality itself allows here for a statement that goes against what is explicitly written, dismembering the sentences and creating an organic and cryptic process similar to death and the physical gesture of "engraving" the text letter by letter on a gravestone[2]

[2] This analogy with the gravestone (and death) is explicit in this interview conducted by the *HTMLLES* collective: https://htmlles.net/2000/webart/lialbf.html

Figure 7: Will-n-Testament. Olia Lialina. 2000.

Source: Print Screens from http://will.teleportacia.org/

These screenshots of the project appear in sequence when the user accesses the website. On the first figure we can see that the message is less readable than on figure two, when the web page continues to load. This gradual apparition of letters - which are in fact images - emerges from the project's material site of execution: the hidden Hypertext Transfer Protocol. While data transmission processes are usually optimized to reinforce the belief that the web is atemporal, this project explicitly uses the temporal characteristics of the protocol; marking then therefore the temporality of the internet visible.

The artwork can be accessed here: http://will.teleportacia.org/

1.14 - RESEARCH ROUTE: FROM LIALINA TO THE TEMPORAL SOFTWARE MODEM PLATFORM

It is from this will to stretch the internet's data transmission temporality that I have been interested in working with dial-up software modems. A dial-up modem is a technology that has the ability to convert digital streams of information into analog modems signals, encoding (and decoding) digital data to sound waves. Using different frequencies - known as baud rates - to encode commands into audio signals, modems were widely used during the early stages of the World Wide Web so that users could connect to the network via a telephone line. Drawing from regular modems, the technology of softmodems - a porte-manteau for *software* and *modems* - are forms of modems that do not require specialist hardware and can therefore be installed (and operate) on our ubiquitous computers.

In the context of dial-up software dial-up modems, this concept of platforms - with their technical limitations and restrictions having agency on the data they transmit - becomes explicit. Transmitted through dial-up modems, data transmission becomes embodied into a process that is explicitly analog and error-prone, tied to what this primitive platform affords and restricts. Moreover, this platform is explicitly temporal, and this characteristic is at the core of my intention to work with softmodems. In the context of dial-up softmodems and likewise the early internet's AOL connections (figure 9), data transmission processes become explicitly temporal, with a specific sound that is transmitted through the local machine's speakers and has a defined temporality (figure 8). In addition to being explicitly physical since it has an analog and tangible presence that is materialized through sound, this use of this platform makes data transmission explicit and contradicts our mainstream beliefs of network instantaneity. I will further expand on my rationale to work with modems along my thesis, using this technology as a frame to deconstruct the three main embodied narratives that are

central inside my thesis: atemporality, neutrality and immateriality.

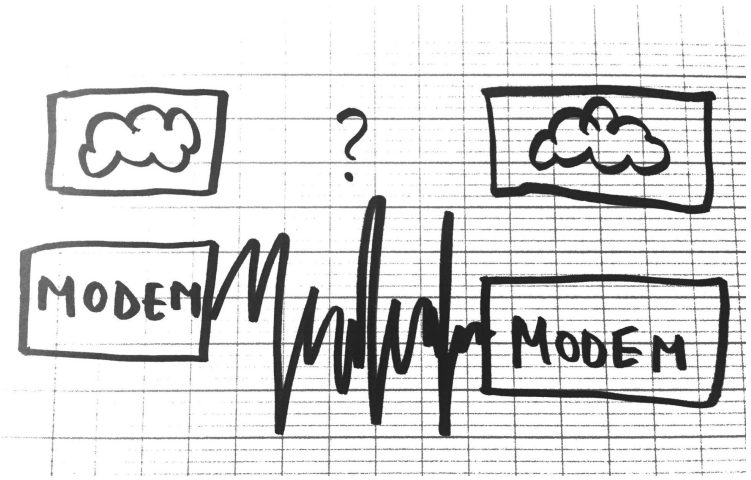


Figure 8: Rationale Drawing #1: Making data transmission processes temporal through dial up modems. This drawing conceptualises here two data transmission processes: those happening inside the internet cloud and those created when data is transmitted through dial-up modems. While processes happening inside the cloud are obfuscated and silent, engaging with the modem technology makes these processes explicit and audible - since data is transmitted via soundwaves.

Figure 9: The AOL connection screen.

In dialogue with my will to engage with modems inside the internet cloud, I have been also interested to revisit my old memories of connecting to my online email box using the dial-up AOL services. What fascinated me in this context was the temporal and sonic characteristic of the internet handshake that was required to establish a

connection with the AOL platform. Acting like a daily internet ritual and in opposition with the seamless and "flowing" nature of our actual data transmission processes, these connections were also error-prone - a characteristic that contradicts our perception of the network as purely operational.
More information: https://bit.ly/37C0ZyZ

1.15 - NET.ART: HTML AND DNS

The second *net.art* project I would like to discuss here was created by Heath Bunting and is entitled *_readme* (1998). The project consists of a webpage displaying the artist's biography. However, each word of the biography is formatted as a link tag and is therefore clickable (e.g: "hello" links to http://www.hello.com). This in turn creates the situation where, as they read the artist's biography, visitors clicking on links are either redirected to websites that exist, but are not related to the artist, or simply do not exist yet (figure 10).

Similarly to other net.artists, Bunting detours the World Wide Web's protocols for the creation of his artwork. Apart from using the underlying ubiquitous HTTP that is central in the work of Lialina, Bunting uses two key components of the internet's *protocological* infrastructure: the HyperText Markup Language (HTML) - responsible for making links - and the Domain Name Server (DNS)[3] - the database responsible for selecting the link destination. What happens under the hood is therefore the following: when someone clicks on a word of his biography, a connection with the DNS is made. If the DNS contains the IP address of the existing domain (e.g: the IP address of http://www.hello.com), the user will be sent to this domain. If, however, the DNS record does not find the attached IP address of the word the user clicked on, a 404 (not found) error will be returned and the internet connection will end.

[3] The DNS is the abbreviation for the Domain Name Server. It is the internet's address book where all domains from the internet are registered and centralized.

Figure 10: _readme. Heath Bunting. 1998.

Source: http://www.irational.org/_readme.html

Here, we can see that each word (except his name and selected keywords) of the artist's biography are underlined, a common styling reference for internet hyperlinks. This artistic reappropriation of one of the network's core features and materiality - hyperlinks - is not neutral. Moreover, it dissolves the artist's bio inside the network's routes, actively using the network's DNS and HTTP to trigger these connections.

The artwork can be accessed here: http://www.irational.org/_readme.html

In this project, Bunting actively *detours* these internet's protocols to create a "total dissolution of the art object into the network" (Galloway, 2007, p. 225). Like Lialina, the internet's materiality is here made visible by intentionally showing its failures and ways it operates. By showing moreover these micro-decisions (and micro-disruptions) happening *under the hood* when we browse the web, Bunting's project reinforces the idea that our data transmission processes are modulated and directed by these protocols. From this perspective, Bunting's project echoes with Meireles' *insertions,* making visible these routes (or embodied ideological circuits) taken when someone clicks on a hyperlink in order to request a webpage.

Finally, this project echoes also with the poetry movement known as the Ouvroir de Littérature Potentielle (OuLiPo). OuLiPo aims to combine mathematics and poetry and explores "the

possibilities of incorporating mathematical structures in literary works" (Matthews and Brotchie, 2005, p.201). From this standpoint, what resides at the core of the movement is this will to create poetic and linguistic associations and outputs based on a system generated around the use of protocols and constraints. Inside Bunting's project, these constraints take the form of the network of protocols enabling the connection between his words and pages.

1.16 - RESEARCH ROUTE: THE MODEM PLATFORM'S PROTOCOL

As explored in the context of Bunting's project, the experience of browsing the internet is directed by an infrastructure of protocols that makes data transmission possible or impossible based on their embodied conditional logics and modulations. This means therefore that the level of data transmission between two entities interacting inside the internet, the communication is regulated and directed by protocols. As an echo with Galloway's theoretical insights (§ 1.12), protocols are therefore what makes communication inside our distributed networks possible; regulating flow, directing netspace, coding relationships and connecting life-forms (Galloway and Thacker, 2007, p.30).
In the context of the software modem technology, the role of protocols is explicit at the level of *baud rates:* the unit of measurement that determines how the soundwave representing data should be modulated and therefore how communication should happen (figure 11). This means, in other words that, if the transmitter and receiver modem instances are operating at the same baud rate, the data transmission will take place seamlessly. If, however, these two instances are not operating at the same baud rate, the data transmission process will be impossible (figure 12).

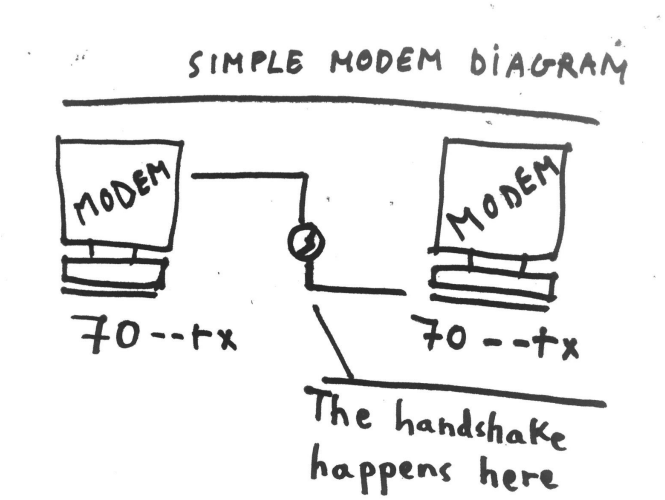


Figure 11: Rationale Drawing #2: The Simple dial up modem Diagram.

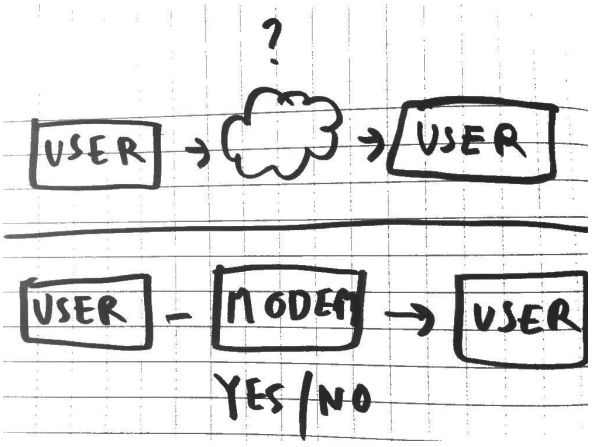


Figure 12: Rationale Drawing #3: Making the modem protocol rules explicit.

In dialogue with MTAA's Simple net.art Diagram, these drawings conceptualise the primitive nature of the modem in which the idea of establishing a connection handshake becomes explicit. In opposition to the metaphor of the cloud that obfuscates its embodied power structures and rules and disconnects its users from engaging with these rules, the dial-up modem forces users to input a set of modulation parameters that will be crucial in establishing a connection or not. From this perspective, the dial-up modem platform and protocol becomes a tangible example of a primitive micro-scaled modulation (§ 1.5) where the technological becomes political - in having an agency on the information being orchestrated.

1.17 - NET.ART: APPLICATION PROGRAMMING INTERFACE (API)

The third net.art project I would like to discuss is Cornelia Sollfrank's *net.art generator* (2003). This project takes the form of an online web app allowing visitors to enter a search keyword in order to query Google's image search service and generate digital collages. With the option to define the number of images that will be returned from the *net.art generator* (NAG) and used as layers of the image, the end result takes the form of a colorful composition with random filters (such as *Saturate*, *Difference*, *Multiply*...) applied to each of the stacked layers (figure 13).

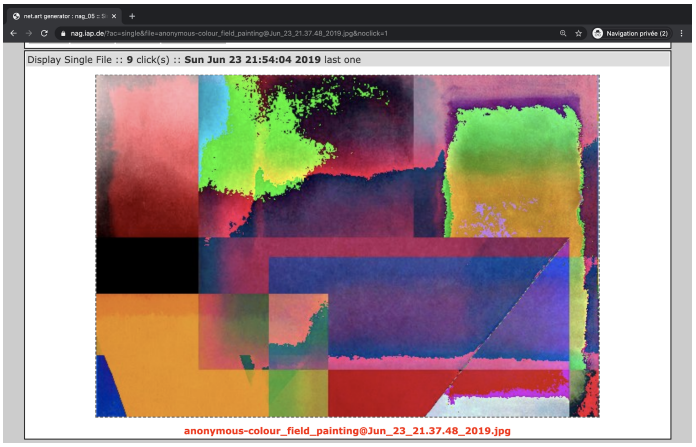


Figure 13: Net.Art Generator Generator. Cornelia Sollfrank. 2003.

Source: print screens from https://nag.iap.de/

This project does not only use a native protocol of the internet (such as Lialina's HTTP or Bunting's DNS) but argues moreover that net.art can be made using Application Programming Interfaces (API) and platforms that sit on top of the internet itself.

The artwork is accessible from this webpage: https://nag.iap.de/.

With this net.art project, Sollfrank tackles another kind of protocol from our internet: Application Programming Interfaces (APIs). Built on top of the *native* infrastructure of the web 1.0,

these protocols are entry points (or handshakes) enabling users to access services and data provided by a third party entity and platform - such as Google. By doing so, Sollfrank extends the limit of net.art to embed platforms that are not only located at the level of the original World Wide Web protocols (such as Liliana's and Bunting's projects) but also at the level of platforms that have been built on top of it. From this perspective, Sollfrank's work echoes with the concept of platform studies, arguing that a core characteristic of platforms is their capacity to be connected to other platforms via these entry points APIs (Bogost and Montfort, 2009). With the creation of this net.art project that encompass both the native web and the Google platform, Sollfrank opens the door to the creation of alternative data transmission circuits where different platforms are intertwined together.

1.18 - RESEARCH ROUTE: THE SOFTWARE MODEM PLATFORM AS PART OF THE INTERNET/ RUNNING ON TOP OF THE INTERNET

Here, the software modem is reaffirmed as an interesting technology to explore since - as with the Google platform in the context of Sollfrank's project - this technology is a platform that can be connected to the World Wide Web via its entry point: the command line of the laptop from where the software operates. Like Meireles' work in which the message written on the Coca-Cola bottle is *inserted into the ideological circuit* of the Coca-Cola bottle infrastructure, data coming from the native internet platform (as well as other platforms built on top of it: Google, Reddit, Twitter) can be detoured with the use of the software modem: that is, extracted from the platform and inserted back into it. Like Sollfrank's project, the software modem is therefore a platform with an API: to connect to, and to output from. In the context of projects doing practice-based critical reflection on the internet's materiality, working with technologies such as the software modem platform (with inputs and outputs) enables moreover the creation of assemblages and alternative networks where the internet is intertwined and reframed in the light of antagonistic technologies inserted inside these

circuits (figure 14).

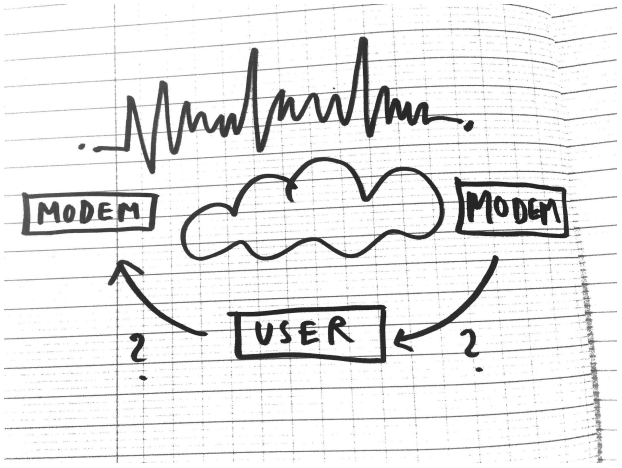


Figure 14: Rationale Drawing #4: Dial-up software modems as APIs.

This drawing conceptualises the potential to use dial-up software modems as APIs from where data can be extracted and inputted/outputted through the modem's platform. Acting moreover as a technological hole (§ 1.8) from where we can interact with the internet's platform routes, this potential allows therefore to 'hack' the internet's embodied values and narratives by adding inside its circuits discourses that are agonistic (§ 1.8).

1.19 - MICRO DECISIONS AND MICRO TEMPORALITIES OF NETWORKS

Whether inside the *Will-n-Testament* or *_readme,* data does not flow effortlessly and without constraints but either takes a significant amount of time to be transmitted or leads to 404 cul-de-sac pages (and the end of the connection). From a theoretical perspective, these transmission interruptions and anomalies echo with the research conducted by the media network scholar Florian Sprenger whose work explores how our ubiquitous digital networks (such as the internet) handle decisions and render time.

Drawing from Paul Baran's article entitled "On Distributed Communications Networks" (1964), the article that introduced the underlying technology of *packet-switching* used by the internet, Sprenger argues that data transmission does not take the form of an "uninterrupted, continuous, and reliable flow of transmission" (Sprenger, 2015, p. 75) but has been designed following the core founding principle of *interruption*. Close reading the article in which this distributed digital architecture enabling data transmission over *packets* was introduced, Sprenger moreover argues that our contemporary digital networks (such as Berners-Lee's WWW) are based on logics of micro-decisions and micro-interruptions that are located at the level of its protocols. In the context of data transmission, this means that when something is distributed over the internet, the content is first chopped into small packets, and transmitted through the network's nodes (in the WWW, the TCP/IP) that have the ability to make autonomous decisions regarding where (and how) data should be transmitted next. During this process of disconnected and fragmented data transmission, the path of data across the network is therefore recalculated at every node. As a result, these transmitted packets are briefly stored inside these protocols, which makes the transmission "constantly interrupted" (Sprenger, 2015, p.20). Although less tangible than our previous decentralized communication technologies,[4] decentralized networks are therefore still based on logics of discontinuous microtemporalities (Soon, 2017), occuring every time these packets are stored inside the platform along the way to their final destination.

In dialogue with Lialina and Bunting, these insights reinforce the need to deconstruct our main beliefs regarding the atemporal nature of the internet. In other words, these positions explore the illusion developed by Internet Service Providers (ISP) that the network we use is atemporal and seamless. From this perspective, Sprenger asserts that our internet is not neutral, but rather embodies

[4]Clear examples of centralized technologies are jails, factories or schools. In the context of jails for an example, time (and how time is perceived and imposed) is controlled and governed by a strict set of protocols and rules imposed on inmates by these jail's policy makers. Centralized technologies are therefore represented by a central node from where all decisions emerge. On the other side, distributed architectures (such as the internet's packet switching technology) are represented by nodes that are interconnected and both have agency in the system - such as in the packet switching technology for an example.

control at the level of its protocols deciding “who can communicate and who cannot, what can be transmitted and what cannot, who is connected and who is kept apart” (Sprenger, 2015, p. 76). From this perspective, Sprenger breaks the idea of transmission *flow* over the internet: a concept coined by the television media theorist Raymond Williams in order to describe techniques of content programming and distribution that implies continuity and follow a relatively stable temporality and sequence (Soon, 2016). In opposition with this concept, Sprenger argues that data (inside the internet) does not flow through the protocols’ platform but “bursts” (Abbate, 2000, p.19) and depends on logics of micro-decisions, with packet deliveries being constantly interrupted and reconfigured at every distributed node - figure 15.

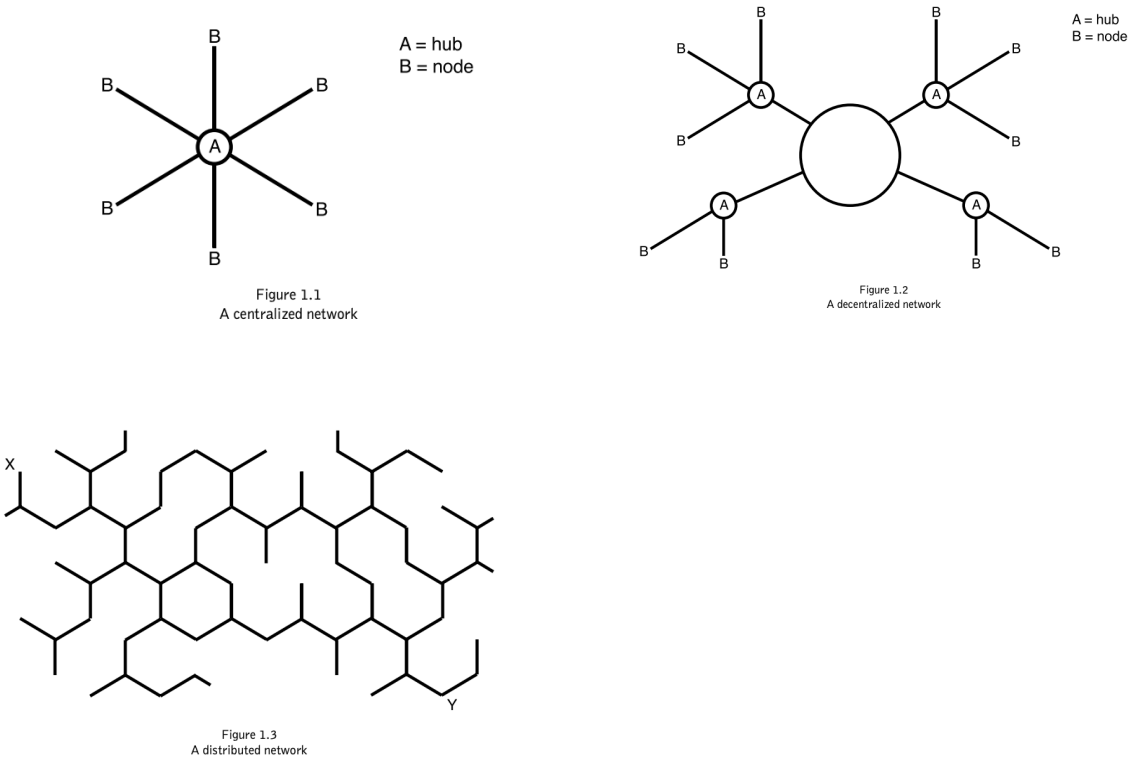


Figure 15: Network topologies.

Retrieved from Alexander Galloway, Protocol. 2004.

Source: https://mitpress.mit.edu/books/protocol

These depict three different types of network embodying different ways to exercise power and control, as

retrieved from Galloway's Protocol (2004) essay. Inside centralized (figure 1) and decentralized (figure 2) networks, control emerges from central (and well defined) nodes and is then relayed by subnodes. In this context, data seems therefore to float from one point to another in a linear manner following a relatively stable temporality. Inside distributed networks (figure 3), each node acts as autonomous agents, with the ability to change the data transisssion's characteristics.

These above insights make tangible the dynamic configuration of the internet's data transmission processes. Moreover, they are crucial in deconstructing our mainstream perception of the internet as well as the first narrative of data transmission atemporality my thesis addresses. In dialogue with the net.neutrality from where my thesis emerges, they make explicit the fact that the network's time of execution is modulated at the level of its protocols and can be used by internet service providers to stretch and alter our perception of time. While these private entities market moreover the internet using this metaphor of the flow - which is blatant in the context of this internet service provider named as such (figure 16) -, this logic of distributed micro-modulation and temporalities contradict this belief.

Figure 16: Broadband of *FLOW*, a mobile and internet service provider.

Retrieved from: https://discoverflow.co/antigua/broadband/overview

1.20 - FROM THE DIGITAL TO THE HARDWARE AND THE ENVIRONMENTAL

When we look back at the Open Systems Interconnection (OSI), the internet is therefore not only digital and structured by digital protocols but also physical, enabled by an entire infrastructure of analog signals, routers, wires, modems, etc. From net.art (and the digital layers of the internet) to the hardware infrastructure, I have been therefore interested to shift the scope of my research questions and to ask how data transmission on the internet - which we experience when we interact with the internet's loading pages and screens - is also impacted by the physical layer that constitutes it. From this standpoint, I have been interested in exploring projects that reflect on the temporality of data transmission through the creation of circuits that are physical and analog.

From this standpoint, I have been inspired by *QFM* (*Queued-Frequency-Modulation*), a project developed by Sarah Grant and Danja Vasiliev (figure 17). Developed as a small experiment to visualise the concept of packet switching using radios (which is then called packet-radio), this project takes the form of a wireless mesh network of radio transceivers (able to both transmit and receive data) embedded in cement cubes. Each of these mini radios is composed of an antenna, a button, and a light-emitting diode (LED). The project works as follows: as soon one of one of the buttons on these cement nodes is pressed, a transmission process is fired across the network of cubes through packet radio - a technology similar to Baran's packet-switching. The signal is then divided into packets and transmitted through the infrastructure via each cube. As soon as these packets are received by one of the cubes via the antenna, its LED turns on. When the mesh network is reconfigured by moving the position of the cement cubes, new routes and configurations of data appear; made visible via the cubes' LEDs.

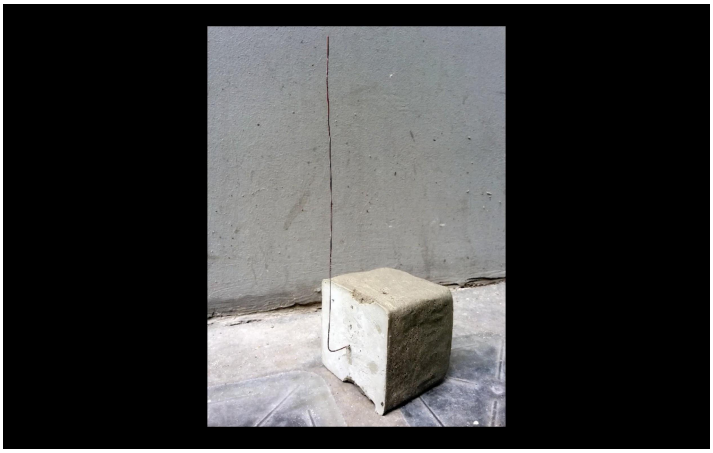


Figure 17: QFM. Sarah Grant and Danja Vasiliev. 2016.

Source: https://stwst48x2.stwst.at/qfm

Inside this project, the emphasis is put on the production of nodes whose materiality is explicit. With these concrete cement blocks from where copper wire emerges and acts as the node radio antenna, the project takes the counterpoint of how we usually perceive technology: as smooth and seamless. Moreover, creating a tension between the "seamless"(since silent) radio packets and these ciment nodes, the project seeks to challenge our mainstream conception of the internet and distributed data transmission processes as immaterial. By making these hardwares, Grant and Vasiliev bring these processes to their physical infrastructure: from antennas to the actual space between these nodes.

More information on the project can be found here: https://stwst48x2.stwst.at/qfm

Envisioned by Grant and Vasiliev as a way to demystify and make tangible data transmission processes, this project's main intention is to break our assumptions that networks are immaterial. With the creation of this "small scale model of the internet" (Oliver and Vasiliev, 2013) designed in order to conduct their research on network topologies, Grant and Vasiliev make therefore legible the fact that the distance between the physical nodes of the infrastructure plays a crucial role in data temporality, with packets configured to find the shortest path in order to reach their final destination. Using radio transmission to make visible and tangible the chain reactions and and data avalanches (Grant, 2016) happening every time the QFM infrastructure is reorganised, Grant and Vasiliev argue therefore that

transmission of data has, first, a temporality, but more importantly that this temporality (and trajectory) depends on the location of the physical nodes inside the infrastructure of the platform. From this standpoint, this research extends the research angles of net.art in order to explore the internet's data transmission temporality outside of the digital and in the light of its analog technologies.

As a recurrent subject tackled inside their critical engineering[5] work, the duo's research stands against the metaphor of the cloud. Used in the context of cloud computing (a data storage and computing service), this metaphor is motivated by a specific agenda: turn the complex infrastructure enabling these services into an overly simplified form (figure 18); create the illusion that this infrastructure is virtual and seamless. Paraphrasing Hu, in the same manner that the word "cloud" is used by internet service providers and stakeholders to over-simplify (and obfuscate) the complex and shifting intertwinement of water vapor, water crystal, and aerosols, the concept of "cloud computing" hides the true materiality of this technology (Hu, 2015). Like Paul Baran's packet switching using the metaphor of the flow in order to create the illusion that data over the network flows smoothly and is transmitted without interruption, the word *cloud* depicts therefore the technology that powers it as non-physical, non-reachable and neutral. As depicted in the figure below, framing this complex assemblage as "cloud computing" turns the network into a *magical* and opaque object that, following the advertisement below, neither has software nor hardware; only providing "success" . As one example amongst others of the mainstream (and market-driven) discourse centered around the cloud, this advertisement is representative of how the metaphor is being used by the industry as a way to obfuscate what the materiality of the internet really is about: from software protocols to data transmission hardwares. In dialogue with the second and third narratives of my thesis tackling the

[5] Grant and Vasiliev are part of a collective of artists called "the critical engineers", whose research is located between engineering, art and politics, using engineering in a critical way to expose its inner workings, its influences and embodied values. Their views are articulated in this manifesto. I will go back to the work of critical engineers in § 2.5.

illusion of neutrality and immateriality, it is explicit through this advertisement that these marketing discourses reinforce these beliefs; over-simplifying and obfuscating the way the network operates.

figure 18: Advertisement for *salesforce*, a major cloud computing services provider.

Source: http://morris-creative-branding.com/ads-cloud-computing

At the opposite of this advertisement's "no software, no hardware" headline, the cloud is operated by an entire infrastructure of humans, digital and physical devices: engineers, technicians, data moderators, computers, hard drives, servers, wires, modems, routers, undersea cables, etc. Moreover, this analogy between the atmosphere and data transmission is not as recent as we may think, with the telecom provider AT&T developing the idea of an "electronic skyway" in 1951 for the

design and the implementation of their microwave relay stations. Emerging from this marketing desire to use metaphors for internet services, the term "cloud computing" appeared later on, in 1996. Coined inside the offices of *Compaq Computer* - a computing firm from Houston, Texas -, this term was first used to introduce a new computing model where data would be delivered externally to users[6]. Framed later as i*nfrastructure as a service* (IaaS), the metaphor gained traction starting 2006 with its introduction to a press conference given by the previous Chairman and CEO of Google Eric Schmidt[7].

In the light of this historical perspective, it becomes explicit that the concept of "cloud computing" is not as recent as we think. As Hu argued, what supports the cloud has also been also layered on top of the old infrastructure of our past: with the internet's (hidden) data centers repurposing the Cold-War's command bunkers[8] (Hu, 2015). This means that even if the cloud is depicted as seamless and diffuse, it still relies on a set of crucial and centralized points that are strategically located around the globe, and most of the time kept secret by IT firms.[9] An example of the cloud's materiality is the case of undersea fiber-optic cables. These cables, laying at the bottom of the sea, are faster than satellites at transmitting data across the globe and are moreover responsible for 99 percent of all our transoceanic digital communications (e.g: phone calls, texts, e-mail messages, websites, digital images, videos, etc.). As with the cloud's data centers, these cables also have a history and have been designed on top of previous technologies like the telegraph. While these cables are still operational, some of them are old, vulnerable and corroded by the effect of water and

---

[6] A more extensive analysis of the genealogy of the cloud metaphor can be found in this *Technology Review* article: https://www.technologyreview.com/2011/10/31/257406/who-coined-cloud-computing/

[7] The verbatim of this conference can be found here: https://www.google.com/press/podium/ses2006.html

[8] This is the case of *Iron Mountain*, one of the largest data management and storage companies. Iron Mountain was founded in 1951 under the name *Iron Mountain Atomic Storage Corporation*. Its original goal was to protect corporate information from nuclear attack by storing it inside underground facilities. More information can be found in this link.

[9] This is explicit in the context of the *AmazonAtlas* wikileaks's project, listing addresses and details of over one hundred data centers from the Amazon cloud computing provider. More information can be found accessing this URL.

chemicals. I will further detail in § 1.23. From this standpoint, the cloud (and the internet) is not a *cutting-edge* technology but a network of both new and old materials and technologies.

1.21 - RESEARCH ROUTE: SOFTWARE MODEM AS A PRIMITIVE TECHNOLOGY INSERTED INTO OUR SEAMLESS DATA CIRCUITS

Inspired by the work of Hu that reinforces the idea that the internet is, at its core, an assemblage of old technologies (e.g: undersea cables) upon which new technologies and platforms (e.g: social media) have been built, I have been therefore interested to create data transmission circuits not only with digital components but also with old technologies whose materiality is explicit and tangible. As in *QFM*'s use of packet-radio, I have been therefore interested to explore the erroneous narrative of the internet's immateriality by creating a dialogue (or a tension) between the software modem and the internet interfaces we use on a daily basis. By explicitly linking these two apparatuses together, my will has been in other words to create an analogy of the *cloud* as it is; using the software modem as a frame to create an analogy with what is hidden from the internet's surface but whose materiality is explicit: undersea cables, modems, routers, wires, etc. (figure 19).

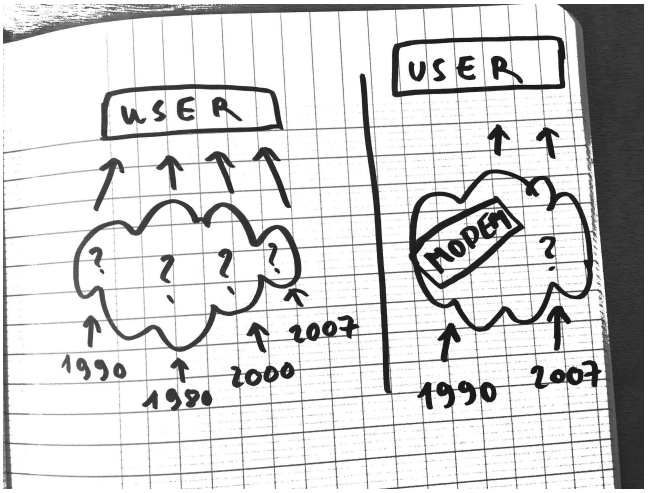


Figure 19: Rationale Drawing #5: Subverting the illusion of the cloud as "always new".
In dialogue with Hu (§ 1.20), this drawing conceptualises the potential of inserting analog software modems inside our seamless data transmission circuits in order to deconstruct the belief that the cloud is a cutting edge (and branded new) technology. As an echo with its crucial rusted undersea cables that are stacked with light interfaces, engaging with software modems inside the cloud becomes therefore a way to recreate a small scale (§ 1.20) and simplified version of our data transmission processes; in which old and new technologies are intertwined.

1.22 - RESEARCH ROUTE: SOFTWARE MODEM, SOUNDWAVES IN SPACE

By working with analog technology, QFM also opens the door to the exploration of the internet's materiality not only at the level of hardwares but also at the intersection between hardwares and the physical space where these hardwares are located and operate. In other words, working with these technologies for the creation of alternative data transmission circuits enables data not only to be digital but also analog and impacted - since with a modem data takes the form of radio waves - by the physical characteristics of the space in which the transmission happens.

My will to work with software modems as a technology that is analog (and transmits data into a physical space) has been also motivated by these research angles tackling the intersection between data transmission and the geophysical activity of the site where the process operates. By inserting analog transmissions into digital circuits through the use of software dial-up modems, I have explored ways to create circuits of data transmission that are representative of the internet; of data transmission over this network that is impacted both by digital, analog, and geophysical agents (figure 20).

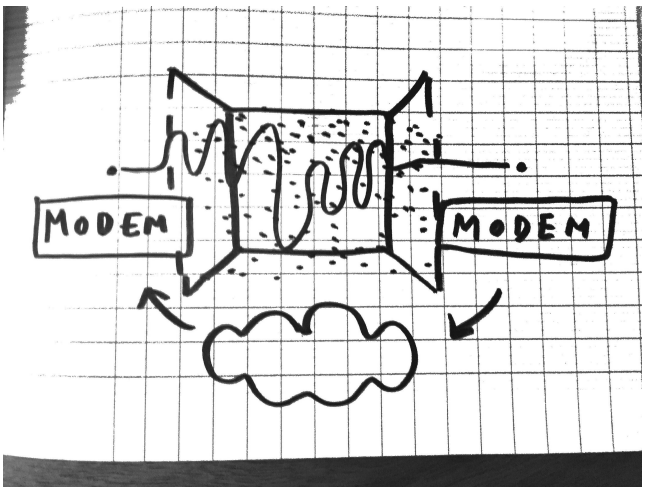


Figure 20: Rationale Drawing #6: Making modems interact with their physical site of execution.

Likewise QFM *and in echo with the case of undersea cables and antennas that intersect with their broader geophysical environment (§ 1.20, § 1.23), software modems are reactive to their material site of execution. Going further with this will to create a small scale model of our internet processes, engaging with modems enables therefore a potential in creating data circuits where - in opposition with the cloud's belief of immateriality - data is both directed by digital, analog and geo-physical agents and forces.*

1.23 - GEOLOGICAL MEDIA

Both the QFM project and software modem technologies are analog and are therefore explicitly linked to a physical site of execution where these data transmission processes operate. Moreover, this physical site is active and interacts with the materiality of sound waves that are transmitted. Linking back these projects with broader research questions related to the intersection between media and its environment, I have been interested in exploring through the work of media studies scholars relationships between data transmission and the activity of the earth. When we investigate what composes the internet, it is clear that the internet emerges from the physical infrastructure that enables it; that data does not flow seamlessly and without friction, but depends on

the complex network of analog devices whose materiality is explicit and tangible. Moreover, these devices do not operate in isolation but interact with their broader human and geophysical context.

An interesting example of this is the case of undersea cables (figure 21). Following the media scholar Nicole Starosielski, these cables are shifting within their "material contexts, including not only cultural practices and political formations but also atmospheric, thermodynamic, geological, and biological processes" (Starosielski, 2015, p.14). These cables operate as expected "until something goes wrong" (Hu, 2015, p.X). This disruption occurs in a number of events: strong oceanic currents, attacks from sharks, seismic events, unintentionally cut cables result in internet blackouts[10], etc. In addition, because these cables are located at the bottom of the sea, they decay and rust slowly. Another example of this intertwinement between the internet and geology is when someone connects to the network through satellites. Depending on the composition and the pressure of the atmosphere, data transmission (sent via radio) will be altered[11]. If the atmosphere contains for example more water vapor, transmission will be slower; during night time, transmission will not occur in the same way as during daylight, due to the atmosphere reflecting radio waves differently.

[10] For attacks by sharks, see this article. For seismic events such as earthquakes and tsunamis, see this article. For intentionally cut cables, see these articles.

[11] For more information on the atmospheric impact on data transmission in the context of radio waves, see this article.

Figure 21: Undersea cable conduit extends out to sea at Gun Beach, Guam.

Source: Retrieved from The Undersea Network, Nicole Starosielski, 2015.

http://www.surfacing.in/?image=tumon-bay-guam

With this image, it becomes clear that data transmission emerges from the internet's material and physical infrastructure. Moreover, with these rusted undersea cables, it is explicit that the internet does not happen without the earth's processes and forces. In the longer time frame, this process coming from the earth is the rust that has an impact on undersea cables, on their design, and ultimately on the communication they transmit - forcing a replacement of these cables and ultimately a disruption of data transmission.

More information about undersea cables can be found here: http://www.surfacing.in

From this perspective, the Open Systems Interconnection (OSI) model is incomplete because, apart from ignoring the central role of humans, it does not extend the internet to the geophysical forces that have an impact on data transmission. In addition, the OSI model does not acknowledge that its foundational hardware (represented in the physical layer of the model) is manufactured with raw materials. Whether it is silicon for making solid-state drive (SSD) memory cards, hafnium for central processing units (CPUs) or aluminum, copper and zinc for hard disk drives (HDD), the internet's hardware is engineered with raw components and metals that each have their own specific properties. These materials, although on a less tangible level, still influence media temporality and media transmission processes due to their geological characteristics and properties enabling in turn different managements of temperature, corrosion, conductivity etc.

Investigating the materiality of media (and the internet) at the level of the raw matter that constitutes it demystifies this analogy of the cloud one step further. Behind this figure of the cloud, engineers and technology makers give the impression that "the earth does not exist" (Smithson, 1968, p.83), and that neither do the complex technological and human processes of extraction that are necessary for polishing and manipulating raw materials. In the light of these inquiries, it becomes clear that technology itself starts with the affordances and restrictions of the planet and its underground resources. Looking at how these foundational raw materials enable all our computational

culture contributes to breaking the idea that technology (and the internet) is magical and celestial as per the metaphor of the cloud. Instead of flowing seamlessly somewhere "up there", the internet is grounded in the complex infrastructure of earth extraction and mining, coming from (and eventually rejoining[12]) the earth.

1.24 - EXPANDING PROTOCOLS TO THE ACTIVITY OF THE EARTH

From a theoretical perspective, this leads to the work conducted by the design theorist Benjamin Bratton in *The Stack (2015)*. In this book, Bratton proposes to reframe the internet's space cartography and the Open Systems Interconnection (OSI) model into six layers that are intertwined and *stacked* on top of each others: the user, the interface, the address, the city, the cloud, the earth (Bratton, 2015). At the bottom of the internet's *stack,* Bratton argues therefore that there is the earth: its energies, forces, minerals and so on. In the context of data transmission through the internet hardware being built with the earth's raw materials and minerals the internet becomes a technology whose physicality is explicit, material and terrestrial. Moreover, this materiality becomes active inside the "accidental megastructure" (Bratton, 2015) of the internet, defining how hardwares operates and computes inside the "global communication" circuit (Starosielski, 2016).

The importance of the activity of the earth in the context of the internet and data transmission is also made explicit in the article of Starosielski entitled: "Thermocultures of Geological Media" (2016). More than a reflection on the role of the earth's raw matter, the author explores here "how thermal manipulation is critical to the transformation of the earth's raw materials into media and to maintaining those materials as media" (Starosielski, 2016, p. 293). In other words, she argues that data transmission (and hardwares enabling data transmission) is *sensitive* to its geo-physical context,

[12] Here, I am referring to electronic waste, when electronic devices are discarded and stored in landfills. Electronic waste has a considerable impact on the earth's global pollution and Human Health and durably changes the composition of the ground where these devices are stored. More information can be found in this case study.

depending on “specific temperature ranges, failing in conditions that are too hot or too cold” (Starosielski, 2016, p. 296). This statement is crucial because it acknowledges that, as with Bratton’s proposition of *the earth layer*, inquiries regarding the materiality of the internet and data transmission need to take into account these fluxes, forces and modulations. Put differently, these statements contribute to exploring the narrative of the internet as an immaterial and purely artificial entity, by explicitly linking the internet with its geophysical context.

1.25 - FROM THE USER TO THE EARTH: MARTIN HOWSE’S EARTH CODES AND EARTH COMPUTERS

This idea of exploring the earth as a computing platform and substrate (Bratton, 2016) from where all computational processes emerge serves as a base for the work of Martin Howse. In his work, Howse creates computing assemblages and circuits where analog and digital materialities are intertwined; where signals and forces coming from the “dirty matter” (Parikka, 2012, 98) of the earth are used as initial inputs to power computational processes. In his *“earthboot”* (2014) project for an example, the activity of the earth becomes responsible for booting a speculative and barely functional operating-system (OS) (figure 22). The project works as a following: when the OS is installed on a Linux machine and the custom USB device made by Howse is “pushed into the earth” (Howse, 2014), fluctuations of the electric currents of the soil (where the device is inserted) are monitored and translated directly into code instructions to boot the minimal OS running on top of his local machine. Tapping into these “small fluctuations in electric current within the local terrain” (Howse, 2015), the OS becomes interconnected to the material (and geophysical) site from where it operates. In other words, depending on the composition of the soil (that in turns affect electric currents), the OS will

boot differently[13].

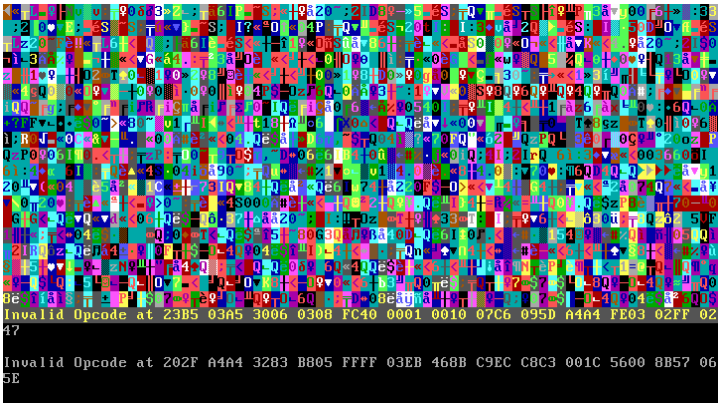


Figure 22: Stills from "the art geeks /// martin howse". Arte, 2012.

Source: https://www.arte.tv/fr/videos/049535-010-A/the-art-geeks-10/

In the first figure, wecan see Howse attempting to boot his local machine after having inserted his hardware sensor on the ground. This creates in turn a situation where the OS capabilities will be directly defined by small electrical fluctuations happening in the ground when the local machine is "plugged". As Howse stated, 95% of the time, the boot will crash (because of wrong instructions) with a black screen with a flashing cursor displayed. Over the remaining 5% of the time, glitchy characters and content from the OS will appear. The second figure displays these glitchy characters.

[13]Following Howse, this OS crashing "is the price to pay for booting straight from the earth"(Howse, 2014). On 95% of the time, the boot will crash (because of wrong instructions) with a black screen with a flashing cursor displayed. Over the remaining 5% of the time, glitchy characters and content from the OS will appear.

More information about the "earthboot" project can be found here: http://www.1010.co.uk/org/earthcode.html

Located between earth art and computational media, Howse's work asks "where precisely does the plague known as software execute" (Howse, 2013), tackling interdependencies between computing and the earth and pushing further the investigation of the materiality of the internet in the light of its *geophysical* foundational base. Working with earth sensors and engaging from a speculative perspective with the earth's signal and raw matter, Howse's work is in direct relation with previous artists I have introduced because it intends to make the hidden initial platform (from which data transmission and computing operates) visible and to reveal these micro processes happening in the ground when computation takes place. In opposition to the metaphor of the cloud, Howse seeks therefore to *insert* the earth's raw matter into the polished, ethereal, and immaterial ideological circuit of the internet (and computing), asserting that all our ubiquitous computational processes and networks not only emerge from the earth (before being engineered and transformed to functional technology), but that these raw materials still have an impact on the technology itself, as well as on data transmission[14]. From this perspective, Howse challenges our perception of design objects and of the built-space emerging from the manufacturing industry. Whereas manufacturing obfuscates the raw matter coming from the earth behind polished and smooth materials and surfaces, Howse's work seeks to question this narrative and process. Drawing from artists such as Shulgin (§ 1.10), Lialina (§ 1.13) or Bunting (§ 1.15), Howse's work is driven here by similar means of making the internet platform and material site visible. More specifically, what sits at the core of Howse's work is the idea to make visible a tension that is inherent to the internet: the intertwinement between its digital materiality and its physical (and terrestrial) infrastructure that supports it.

[14] This alteration of data by its geological context is explicit in the context of satellite transmission, when data is being sent over by radio. For more information, see this article.

1.26 - RESEARCH ROUTE: EARTH MODULATION AND SPECULATIVE PROVOCATIONS

With a desire to use provocation as a strategy to challenge our mainstream perception of the internet as operational and always functional, Howse's work is developed in opposition to the internet's narrative of the cloud. By developing these interaction design provocations that are emerging from non-technical (and non human) components, Howse's proposals have been moreover a turning point of my research because they inspired me to connect through design my research on data transmission processes with processes that are located outside of our common understanding of the internet's materiality. In other words, and in echo with the analysis of internet scholars such as Hu, Bratton and Starosielski, Howse helped me to extend concepts of the internet's protocols and platforms that are central to my work in the light of the geophysical context of the internet; of the internet's earth site of execution. From this standpoint, Howse inspired me to engage with assemblage as a strategy to provoke critical reflection on the materiality of technology. By explicitly creating data assemblages where the earth and the internet's softwares are connected together, Howse's work has been foundational in my quest for strategies to reflect through design on the internet's materiality (figure 23).

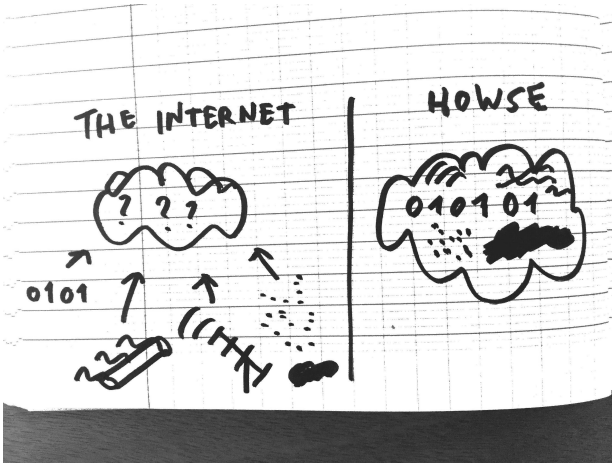


Figure 23: Rationale Drawing #7: Turning the cloud into an assemblage of intertwined matter, forces and binary codes.

On the left, the figure represents the internet's materiality as it is. It is composed of an assemblage of hardwares, earth forces and softwares but this stack (Bratton, 2015) is being obfuscated behind the cloud's interfaces. On the right, the figure represents Howse's work and attempts: creating data transmission assemblages where binary codes and softwares are explicitly intertwined with the internet's non-digital forces and components.

CHAPTER 2: DESIGN AND METHODOLOGICAL FRAMEWORK

2.1 - INTRODUCTION

This § connects my research with the foundational framework of research-creation as well as discursive design practices and methods that operate under this research banner. As with the previous chapter, this chapter is also composed of a variety of nodes that connect to my work and within which I ground my research rationale. More specifically, this chapter links together different perspectives on design that have all focus on using design making strategies to extend critical research. This means therefore that, in a more explicit manner than practices encompassed in the first chapter, the following approaches to design serve an academic agenda of *research through design*. Whereas projects I detailed in the first chapter emerge from contexts that are either cognitive (e.g: critical theory) or practical (e.g: art), these inquiries seek explicitly to merge these two approaches to conduct research inside academia. In other words, these projects seek to challenge the common frame of applying design without the ability to explain or connect its rationale to a broader cultural context. As a researcher conducting critical work on design infrastructures inside academia, my research connects to these problematics.

§ 2.2 to 2.4 contextualise for a non-expert audience the academic framework of research-creation from which I operate, introducing its main challenges and problematics. § 2.5 to 2.11 connect my thesis with a network of discursive design practices. Merging practices of technology making with critical theory and reflection. These practices offer a space inside academia to engage with technology making outside of the duality between practical embodiments (e.g: in engineering or art disciplines) and the cognitive (e.g: in philosophy and media studies). In dialogue with these hybrid practices, I return to artistic and theoretical references I introduced in the previous chapter and circle back to my rationale for working with modems. Finally, § 2.12 to 2.17 draw from these critical design frameworks to explore design methods I use in parallel to my modem works to map my project's design trajectories, recover insights from my process and support my claims and decisions.

2.2 - THE INSTITUTIONALISATION OF LIBERAL ARTS

The research-creation framework from which my research emerges seeks to bridge a gap between two modes of engagement we often perceive as disconnected: *thinking* (theory) and *making* (practice). In order to contextualise my research and introduce the research-creation framework to a broader audience, it is important to revisit the historical context of the renaissance, when the structure of universities took shape.

For the design scholar Richard Buchanan, this division (and hierarchy) between theory and practice originated from the fourteenth and fifteenth centuries, when what we now understand as the liberal arts (encompassing natural sciences, social sciences, arts, and humanities) were institutionalised within universities. During that time, the activity of design (as well as an entire body of *making* practices) was "regarded as a servile activity, practiced by artisans who possessed practical knowledge and intuitive abilities but who did not possess the ability to explain the first principles that guided their work" (Buchanan, 2001). With prominent scholars like Newton separating "the mathematical science of mechanics from practical mechanics and the manual arts" (Buchanan, 2001), the activity of design became isolated from universities and categorised as an old knowledge, as opposed to the new (theoretically-driven) knowledge defined as liberal arts. From this standpoint, the renaissance movement laid down the foundation of an academic model where theory was widely used and prized inside academia whereas "practice was tolerated, and production or making (...) was generally ignored as a subject of learning" (Buchanan, 2001).

2.3 - THE OLD LEARNING VS THE NEW LEARNING; WICKED PROBLEMS VS TAME PROBLEMS

This division between tacit[15] practices and theory left us, as Buchanan has argued, in a "deeply troubling situation" (Buchanan, 2001). Specifically, it resulted in academic research fragmented into such an array of specializations and expertises that it became harder, using traditional (theoretically driven) models and disciplines of our past, to find "connections and integrations that serve human beings either in their desire to know and understand the world or in their ability to act knowledgeably and responsibly in practical life" (Buchanan, 2001). In addition, this division proved to be problematic for tackling new kinds of complex, systemic and interconnected problems that started to appear inside academia: "wicked problems" (Rittel and Webber, 1973). In opposition to tame problems which are problems of science and logic, wicked problems emerge from design. In other words, these problems intersect with (or emerge from) the built space and the implication of human practices, contexts and conditions inside our world. There are a variety of wicked problems tackled by researchers inside universities: fossil fuels, fake news, the internet, climate change, etc. Wicked problems are complex to tackle because they emerge from "the real world" (Papanek, 1985). With every wicked problem being "a symptom of another" (Rittel and Webber, 1973, p.165), these problems are interconnected (and interdependent) and cannot be studied only through the lens of single academic disciplines nor isolated from their practical and design context.

[15]The term tacit is crucial in the context of research-creation, where tacit knowledge is opposed to *explicit* knowledge. Design practices, for example, are considered tacit because they represent forms of knowledge that are difficult to explain and transfer to other persons verbally or through writings. By being defined as "know-how" as opposed to "know-that" (Ryle, 1945), tacit knowledge represents a body of practices that are learned through making rather than through theory.

2.4 - DESIGN AS A NEW LIBERAL ART; DISCURSIVE DESIGN; REFLECTION-IN-ACTION

In order to tackle these complex design problems, there is a need to build bridges between disciplines, engage with new kinds of (pluridisciplinary) research models and to foster new ways to pursue research that acknowledges theory but does not disdain practice. From this perspective, combining design practices with academic research becomes an interesting standpoint from which we can operate in order to research our material and technological culture. Moreover, using design inside academia can be leveraged to escape the "patchwork quilt of specializations" (Buchanan, 1992, p.6) that structure our universities nowadays and develop a critical reflection on and analysis of our material culture (as well as its underlying embodied values) while still engaging with the material that structures our culture: design. This hybrid form of engagement is known as "discursive design" (Tharp and Tharp, 2018) and differs from the traditionally taught objective of design (and engineering) being to solve problems.[16] In discursive design, design becomes a way to conduct reflection (*through* design) and to ask questions as well as foster debate rather than search for answers. Put differently, through the language of design, critical designers seek to lead users through the development of thoughts and ideas by asking them to interact with design objects. This form of critical engagement with a specific subject can, for example, take the form of in situ performances, games, wearables[17], etc. Discursive design practices leading to the formation of embodied cognition and "experimental thinking" (Buchanan, 1992, p.8) are also closely related to the foundational

[16] This is closely related to Evgeny Morozov's concept of "solutionism" (Morozov, 2013). This term has been coined by the author in order to critique the belief that technology can solve all mankind's problems. More information about this can be found in his essay *To Save Everything, Click Here: The Folly of Technological Solutionism* (Morozov, 2013).

[17]For on site installation, see Martin Howse's *earthcode* (2014). For games, see Pippin Barr's *It is as if you were doing work* (2017). For wearables, see Auger+Loizeau's *Smell+* (2009). Although working with different themes and mediums, it is clear that these three design projects use design as a medium for critical reflection.

research approach known as “reflection-in-action” (Schön, 1983). In this concept, Schön intertwines making and thinking; and turns reflection into “an active, in the moment, and almost intuitive, visceral process as opposed to a detached cerebral analysis occurring pre- or post engagement” (Sengers et al, 2005, p.4).

2.5 - FOUNDATIONAL CRITICAL TECHNICAL PRACTICES: ADVERSARIAL DESIGN, CRITICAL ENGINEERING, CRITICAL PLAY, CRITICAL MAKING

This hybrid form where *making* and *thinking* are intertwined opens the door to new ways to critically engage with technology inside our traditionally theory-driven academic world. This body of practices are defined under the banner of *critical technical practices*. By applying Schön’s *reflection-in-action* principles to the context of Human Computer Interaction (HCI) and engineering, these hybrid practices propose a “systemic approach to folding critical reflection into the practice of technology design” (Sengers et al, 2005). Combining computer programming with critical reflection, operating under these practices becomes a way to be critical towards technology *while* making it and to question (or reveal) the underlying values embodied inside technology by engaging with its materiality and design. Inside this body of design practices and drawing moreover from Anthony Dunne and Fiona Raby’s *critical design* attitude, I have been inspired by four different frameworks that I will, in the next paragraph, place in dialogue with my research.

Carl DiSalvo’s (2021) *Adversarial Design* framework is central to my research because it explicitly states that design is political (by imposing its embodied values on us) and that design projects and practices can be applied to the practice of *agonism*, a term I already introduced in

dialogue with Cildo Meireles' work (§ 1.8). As with that artist's "YANKEES GO HOME" insertions, DiSalvo asserts that design projects can be used as a medium to conduct political contestation and disrupt the statu-quo imposed by dominant forces such as the market or the cultural American hegemony in the context of Meireles' project.

Both Meireles and the Adversarial Design frame, as disrupting strategies, lead to practices of infrastructure hacking, which plays an important role inside my practice. From an artistic perspective, this is closely related to net.art where artists seek to disrupt the normal *flow* of data inside the internet by forcing the network to cause delays and crashes (§ 1.12, 1.13, 1.15, 1.17). From a discursive design framework, this connects to the "critical engineering*"* (Oliver, Savičić and Vasiliev, 2011) movement. Critical Engineering, as explained by the collective's manifesto (2011), draws from DiSalvo's general framework in order to apply to engineering language. Inspired by hacking terminology, critical engineering acknowledges, first, the political nature of engineering inside the world we live in, and proposes to *exploit* (or subvert) these engineered networks in order to reveal how they work and embody values on us. From this perspective, critical engineers are less interested in the idea of building new technologies from scratch than opening, modifying, disrupting and subverting the ubiquitous pervasive technologies of our networked-enabled world.

An example of this work conducted by critical engineers under this framework is the *Packetbridge/Packetbrücke* (Sjölen, Savicic, 2015) project (figure 24). *Packetbridge/Packetbrücke* is an intervention into the pervasive technology of digital maps and smartphone positioning systems. Connected to Meireles and net.artists, the project has been moreover conceived as an *insertion into the ideological circuit*[18] of the GPS network, using the *beacon* technology to create *location spoofing attacks* of user's devices that depend on the network. Taking the form of a physical installation

[18] An interesting critical engineering project taking the form of an *insertion* is NULLSTECKER (2013) by the German artist Dennis P Paul. The project consists of "220 V power plugs modified to trigger short circuits when plugged into the wall, shutting down all electricity"(Paul, 2013). More information about the project can be found here: https://dennisppaul.de/nullstecker/

operating inside an art gallery, this creates therefore amongst visitors a sense of confusion, with their devices' locations being rerouted to different physical spaces.

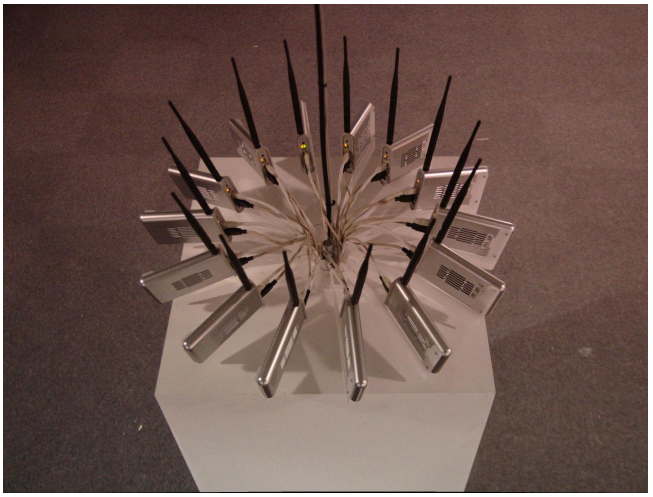


Figure 24: Packetbridge/Packetbrücke. The Critical engineers. 2015.

Source: https://criticalengineering.org/projects/packetbridge/

In this project, routers are placed in a circular shape so that they can intercept the gallery's visitors' smartphone signals. By doing so, commands can be sent to their positioning systems so that these can be detoured with fake GPS coordinates.

Critical engineers seek to encourage design interactions and interventions to support critical reflection rather than exhibit artworks inside art institutions where the audience is detached from the project. From this perspective, critical engineers work with satire, provocation, and connect to the concept of "critical play" (Flanagan, 2009) developed by the theorist and game designer Mary Flanagan. Critical play had an influence on my modem work. Within this discursive design approach, Flanagan proposes to use *play* as a means to foster critical reflection. Moreover, as a critical technical practice applied to the context of games, she argues that play can be used to reflect social values, social norms and ask questions about the technopolitical world we live in.

An example of a critical play work is Mary Flanagan's *[giantJoystick]* (2006) project, designed as a system for collaborative play (figure 25). This project connects to net.art and platform studies (§ 1.10)

in the sense that it detours a technological object outside of its purely operational usage and actively uses a materiality we take for granted (e.g: the Joystick) in a critical and artistic way. With, more specifically, the creation of this giant Joystick that needs to be controlled by multiple players simultaneously in order to play the *Atari* game it is connected to, the project is a reflection on the normative values embodied by the technological platforms. It questions, in other words, this component of the platform from a cultural perspective, asking how the design decisions embodied inside these platforms impact spheres that are bigger than the technology itself and contribute to reinforce an individualistic agenda (Knobel and Bowker, 2011).

Figure 25: [giantJoystick]. Mary Flanagan. 2006.

Source: https://studio.maryflanagan.com/giantjoystick/

In this context, it is explicit that this game design proposal and object does not follow the mainstream (and capitalistic) approach of technology as purely functional and efficient. By being then oversized, error prone and hard to manipulate alone, the project serves a first a discursive approach; and is used as a means of enacting critical reflection on these technological apparatuses.

Finally, a prominent form of critical technical practice I have been interested to engage with is "critical making" (Ratto, 2011). Critical making differs from the previous discursive design frameworks in the sense that it does not depend on the realisation of design props nor on finite projects but acts on a more foundational level: the production of technology. Created in opposition to the *Maker Faire* association and events where prototyping is disconnected from technology's entanglement with the *real world*[19], critical making proposes to turn hands-on making into a medium for critical reflection. Actively using prototyping and open-source microcontrollers such as the *Arduino* platform, critical making seeks then to engage with technology outside of the market incentives, explore and deconstruct its embodied values and un-sanitize, un-smooth and re-politicize it (Hertz, 2010).

2.6 - RESEARCH ROUTE: CRITICAL TECHNICAL PRACTICE IN MY RESEARCH

Discovering the critical technical practices just discussed has been foundational for my research because it helped me to contextualise my design work inside a broader academic body of research that sits outside of the market and its incentives. Moreover, engaging with adversarial design resonated with my practice because my works are explicitly rooted in a set of political questions that gravitate toward the debate around network (or *net*) neutrality. In reaction to these actions undertaken by Internet Service Providers (ISP) to control our behaviours by altering - at the level of protocols - the speed of data transmission or by using state jurisdictions to discriminate specific groups of users based on their geographical location, my work originated from the debate occurring currently inside

[19]The *Maker Faire*'s disconnection between technology and its political implication was made explicit when the association accepted a grant form the Defense Advanced Research Project Agency (DARPA). This decision, which is in opposition to the initial hacker and maker space culture, has resulted in a backlash from prominent hackers and makers. For more information, see https://nyti.ms/2Wgy26v.

our techno-political sphere. It is from this debate that these embodied narratives of atemporality, neutrality, and immateriality of data transmission are made explicit.

Deconstructing these embodied narratives through research through design, my work also connects to critical engineering because of the way I engage with existing networks and platforms. In addition to working with engineering and software in a critical manner (which is the focus of the critical engineering framework), my work moreover echoes with this framework because I do not seek to build new technologies from scratch but to detour and subvert existing ones. From this standpoint, my research is grounded in practices of *hacking*. In my work I use, in other words, network *insertion* as a disruptive strategy, *exploiting* technological *holes* and creating breaches in the normal flow of data in order to conduct my critical technical projects with modems.

Working within the context of play and game design for the *MODEM_GUESSR* suite of projects I will expand on in the next chapter, my research also connects to the *critical play* framework developed by Flanagan. It connects to this framework because, as with Flanagan's *[giantJoystick]* (2006) project, I have been interested in using a component of the modem platform outside of its technical realm: the modem baud rate modulation. Here, tuning the modulation baud rate as a key component of a game becomes a way to conduct critical reflection on something that is hidden and that we usually take for granted via a game design setting.

Finally, the last discursive design framework I have been interested to engage with is *critical making*. I connect my work to this framework on a more methodological level. More specifically, this framework has been foundational in my will to seek methods intertwining reflection and analysis *while* creating technology and software; such as the *Games as research/MDMA* I will expand on in the § 2.14 of this chapter.

2.7 - MEDIA ARCHEOLOGY: INTRODUCTION

The last framework I engage with is *media archeology*. Media archeology, as a research field, emerges foremost from the work of Michel Foucault, from whom it borrows its reference to the archeological discipline. In Foucault's essay entitled *"The Archeology of Knowledge"* (1969), archeology is turned into a research framework in order to redefine traditional historical research and to seek new ways to put forward forgotten, subaltern and local discourses and events of our past (Hertz, 2015). Like traditional archeology, where material sites are excavated in search of past human artifacts and contexts, Foucault's *archeology of knowledge* proposes to use written archives and repositories as archeological sites in order to cross disciplines and develop genealogies of ideas (Foucault, 1969); tracking lineages of concepts or discourses as a way to understand how these ideas become significant (or are discarded) in our western societies.

In addition, media archeology also emerges from the work of the German media scholar and historian Friedrich Kittler. Drawing from Foucault in order to develop his work on alternative genealogies and counter-histories of media (Goddard, 2015) and to question from a hands-on perspective the dominant ideologies and narratives embodied inside our surrounding technical systems, Kittler proposes to extend Foucault's archeological approach to these other technical forms of writing and storage that are media specific. With Kittler, research on media becomes bound to a technical analysis of what constitutes media: networks, hardware, software, switches and so on. With the work of Kittler (that had a foundational influence on the critical technical practices I discussed earlier), research on media acknowledges then that technology is political and embodies (or modulates) discourses inside its materiality. Put differently, it acknowledges that technology cannot be separated from the political and that this normative aspect of technology needs to be addressed through the lens of critical theory and reflection.

2.8 - MEDIA ARCHEOLOGY: TEMPORALITY

From this perspective, media archeology's central enterprise is to revisit the history of media in order to explore our current media's dominant embodied narratives, such as those I address in my own work. This desire to uncover hidden discourses and to seek counter-histories of media is explicit in the work of one of the leading figures in the field of media archeology, Jussi Parikka. As an echo with the work of net.artists or the research on micro-temporalities conducted by Sprenger (§ 1.19), an important embodied narrative tackled by Parikka through the media archeological gaze is the illusion enacted by our network culture that time (and temporality) does not exist inside the digital; that our networks are atemporal and do not manipulate time. In opposition to this idea, Parikka argues that our networks are not just in time but *constitute* and *manipulate* our perception of time (Parikka, 2013). Studying Paul Baran's patents and white papers[20] made during the implementation of packet-switching and zooming in to the level of the technical to critically reflect on the way we sense time, Parikka proposes to replace the erroneous idea of "data flow" by the concept of "bursts" (Parikka, 2013). In the light of these technical papers, Parikka asserts that data transmission does not happen as it is usually depicted - smoothly and seamlessly - but rather takes the form of a circuit of "bursts that need to be made to flow" (Parikka, 2013). From this standpoint, Parikka deconstructs our main beliefs around our ubiquitous data transmission networks, arguing that inside these networks the instantaneity of data is an illusion that has been (and still is) carefully crafted and engineered.

[20] A whitepaper is a term used by the engineering industry and (computer) scientists in order to introduce in a concise publication a proposed solution for a defined problem. In the context of Baran's Packet Switching, this problem is the centralised infrastructure of data transmission, a model that becomes vulnerable to the possible targeted attacks of the Cold War.

2.9 - RESEARCH ROUTE: SOFTWARE DIAL-UP MODEMS AS A MEAN TO QUESTION AND HIJACK DATA TRANSMISSION'S (A)TEMPORALITY

Media archeology - or (an)archaeology[21], as Rudi Visker defines it - offers a space inside academia to explore "weird materialities" (Parikka, 2012), processes and agencies of media that are not usually acknowledged inside (or are even suppressed by) media's dominant discourses focusing on the concepts of efficiency and operationality. As proposed by Parikka (2012), building on top of Kittler, media archeology, while offering researchers a material and nonlinear way to engage with media, also opens the door to a whole body of media archeological design and art practices, such as that of Martin Howse introduced earlier. From this standpoint, media archeology proposes artists to question these embodied discoursess by engaging with "repressed, forgotten or past media technologies" (Hertz and Parikka, 2012, p.425) inside our contemporary technological contexts, creating alternative circuits of data transmission as a mean for critical reflection on the technological.

In the context of my research, this practice-based media archeology is in direct relation to my work with software dial-up modems, an old and forgotten technology that contrasts with the internet's dominant narrative and discourse regarding data transmission's atemporality. By engaging with these error-prone and evidently temporal devices, I have become interested (through design and engineering) to break the black box of the internet presentism and assert that the temporality of data transmission on the internet has been crafted step by step by engineers. Inserting, in other words, these primitive apparatuses inside the silent (and seamless) cloud of the internet, my aim has been to 'hack'

[21] The field can be also defined as (an)archaeology because it seeks to distance itself from the linear approach taken in traditional history and archeology. While these disciplines imply a sense of ordering and seek to create a coherent path of events and concepts, media archeology, driven by the idea of counter-narratives, is more interested in "losers" of media history: technologies that have not been fully implemented, that sit outside of the traditional market, etc.

dominant ideologies embodied inside the internet and create data circuits as well as critical interaction design situations where this temporality is revealed and made explicit.

2.10 - MEDIA ARCHEOLOGY: MATERIALITY

In addition to exploring the dominant discourse of "flattening" the temporality of networks and the internet (Starosielski, Soderman and Cheek, 2013), Parikka's work seeks also to deconstruct through the media archaeological gaze the tenacious idea that, because our ubiquitous networks are not tangible, they do not have a materiality nor a physicality. In his essay entitled *"A geology of media*" (2015), the author proposes moreover to extend media archeology to what he previously defined as "dirty matter" (Parikka, 2012, p.98) and reframe how we perceive media in the light of its intersection with geology and the earth's activity. Extending from the provocation of Kittler stating that "there is no software" (Kittler, 1995) in which he argues that software, compiled to binary code, needs to be studied through the lens of hardware circuits, physical components and voltage differences, Parikka proposes to extend this inquiry into media's materiality beyond the Open Systems Interconnection (OSI) physical layer and to investigate the role of sediments, metals and chemicals involved in computing and how these contribute to the production of our "perfectly polished" (Galati, 2015) digital networks. Tracking, for example, the crucial role of silicon used in the context of computing in order to establish logic gates, lithium used for laptop batteries or copper in the context of our transoceanic undersea fiber-optic cables, Parikka extends the archeology of media to a cultural analysis of "concrete material contexts in which media takes place and displaces" (Goddard, 2015, p.21). By doing so, he acknowledges inside our discourses on media these geophysical elements and forces "that give us digital culture" (Galati, 2015, p.139). In dialogue with Starosielski (2015), Hu (2015) and Bratton (2015) whose works also connect to projects of Howse (2013), Parikka proposes therefore to decentralise the central role of the human (user) inside technology. From the standpoint of

geological media, users (usually understood as main stakeholders inside our dominant technological narratives) become consequently not discarded, per se, but understood within a broader assemblage (and context) of forces and energies that are not only human but also nonhuman and natural. Intertwined as a result inside an ecology of signals, flux and transductions between heterogeneous states and matter, Parikka (and media archeology) seeks then to bring counter-narratives to our initial conceptions of technology as seamless and "cloudy". From this perspective, media archeology argues that media discourses on the internet and data transmission processes need also to acknowledge the agency and shifting properties of these technology's physical sites of execution, as well as those of the foundational-level components that are being used during these infrastructures' manufacturing process.

2.11 - RESEARCH ROUTE: SOFTWARE DIAL-UP MODEMS AS A MEANS TO EXPLORE DATA TRANSMISSION'S MATERIALITY

In the context of my research, this will to deconstruct the erroneous metaphor of the immaterial and seamless cloud echoes with my work with dial-up modems, a technology whose materiality is explicit and analog since it uses analog sound waves to transmit data. Since data is thus transmitted into audible audio elements in the context of dial-up modems, the materiality of the data transmission process is more explicit than digital data transmission processes, whose materiality is obfuscated by the designed and engineered web apparatus (§ 1.2). Moreover, In dialogue with the internet's materiality acting as a system where the activity of the digital (located inside the OSI top-level layers) is impacted by the one of the physical (located, in turn, inside the low-level layers and physical infrastructures), working with dial-up softmodems becomes an interesting way to tackle this dynamic of data transmission translation. Inside the *protocological* chain of software modem data

transmission, the process is therefore not only digital, nor only physical, but intertwined: digital protocols that operate the technology's software and the stack of hardware that the technology requires to output and process the data in its analog format. This hardware includes, non exhaustively, the speakers, the microphone, and the sound card; whether built-in or external. This assemblage of protocols creates a circuit where, like the internet, the process of data transmission is intertwined with the software dial-up modem's digital and physical materiality. As with the internet, where the illusion of a seamless data transmission processes relies on the optimisation[22], maintenance[23], location and expansion[24] of its material infrastructure, engaging with modems in a digital context makes the role of such devices explicit. Finally, just as the internet's layers are impacted by their physical built-space and geophysical site of execution, I have been also interested to engage with dial-up modems because of their explicit connection with their site of execution. Just as the internet's physical layers (and therefore the entire operation of the internet) are disrupted by the activity of the earth - earthquakes,[25] modulations of particles inside the atmosphere - software modems using soundwaves transmitted through the air can also be altered by modulations of their geophysical site.

Inserting (material) software dial-up modems into data transmission circuits that are digital thus becomes a way to challenge the narratives of immateriality (and networks as purely digital) that Parikka and other media archeologists are exploring. Drawing from the work of Bratton and Parikka, inserting analog data transmission processes into digital circuits becomes then a way to extend the

---

[22] The quest for internet hardware optimisation is explicit when private companies such as Google are implementing their own undersea cables. For more information about this, see this article.

[23] Maintenance is crucial for the illusion of the flow, due to the impact hardware disconnection has on data transmission. A blatant example of this is when the entire Armenian country lost access to the internet for four hours after a Georgian woman decided to slice an underground cable. More can be seen here.

[24] The importance of location and expansion of hardwares - antennas, data centers, undersea cables, etc - is crucial when we attempt to establish an internet connection with countries whose internet infrastructure is minimal or non-existent such as North Korea. More information can be seen in this project scanning the country's IP addresses.

[25] Earthquakes or Tsunamis also have an impact on the internet's illusion of connectivity and flow, damaging its infrastructure. This is explicit in events like the 2011's Japan Tsunami or the 2020's Porto Rico's earthquake.

OSI's layers (§ 1.7) to these physical processes that take place outside the internet and emerge from the internet's geophysical context. In connection with the work of Howse (§ 1.25), this intertwining of data transmission processes and geophysical sites of execution is even more explicit in the context of the speculative proposals and projects I expand on at the end of the next chapter, connecting the activity coming from soil samples to modem instances in order to impact their modulation parameters.

2.12 - RESEARCH ROUTE: FROM DISCURSIVE DESIGN FRAMEWORKS TO DESIGN METHODS

These design frameworks discussed above have been foundational for my research because they help me to ground my work outside a purely functional and market-driven understanding of design projects. Moreover, following Dunne and Raby's seminal *a/b manifesto* (Dunne and Raby, 2009), these frameworks enabled me to change my underlying rationale and understanding of design projects and practices conducted inside academia. Going back to Dunne and Raby's manifesto, I have been therefore interested in designing projects for *implications* (with broader critical research contexts) rather than (market-driven) *applications*, *asking questions* rather than *providing responses*, and using design as a *medium* rather than as a *process*. In other words, these frameworks contextualised my research as a form of critical discourse and reflection, acknowledging the politicality of design (e.g: imposing on us a set of embodied values) and using design as a means of deconstructing these values and narratives. However, these frameworks do not explicitly address a central problem of research-creation: engaging with methods to provide evidence for decisions and claims made during the design process. Moreover, these research frameworks discussed thus far do not tackle issues of building knowledge from tacit design practices nor research recoverability and context, which are key assets of scholarly design methods. Paired with critical technical practices and

media archeology, I have structured my practice around the use of methods suited for my work with software making and modems. These methods are prototyping, games as research/MDMAand speculative sketches. I will detail these methods in the following §.

2.13 - DRAWING FROM REFLECTION-IN-ACTION AND CRITICAL TECHNICAL PRACTICES: PROTOTYPING

Prototyping is the primary research-creation method from which my work emerges. In dialogue with critical making and media archeology, I use prototyping in order to embody my research in design, to critically engage with the materiality of my research object (the internet), and to test my initial assumptions in light of what this materiality affords and restricts. Using prototyping, my research-creation approach thus follows an iterative format, using quickly generated design objects to gain valuable feedback and in turn to reevaluate my research trajectory through these prototypes.

Working with the most popular programming language of the internet, JavaScript, my prototyping approach refers to what Brandt et al. (2009) define as “opportunistic programming” . In dialogue with this concept, I therefore place emphasis during my prototyping sessions on “speed and ease of development over code robustness and maintainability” (Brandt et al, 2009). Moreover, using a *high level* language such as JavaScript instead of lower level[26] programming languages (that are more robust but also more verbose and time-consuming) enables me to build prototypes quickly and to tailor existing components to the needs of my projects rather than building entire software architectures. From this perspective, my prototyping approach can be described as a form of bricolage

[26]The difference between high level and low level depends on the degrees of abstraction embodied inside the programming language. When programming languages are high level, they will often be composed of natural language (e.g: English) words making the act of programming easier (but at the same time more abstract). High level programming languages include: Ruby, Python, JavaScript. Low level languages include: Fortran, C, Assembly, etc.

and copy-pasting with code taken from the internet mixed with code I write myself, gluing pieces of software together rather than building systems from scratch. In addition, since all major social media platforms have been built using JavaScript, I am also able to easily embed these platforms' APIs into my workflow, and thus use these platforms as a source of live data. Finally, I also work with *Git*, a distributed version-control system (that is foundational for Github, an open-source social media enabled by Git) that enables programmers to store and share code and its history online. With this ability to upload my code's iterations over time on this repository, Git enables me to gain more modularity, to revisit code I produced during old prototypes and to use this code as a starting point for new work.

2.14 - DRAWING FROM REFLECTION-IN-ACTION AND CRITICAL TECHNICAL PRACTICES: GAMES AS RESEARCH/MDMA

Git and *GitHub* are core components of another foundational method that structures my work: *"Games as research/MDMA"* (Khaled, Barr and Lessard, 2018). Games as research/MDMA stands for *Method for Design Materialisation and Analysis.* Building from Schön's reflection-in-action and prototyping, this method emphasizes the methodological value of archiving and centralizing all stages of a software project's process and ideation. In this method that can be used for developing projects of different scopes and formats where the activity of writing software is involved (whether a software bot, an app, a game, or an installation), GitHub repositories serve as a way to materialize and disseminate the research creation processes conducted. In addition, with the Git software creating a new (accessible) fingerprint of the project every time a *commit* has been made and *pushed* on its GitHub repository, materialising projects via this platform enables researchers to monitor and revisit the chronological evolution and design trajectory of the project (figure 26). This

feature allows researchers to recover data through the project's iterations and design embodiments and to use these to support research-creation claims.

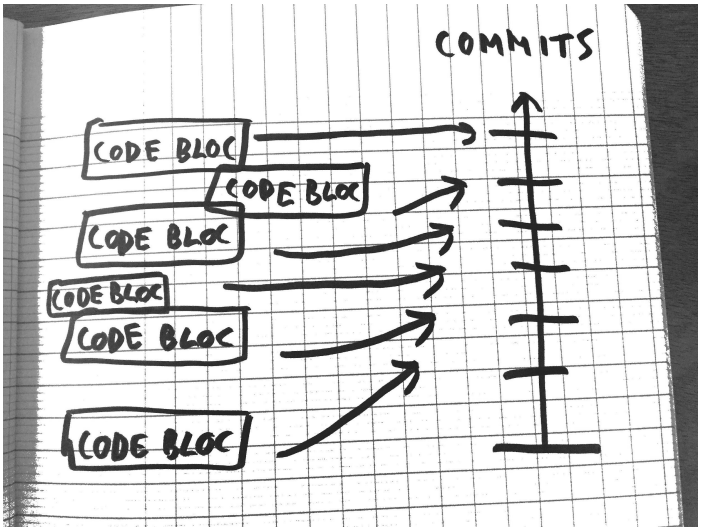


Figure 26: Drawing #8: GitHub commits.

Here, we can see that different blocks of codes added (or removed) to the project's software have been pushed to the commit timeline that is sorted from the most recent to the oldest. This enables programmers or external visitors to revisit the project's different states through the time of ideation and production.

For a practical example, see the commit timeline of my MODEM_BROWSER project (§ 3.4):

https://github.com/cyruslk/Modem_clicker/commits/master

Games as research/MDMA proposes therefore to use what the Git and GitHub infrastructure enable as a research strategy to elevate design from its *tacit* approach and to centralize research inside an online archive that can then be revisited and serve as a base for external research conducted by scholars or the researcher themself. From this perspective, the method proposes a set of key research protocols to gather information in a specific and unified way. The first protocol within this Git repository is the use of Git *commits*, that are used here in a descriptive way in order to give more context to each block of content or code being added to the repository during the project's lifetime. Coupled with the GitHub interface, this enables the creation of a process timeline where *commit*

messages are displayed next to their timestamp and date of creation. Since they are clickable, they also allow users to have an overview of the content that has been pushed to the repository and labelled with each commit. These can later be used for inline citation and references inside research outputs, either from the designer itself or from external researchers.

In addition to investigating the role of *commits*, the method proposes to disseminate the process around the use of another component enabled by the GitHub infrastructure and interface: *Markdown* files. With these files allowing users to write in natural language (such as English or French), quickly format the styling or embed media, design researchers can therefore structure the dissemination of the process in a legible way and explain the project's different components within its repository inside a *README Markdown* file: displayed in the root of the project. In addition, these files also allow the creation and inclusion of a conscientious and regular design diary kept by the designer (Khaled, Barr and Lessard, 2018). This enables researchers to give more context about their day to day work on the project, expanding therefore both on the project's leitmotiv, technical challenges, inspirations and connection with a broader artistic, cultural and theoretical context. Entered in the form of chronological entries that can be accessed independently through anchor tags, these *logs* can then be, in the same manner as commits, used as references to support claims (Khaled, Barr and Lessard, 2018).

Third, another built-in feature the method takes advantage of is the use of *GitHub Pages*. With *GitHub Pages* (though this can easily be replaced by another publishing platform), the method proposes when possible to create playable *builds* of projects. Through the creation of these builds, researchers are then able to gather meaningful evidence of the project's design embodiment over time. This feedback given by peers can then be included inside *logs* and used inside the project's process documentation to reframe the project's intention and the design decisions. Finally, the method suggests the creation of a manifesto; or *artist's statement*. This should describe in clear and simple terms what is meaningful about the project and how the project connects to a broader context of

research.

2.15 - RESEARCH ROUTE: BUILDING ON TOP OF GAMES AS RESEARCH/MDMA

Working with software in a research-creation context, I have been interested in using *Games as research/MDMA* as a framework for my projects. Since the method can be adapted to meet different research context needs (Khaled, Barr and Lessard, 2018), what I propose here is my own interpretation of this method and how I have been then interested to push further specific aspects of the method that are underdeveloped. For each of my research projects, my use of *Games as research/MDMA* is first structured around the production of the *process journal*. Throughout the course of each project, I use this digital diary in order to situate my work within a broader context of ideas, inspirations and projects by others. Extensively using the *Markdown* formatting syntax and the possibility of adding checkboxes, I also use this file as a technical to-do list, detailing both technical challenges I face on a daily basis while I work on the project's materiality and possible options I could implement to address these challenges. Intertwining inside the same file the technical aspects of the project and notes on the rationale and the context helps me in turn to build my critical reflection on the project and reframe this critical discourse while staying close to the materiality of the project itself. In other words, I use this diary to develop a critical conversation with the initial project's intentions and the design materiality (Schön, 1983), reframing my research questions in the light of the technical challenges I face and engage with. From this perspective, I seek to engage with design's materiality not in a disconnected way but in a manner that connects with my broader academic research.

Along with this, I have been also interested in embedding blocks of code inside the process

journal. This addition to the initial *Games as research/MDMA* proposition allows me to extend their critical conversation with the materiality of the design project to the code itself. Navigating between these blocks of code I create and diary entries written in plain English helps me as a result to go back to my initial design assumptions in the light of what the materiality of the code affords and restricts, and thus to reevaluate my research proposal. Further, exploring the low level of the code itself allows me to be more specific while describing what the software does when detailing its procedural authorship. A feature that I also push further from the initial *Games as research/MDMA* proposition is the use of GitHub *branches*, a functionality that sits at the core of the Git software and allows developers to work in parallel on differently coded versions of the same project. Embedding this feature inside my workflow allows me therefore to break the linearity of the design process and work on different (design) embodiments at the same time, exploring in parallel different ideas and design solutions before deciding which path I should take (figure 27). I will further develop this in chapter three when discussing the *OROBOROGRAM* (2018) project.

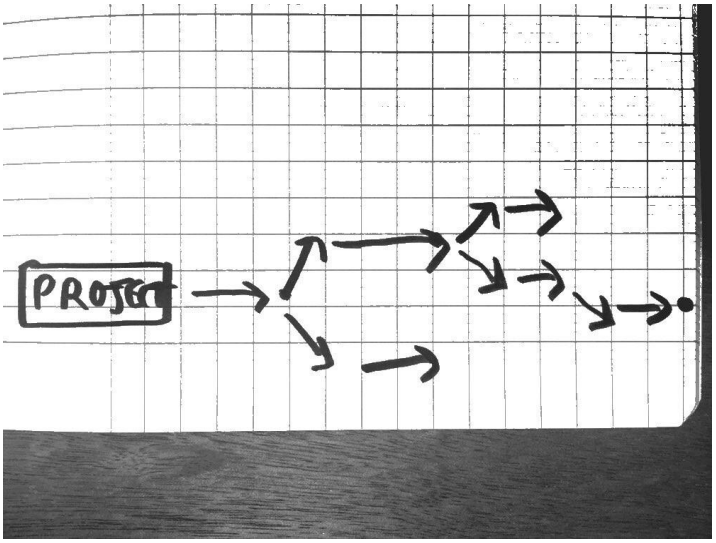


Figure 27: Drawing #9: GitHub branch.

Branches enable programmers to work on different ideas and implementations simultaneously while keeping the trace of these implementations through time.

For a practical example, see branches developed while creating my OROBOROGRAM project (§ 3.2): https://github.com/cyruslk/OROBOROGRAM/branches

Finally, and in dialogue with my practice of embing blocks of code inside my process *logs*, I have ways to couple *Games as research/MDMA* with the analysis of the source code that is generated and serves as an important part of the project's materiality. What I present here is however not fully completed but since I would like to expose the reader both to my actual research and its future directions, I have decided to include these reflections below that I also support by sketches. From a theoretical perspective, this inquiry is rooted in the seminal *software studies* text of Katherine Hayles entitled "Print Is Flat, Code Is Deep: The Importance of Media-Specific Analysis" (Hayles, 2004). In her article, Hayles argues that Electronic Hypertexts (and the internet, built from a top to bottom approach using high level programming languages) are, before they are translated to machine instructions and binary code, *bilingual*, written in code as well as human languages (Hayles, 2004, p.6). This means, in other words, that inside all our computational processes, human (or *natural*) language (and more specifically, English) serve as a "ground for the syntax and grammar of computer languages" (Hayles, 2004, p.7).

In *JavaScript*, the ubiquitous programming language I use in the context of my research, this intertwinement between legible human and machine commands and contexts is explicit in the context of two elements of syntax: function names (e.g: `function()`) and pseudo code comments (e.g: `// comments`). This means, in other words, that these two techniques frequently used during the ideation and the production of the software can be intelligible for a non-expert audience, such as for researchers who are eager to analyse the project's process but not easily able to investigate its materiality at the level of the code itself.

The first of these two elements, function names, plays a key role in the ideation and creation of software. Function names are generally written in plain English (following the camel case or snake case conventions) and are used to define and identify blocks of reusable code and. In the context of

the *functional programming* paradigm I use to write code, functions are foundational, they handle and alter data, and define how this data is processed along its trajectory through the software. As a result, there is a need to make these function names self explanatory and descriptive for the sake of clarity, explaining what tasks these functions perform in order to recall them easily afterwards. Pseudo code comments, in turn, play a different role during the creation of software and are crucial during the ideation phase. Written by programmers inside the source code file itself in order to conceptualise steps a function should follow to process data or technical challenges to resolve, these comments are usually written in plain english.

As a programmer working within academia and interested in extracting meaningful information and evidence from my projects to support my overall research, I have been interested to apply Hayles' understanding of programming languages as *bilingual* in the context of research-creation. Moreover, building on the *Games as research/MDMA* framework and its aim to materialise research trajectories (Khaled, Barr and Lessard, 2018) in a linear format through the use of the *commit*s timeline, my approach has been to pursue the investigation of these research trajectories through the extraction of data that is intelligible for a broader audience. By manually (or automatically, using a scripting bot and the GitHub API) post-processing files pushed to the project's GitHub repository, I argue that extracting these data chronologically can give us an additional layer of insights into the project's process. First, function names can inform us of a project's *runtime execution* and on its *procedural authorship*; how the software operates to produce its final output. This can in turn help researchers to decrypt in a more precise manner what happens *under the hood* when the software runs and to get additional insight into how the designer has translated their ideas into the code's affordances and restrictions. In addition, I also argue that, in addition to function names, pseudo code comments play a critical role during the ideation phase and can therefore be explored in the context of research-creation. While, instead of function names, they are not read by the machine to execute the program (and are often removed by the programmer to *clean up* the code), they can be extracted in a chronological manner to gain insights from the researcher's ideation process. Located

one level closer to the creation of the source code (and therefore of the project's materiality) than the *Games as research/MDMA*'s process logs, they can be extracted and displayed in a timeline format to conduct a *cold analysis* of the technical challenges, constraints and solutions faced by the researcher along the project's process.

2.16 - SPECULATIVE DESIGN, SPECULATIVE SKETCHES, SPECULATIVE DATA TRANSMISSION CIRCUITS

Finally, I have been interested in engaging with design projects in a more *speculative* manner for my work's future directions, something I will expand on at the end of this thesis. Developed by Dunne and Raby in their Speculative Everything (2013) essay, the *speculative design* framework plays a different role than other critical technical frameworks I have mentioned (see § 2.5). Following Dunne and Raby, *speculative design* proposes to enquire what surrounds us in a more open-ended and *fictional* manner. Whereas discursive design frames such as adversarial design or critical engineering are explicitly political, speculative design's emphasis is on using elements of the real-world in an alternative configuration to speculate on plausible futures (Auger, Smyth, Helgason and Hanna, 2019). This means, in other words, that speculative design proposals may be less anchored inside current political debates but ask questions about our future from a more foundational perspective. This means that, inside the speculative design framework, designing objects and situations becomes a way to speculate on and inquire in a more open-ended way about the *plausible* future embodiments of our culture and about the practices that constitute it: technology, science and others.

An example of speculative design is the work conducted by Howse introduced earlier (§ 1.25). Howse's projects operate differently than those of Meireles (§ 1.8) or critical engineers (§ 2.5). More than being explicitly political, Howse's projects propose fictional situations in order to speculate

on the intersection between nature and computing; between the geophysical and the technological. From this research angle, Howse' research draws from the land art movement to inquire on a more foundational level into the materiality (and territory) of computing and the internet. Through the creation of his speculative (or fictional) computing data circuits, Howse's work invites us to explore poetically how computing is (and will be) impacted by the anthropocene and disturbances caused by this global demands on the earth's raw matter.

From this discursive design framework to the need to engage with design methods in the context of research-creation, I have been keen to build on top of Amen Avenassion and Andreas Töpfter's *speculative drawings* proposal (Avenassian and Töpfter, 2014). Drawing from speculative design, speculative sketches propose to materialise speculative design situations and interactions through the use of sketches. Moreover, Avenassion and Töpfter propose - in reaction to the literature - to pursue the critical activity of *speculating* on the world that surrounds us in a less cognitive and text oriented way. Like prototyping (§ 2.13) and MDMA (§ 2.14), these sketches can be used inside an academic context to support claims and help to build a record of a research project's processes and trajectories.

Howse connects to critical making and extensively uses sketches in the context of his research. In the context of his *earthcode* (2014) suite of research, for example, he uses this strategy to materialise speculative installations intended to be conducted in woods where components of a computer (such as the display or the CPU) are mimicked using the earth's chemical forces and reactions. While this installation project is site-specific and intended to operate at the level of a large time-scale, using sketches allows the production of a draft of action, a proof of concept that supports the research, its rationale and technical implementation (figure 28). In addition, Howse engages with the production of speculative data transmission circuits as well as speculative printed circuit board (PCB) schemas for the creation of its hardware. Coupled with prototyping, these methods offer research-creation practitioners interesting ways to engage technology outside of the incentive for

operationality and functionality driven by the market.

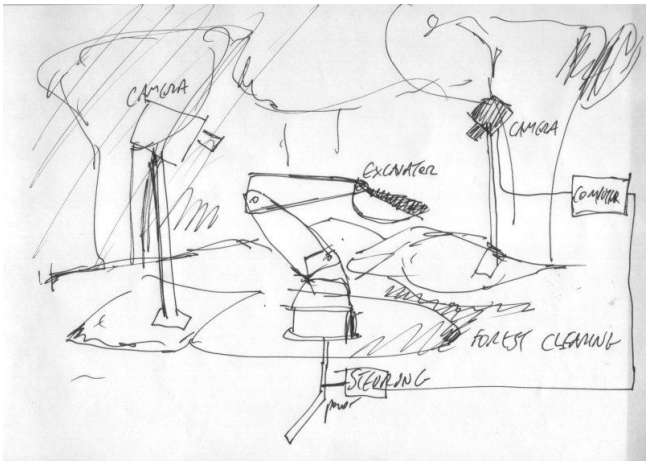


Figure 28: Martin Howse. Speculative sketches for an earth computer. 2010.

Source: https://we-make-money-not-art.com/earth_computer/

In this context, it is explicit that Howse uses sketches in a speculative manner; to embed in his earthcode *project situations and design proposals that are not (or hardly) feasible technologically but are crucial in extending his research.*

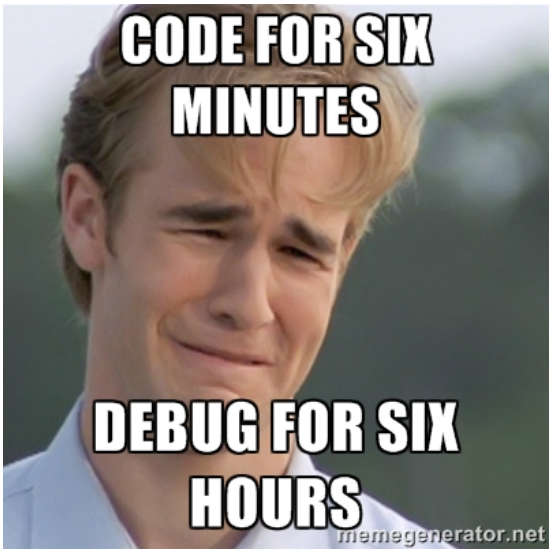
2.17 - RESEARCH ROUTE: SPECULATIVE SKETCHES AND PROPOSALS IN MY RESEARCH

Howse's use of drawings has been a key inspiration inside my thesis and research. As I have pursued critical reflection toward the materiality of the internet, the use of sketches has helped me to anchor my rationale not only through words or prototyping but through schemas and sketches. Through these schemas (e.g: the *Rationale Drawings* shown throughout this thesis), I have been able first to build my rationale in a less linear and, from my perspective, in a more humorous format. While the production of texts has played an important role in the conceptualisation of my thesis

objectives and intentions, these sketches helped me to reframe my research through the use of visual and spatial symbols and strategies.

Finally, another contribution of these sketches in the context of my thesis relates to the potential these drawings enable for speculation and poetry. Going back to the work of Howse, starting with the drawing medium - such as in his *Sketches for an earth computer (2014-2015)* - allows him to approach technology making outside the purely operational incentive. Moreover, starting from drawings instead of lines of codes allows Howse to escape limitations given by the materiality of technology during prototyping. In dialogue with Howse, this gesture has enabled me to use provocation and satire as strategies to push further the deconstruction of the internet's materiality and narratives through design.

CHAPTER 3: CASE STUDIES, FUTURE WORKS



3.1 - INTRODUCTION

This chapter gives the reader an in depth analysis of the critical technical projects and proposals I have created during my thesis work. These projects and inquiries question the three narratives of internet *neutrality* (§ 1.10, 1.12, 1.16, 1.17, 1.18), *atemporality* (§ 1.13, 1.4, 1.19) and *immateriality* (§ 1.20 to 1.26) that are central to my thesis. I have structured this chapter into five § , each addressing one project.. In each section, I connect a project with the preceding chapters' materials including excerpts from my GitHub logs. The structure in each § is as follows:

1. *Research Context and Rationale*

   I situate each project within the artistic, theoretical and methodological contexts underlying my thesis. In doing so, I connect each project to a specific cluster of research questions that emerge from my thesis' three core narratives. In addition, I also tackle specific inspirations and design projects that helped me in materialising my rationale while developing my work and its critical discourse. Finally, I draw on the feedback received for previous projects to further ground my rationale and research.

2. *Procedural authorship, visual documentation*

   I describe each project technically and procedurally. In addition to grounding my project's processes with visual documentation and sketches, I go further into the project's materiality by detailing a step-by-step computational (or *procedural*) recipe, e.g: how does the project's software/hardware operate technically.

3. *User experience, feedback and takeaways*

   I provide a description as well as a critique of the project's user experience. As a critical

designer (§ 2.5), it is crucial to root each project in a context of execution and experience. As projects that emerge from research-creation and are iterative (§ 2.13, § 2.14), this § also exposes the reader to my own feedback on the overall project and how each project helped me to tackle and navigate between the three narratives that are central inside my thesis.

In addition to this micro-structural approach for each project, I also address three core research-creation clusters from which my research questions and narratives emerge. Echoing § 1, these clusters follow the hierarchy of the Open Systems Interconnection (OSI) model as follows:

1. Interface and connectivity: *Application, Presentation* layers

   This cluster connects to the OROBOROGRAM (2018) research project I detail in § 3.2. This cluster does not directly engage with modems. However, like the work of Meireles (§ 1.8), it is fundamental in positioning my research on the internet's materiality. Through this cluster, I expand on my critically investigation of the illusion of data transmission flow, from where my three narratives of data transmisson's neutrality, atemporality and immateriality emerge.This cluster is also concerned with practices of top level hacking, proposing a way to detour internet platforms' embodied narratives using their Application Programming Interfaces (API).

2. Temporality, neutrality: *Session, Transport, Network* layers

   This cluster connects to the MODEM_BROWSER (§ 3.3), MODEM_GUESSR (§ 3.4) and 2XTWEETSXMODEMSXTEXTXTWEET (§ 3.5). This cluster sits at the core of my research with modems and critically questions the metaphor of data transmission atemporality and neutrality. In this cluster, I shift from the top-level approach I described in the cluster

below (focusing on software) to the broader approach of the *platform*, taking the perspective of both hardware and software.

3. Materiality and its intersection with the earth: *Data link, Physical layers*

This cluster connects to the *EARTH_MODEM_GUESSR* proposal (§ 3.6). Drawing from the previous projects and emerging from the preceding platform-centered cluster, this design proposal extends on the third narrative of data transmission *immateriality*. In doing so, it connects to research located at the intersection between data transmission and its environmental site of execution. As with Howse's work (§ 1.25), this body of work is less operational than others. Nevertheless, it acts as a crucial extension of my research process by representing the current state of my work and interests working with modems and the internet's materiality.

3.2.0 - OROBOROGRAM: VISUAL DOCUMENTATION, PROCEDURAL AUTHORSHIP

GITHUB REPOSITORY: https://github.com/cyruslk/OROBOROGRAM

PROJECT'S LOGS: https://github.com/cyruslk/OROBOROGRAM/blob/master/logs.md

Even though this project does not interact with modems, it is foundational for my work with modems because it inquires how the internet narrative of data transmission flow is crafted and engineered on platforms. The final and actual iteration of this project I will expand on below proposes to subvert this illusion in the context of *Instagram.* By doing so, it detours the platform's use of likes, comments and image filters; features that I argue as core components for reinforcing this illusion of connectivity and flow when we navigate on the platform. As a *clin d'oeil* to the concept of information overload (or information obesity), this project starts from a simple logic that I use here as the starting point for the OROBOROGRAM. This logic is the following: the more the content is popular on the original Instagram platform - and the more it therefore contributes in reinforcing this illusion of connectivity by producing links within this network -, the more its image will be altered in the project. One final detail: these images will be altered by the help of filters, using each post's likes and comments values as these filters' required parameters. While filters are used inside Instagram as a way to make each post even more homogeneous, the OROBOROGRAM seeks then to detour these features: using these for critiquing the initial narrative of the *flow* they serve.

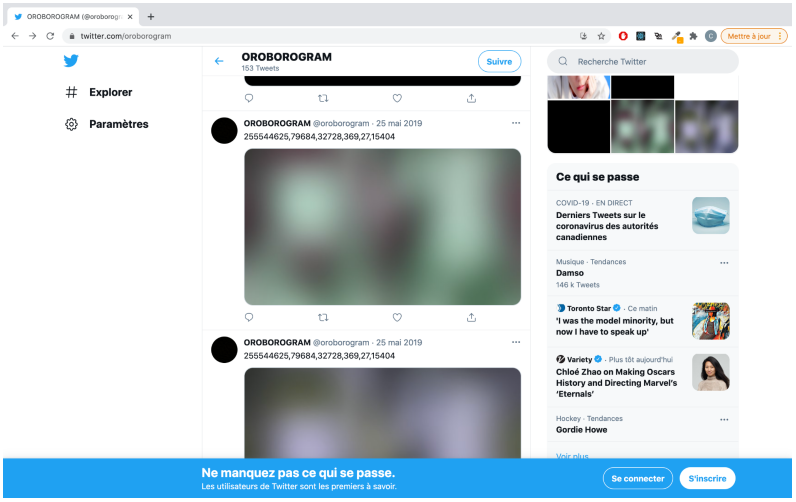


Figure 29: OROBOROGRAM, Twitter version.

Here, we can see the altered images produced in a chronological order and published on the project's Twitter

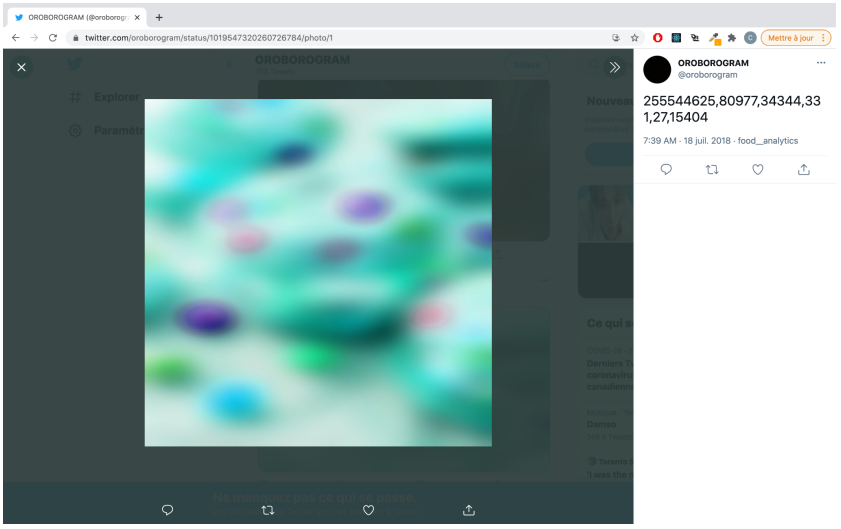


Figure 30: OROBOROGRAM, Twitter version: post.

Here, we can see a single post produced by this OROBOROGRAM's Twitter version.

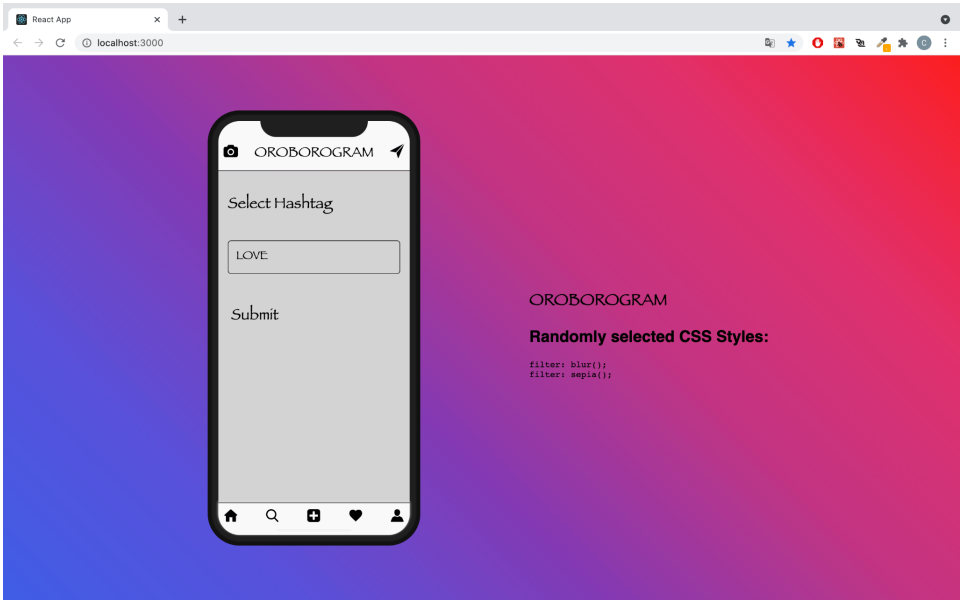


Figure 31: OROBOROGRAM, Instagram version: Homepage. Here, we can see the homepage of the second and last Instagram-based iteration of the project. On the left, the user is asked to enter a hashtag inside this mobile phone mockup (e.g: LOVE); on the right: two CSS filters are randomly selected (here: the filter blur() and sepia()).

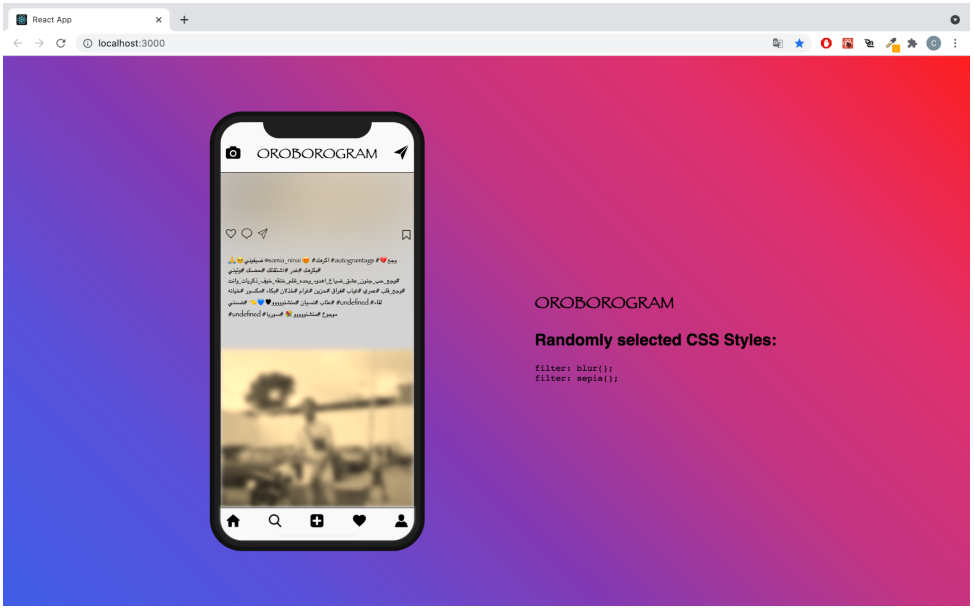


Figure 32: OROBOROGRAM, Instagram version: Feed. Here, we can see the returned feed being outputted in the phone mockup, with the possibility to scroll through the content. The scroll recreates the design of the Instagram platform, with each post displaying the (original) poster's name, thumbnail and description.

However, each image is altered based on the amount of likes and comments retrieved from the platform's materiality. The mockup's view displays here two images. The top one is substantially altered due to it's high number of likes and comments; the one at the button has less likes and comments and is therefore more visible.

The procedural authorship of this project goes as follow:

1. On the client interface, the user accessing the webpage is asked to enter a string. This will be used to start the process.
2. When this query is entered, this string is passed to the server side and sent to the Instagram scraper. The scraper returns in turn a *JSON* file containing an *array* of *objects* - Instagram posts - that match with this specific keyword. Each object of this array contains an image URL as well as the numbers of likes and replies attached to this image on the platform.
3. This array of posts objects is sent back to the client. At the same time, two CSS filters - commands that have the ability to modify the aesthetics of web images - are randomly chosen. Inspired by the original mobile app Instagram filters proposed (see OROBOROGRAM logs 2020.09.03), the OROBOROGRAM selects these two filters from the list of the browser's CSS filters available. These are ["blur", "brightness", "contrast", "grayscale", "hue-rotate", "invert", "opacity", "saturate", "sepia"].
4. For each image displayed in the scroll, this same combination of filters are applied. These filters require moreover specific percentage based arguments and this is where each CSS command differs from image to image (see OROBOROGRAM logs 2020.09.03): these arguments will be the image's number of Instagram likes and comments. This means therefore that:
    a. If a content is popular on the platform, the software will alter its image substantially. If, for example, an image (and therefore its post) has 300 likes and 50 comments and

the selected filters are contrast() and sepia(), the css filter command applied to the image will be *filter: contrast(300%) and sepia(50%).*

b. If, however, this image is less popular, the filter command applied to the image will be less substantial. If, therefore, the image has only been liked 2 times and commented three times, its aesthetic alteration will be *filtered: contrast(102%) and sepia(50%)***.**

5. Finally, the altered images are being displayed in the project's Instagram feed clone as well as in the iPhone mockup, allowing the visitor to scroll through the content.

3.2.1 - *OROBOROGRAM (2018):* RESEARCH CONTEXT AND RATIONALE

The name of this project consists of a contraction between two words: *Ouroboros* and *Instagram*. From this perspective, its starting point is - as its name suggests - this mythological Greek figure mentioned earlier in my thesis (§ 1.9). In dialogue with this metaphor depicting a snake (or dragon) eating its own tail, I sought in this project to engage with a specific approach: subverting an existing system - rather than produce something from scratch. In other words, I started this project with the intention to intervene with an existing internet infrastructure and critically detour its materiality; detour the way this materiality operates in order to inquire about the values and ideologies it embodies.

This starting point connected my rationale on the OROBOROGRAM with practices of infrastructural hacking. From this perspective, another major inspiration of this project (as well as a recurrent reference for my overall thesis) is the *insertion* project of Meireles (§ 1.8). Where the work of Meireles seeks for ways to subvert the embodied (american imperialistic) narratives of the Coca-Cola infrastructure by inscribing this "YANKEES GO HOME" antagonistic message, I have been in this context interested to follow the same disruptive strategy. More specifically, I have been

interested to critically interact with the Instagram social media platform by generating on this project'sInstagram clone inscriptions that contradict with these initial narratives of flow and connectivity. Where this social media platform seeks to give its users the illusion of connectivity, data transmission seamlessness, I sought via the OROBOROGRAM to create an interaction context where these Instagram posts (embodying this narrative) would be explicitly disrupted, disconnected and isolated.

With this desire to disrupt the way the Instagram platform is intended to operate in a seamless manner, this project is driven by the work of the artist and activist Gustav Metzger; and more specifically its concept of "Auto-Destructive Art"(Metzger, 1959). Developed inside a manifesto[27] and framed as a critical response to the use of science and seamless progress for military purposes and techniques of mass destruction (with the atomic bomb being a blatant example of this), Metzger developed artworks using materials that are destructive and have a destructive impact on their material site of execution, such as the case of acid on fabric in the figure below (fig. 32). As a critique, moreover, to this narrative of neutrality and apoliticality that modern science developed, Metzger framed this auto-destructive concept as explicitly political and antagonistical; using these materials to make visible the violence and destruction they embody.

This echoes with the solutionism posture of the platform: the belief I introduced in § 2.4 that technology can solve all mankind's problems. From this perspective, this project has been also a reflection and a critique on the concept of information overload, a way to experience information in data transmission processes that I argue as inherently connected to the narrative of data transmission flow. Also known as *infobesity* or *information anxiety,* I have been interested to use this concept to assert therefore that - drawing from this quest for connectivity - the Instagram platform's likes, comments and image filters features have harmful characteristics. By doing so, I have been eager to make visible the fact that the more these features are amplified inside the platform's feed and "jittery-schizoid intervals"(Greenfield, 2017), the more these disappear from our understanding. This

[27] The manifesto can be found here: http://radicalart.info/destruction/metzger.html

motivation grounded my will to create a system *(figure 31)* where, the more the retrieved posts will be connected (based on their amounts of likes and comments) to the platform, the more these will be altered; and the less these will be visible.

Figure 33: Gustav Metzger. Auto-destructive Artwork. 1959.

Source: http://radicalart.info/destruction/metzger.html

Here, we can see the artist (with the gas mask) is destroying the fabric canvas with acid.

3.2.2 - OROBOROGRAM: PROJECT'S EXPERIENCE, FEEDBACK AND TAKEAWAYS

Experiencing the actual iteration of the OROBOROGRAM creates a feeling of destruction that contradicts the way we normally engage with the platform. It creates moreover a sensation of loss; the feeling, in other words, of losing the content and post that we usually would see since these are popular on the platform. While we are moreover used to engaging with the platform in a frictionless and seamless way - reinforced by the likes and comments creating endless navigation possibilities -, engaging with the OROBOROGRAM triggers an experience of noise and absence of information. Experiencing the project echoes, as mentioned above, with the feeling of information

overload; where higher the amount of information is, the less we can focus on each specific content.

This feeling of loss is, from my perspective, due to the contextualisation of these altered images inside a scrolling feed where the amount of iteration differs from images and images; and this is where the Twitter and Instagram version of this project differ. On the Twitter version *(figure 28, figure 29),* my idea was to post these altered images (using the Twitter likes, replies and comments values) in a specific Twitter endpoint so that these can be accessed by the viewer. However, by doing so, these images became standalone posts, with no context given about their transformation or their initial displayed context. This initial strategy developed in the Twitter version of the project also contributed to aestheticize these posts, turning them into graphical entities and compositions viewers would focus on. This has been problematic in reinforcing the agonistical nature of the project and it is for these reasons that I developed the second and final version of the project in dialogue with the Instagram platform. While the first version of the project did not engage with the scrolling interaction which is a key component of social media platforms, I sought here to display these altered images inside a feed so that these can be connected together. This motivated also my will to engage further in my projects with repetition; a characteristic that is explicit in the modem works I will expand on in the following sections.

From this perspective, another key takeaway of this project has been to further engage with (and detour) the materiality of each project's target platform's visual and interaction characteristics. In this project, this resonated with my desire to build a clone of the Instagram platform, a realistic mockup that would trigger explicit references of the platform's materiality. Recreating a feeling of this materiality served here as a way to make parallels with the platform's original design and embodied narratives; and then create a dissonance between this materiality's narratives and my project's agonistic discourses (see MODEM_BROWSER logs 2018.11.08). Drawing from this project where the corrupted feed is displayed inside the project's Instagram clone and the shiny *iPhone* mockup, this exhibition and communication strategy has been recurrent in my following projects.

3.3.0 - MODEM_BROWSER: PROCEDURAL AUTHORSHIP, VISUAL DOCUMENTATION

GITHUB REPOSITORY: https://github.com/cyruslk/Modem_clicker

PROJECT'S LOGS: https://github.com/cyruslk/Modem_clicker/blob/master/logs.md

PROJECT'S VIDEO DEMO: https://vimeo.com/314274269

The MODEM_BROWSER detours and stretches a micro-event we use everyday inside our network-enabled culture. This event is the action of moving the computer cursor we see on screens and control via the help of mouses or trackpads. This project moreover starts from the will to use the primitive software modem technology inside our contemporary computing and internet ecosystems where temporality seems to be annihilated. Moreover, connecting this object and process with the software modem platform, the MODEM_BROWSER proposes an interaction design setting where each micro-temporality of the cursor movement is made tangible and temporal: turning each of these streams to modem signals that need to be sent and received to move the cursor.

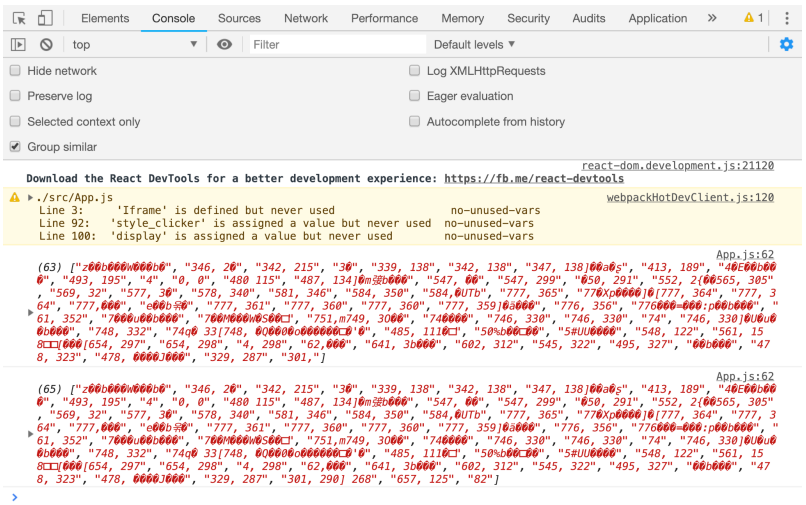


Figure 34: MODEM BROWSER, Corrupted coordinates.

Here, we can see the array of coordinates sent to the client: with the last set of coordinates used to move the fake cursor on the screen. As we can see, a substantial amount of these sent coordinates are corrupted, due to the unstable and error-prone nature of the modem transmission characteristics.

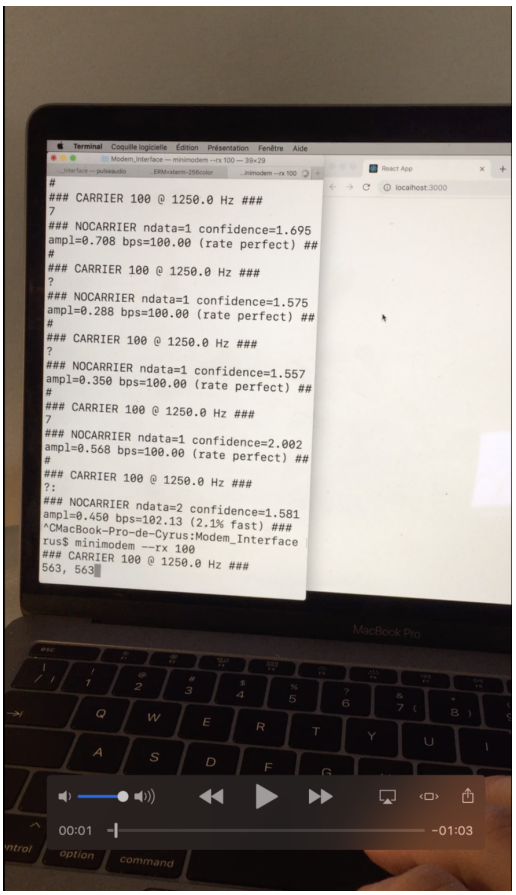


Figure 35:MODEM_BROWSER, Retrieved coordinates and fake cursor.

Here, we can see the fake cursor on the right, moving at the coordinates retrieved by the modem instance running in the server (on the left, with the output displayed on the terminal), and then sent to the project's client.

The project's procedural authorship follows the following steps:

1. The project is composed of an interface which is connected to a server running on a port of the local machine. On this server, a software modem software operates, listening for incoming data to convert it to modem signals.

2. The interface of this application is composed of a blank page where the actual mouse cursor is hidden and replaced by an identical fake cursor (figure 34).
3. Every time the user moves the real (hidden) cursor, its coordinates (on the screen) are sent to the transmitting modem instance.
4. Using the received coordinates as the transmission data, the coordinates are then translated into analog modem signals. Audio modem signals are then output from the laptop's speakers.
5. In the meantime, a dial-up software modem receiving instance runs in the background, ready to demodulate analog modem signals into coordinate data. Listening to modem signals through the laptop's microphone, the instance demodulates the cursor's location and sends it back to the browser extension (figure 33).
6. The fake cursor is then displayed at the received (and usually incorrect) coordinates (figure 34).

3.3.1 - *MODEM_BROWSER* (2018-2019): RESEARCH CONTEXT AND RATIONALE

Drawing from the *OROBOROGRAM* and a desire to further engage with the materiality of platforms, the first inspiration for this project is the concept of *platform studies* as developed by Montfort and Bogost (§ 1.10). Platform studies proposes to use the materiality (and restriction) of platforms as artistic and design constraints. Inside this project, platform studies motivated me to engage at the same time with two different platforms that both embody different design constraints: the computer cursor object and dial-up data transmission modems. I decided to work with the cursor object because of its ubiquitous and non-temporal characteristics. Even though this platform is not inherent to our web browser platforms, it appeared for me as an explicit representation of this state of micro-temporality (§ 1.19) developed by Ernst and Parikka. While these disconnected and imperceptible actions of moving a cursor on the screen create moreover the illusion of a non-temporal

and annihilated time over our computer processes, intertwining it with the modem platform became a way to reassert that these processes have temporal characteristics; and that the way we perceive time over the network is crafted by engineers (See MODEM_BROWSER logs 2018.11.07). From this perspective, Lialina's project has also been a key inspiration for the MODEM_BROWSER. While in the context of her project (§ 1.13), the micro-event action of loading and accessing a page is made explicit, my motivation has been here to stretch each micro-temporal event occuring while we move the cursor by the use of the modem platform; forcing here these imperceptible event to go through the temporal and error-prone modem platform. This echoed with the media archeological quest for making visible forgotten discourses and narratives about data transmission processes. While we have the illusion that these processes are purely digital and only happen on the OSI's (§ 1.7) digital layers, I became interested to use here the modem as a metaphor and strategy to intertwine these processes into circuits that are analog and physical, with these cursor's position data converted to analog signals via the hardware's microphones and speakers. Going back to the AOL (§ 1.14) connection screen where we experienced this protocol handshake in an explicitly tangible manner due to its sonic characteristics, my desire has been to here each of these processes into analog modem signals whose sense of temporality is explicit (See MODEM_BROWSER logs 2018.11.24).

Another intention of the MODEM_BROWSER was to further engage with the user. From this perspective, a core inspiration for this project emerged from the exploration of modes of critical technical practices engaging with game design, such as Flanagan's concept of critical play (§ 2.5) where *play* is used as a catalyst for critical thinking. Inspired by Flanagan's *[giantJoystick]* project, I was here interested to follow the same game design logic and strategy. By doing so, I was interested in displacing a technological object (in her context, a joystick) from its purely operational characteristic; and using it as a starting point for building a playful interaction. Moreover, I was interested here in exploring a technological process outside of the quest for efficiency: playing therefore with errors (figure 33) and delays emerging from the primitive modem platform (See MODEM_BROWSER logs

2018.11.15).

3.3.2 - MODEM_BROWSER: PROJECT'S EXPERIENCE, FEEDBACK AND TAKEAWAYS

Attaching these micro-events of mouse movement to modem signals makes those processes explicitly temporal, tangible and error-prone. Instead of taking these micro-events for granted within a "seamless" platform, the process occuring every time the user moves the mouse on the screen creates in this context a set of discontinuous events, making explicit the normative nature of platforms' interfaces; forcing the user to abide to what the platform affords and restricts in order to navigate through the page. Based on the analog nature of the process that relies on the quality of the microphone and speakers that are attached to the local machine, the cursor coordinate data being transmitted is often corrupted and unstable. This gives the user experiencing the project a feeling of chaos, with the cursor often displayed in areas of the screen where it was not intended.

From this perspective, making this project reinforced my will to work with modem signals, using these explicitly error-prone and temporal apparatuses as a frame to deconstruct the belief of data transmission atemporality and immateriality. However, I have realised while making this project that there was a core aspect of the platform I did not engage with: the protocol. While I have, in other words, used the modem as an API through which data could be input and output, I did not critically and creatively engaged with the modulation parameters that are required to transmit digital data to signals. Reframing at the same time my theoretical framework with the work of Galloway on protocols (§ 1.11), this enabled me to connect my design works with my theoretical insights in order to build on top of this project for the purpose of the second narrative I have seek to debunk: the illusion that the internet (and protocols) are neutral.

3.4.0 - *MODEM_GUESSR*: PROCEDURAL AUTHORSHIP, VISUAL DOCUMENTATION

GITHUB REPOSITORY: https://github.com/cyruslk/MODEM_GUESSR

PROJECT'S LOGS: https://github.com/cyruslk/MODEM_GUESSR/blob/master/logs.md

PROJECT'S VIDEO DEMO: https://vimeo.com/543472615

This project uses software modem technology as a means to critically reflect on the second narrative of my thesis: the illusion that our internet networks are neutral and do not embody power nor regulate our data. Moreover, it follows the same design setup as the *MODEM_BROWSER*, inserting analog signals into our digital platforms. In this context, the starting point of the MODEM_GUESSR is a set of objects we widely use to communicate: online chats. While the experience of using these chats gives us the illusion that our data flow seamlessly from the emitter to the receiver without control, our imputed and received text are in fact connected to a network of protocols that control and handle our data based on their *logic of modulation* (§ 1.5, 3.5, 3.11). Drawing from this, the MODEM_GUESSR uses the required modulation parameter of the software modem as a frame to make explicit these political and normative characteristics of the internet protocols.

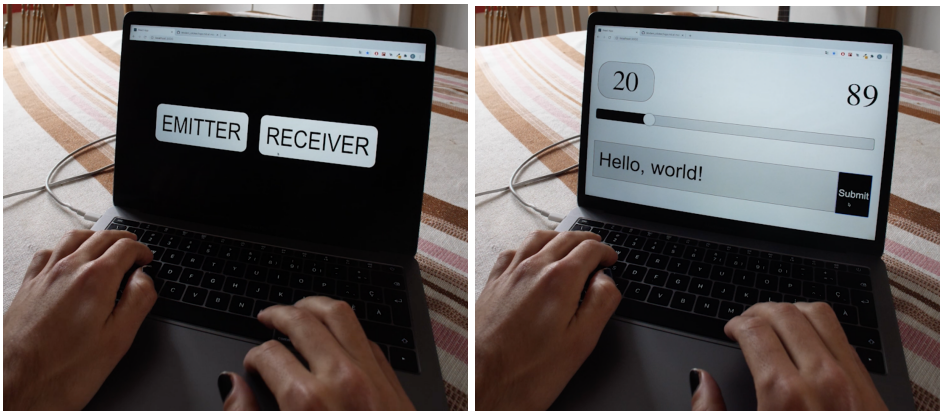


Figure 36:MODEM GUESSR, landing page.

Here, we can see the project's first page, where the user can select between the emitter or the receiver role.

Figure 37:MODEM GUESSR, emitter player: sending the message.

Here, we can see the emitter player entering a string (e.g: "Hello, world!") to the input field and selecting the modulation frequency (e.g: 20) that will be used as the required modulation parameter for the modem transmission process. On the right, we can see the countdown timer, decrementing each second from 100.

Figure 38:MODEM GUESSR, transmitter page: corrupted message.

Here, we can see the transmitter's page player with corrupted data displayed. This data is corrupted due to the fact that the modulation parameter selected to decrypt the modem signal does not correspond to the one used on the emitter side.

Figure 39:MODEM GUESSR, transmitter page: decrypted message. Here, we can see that the modulation parameter is set to 20, and therefore match with the one selected by the emitter player. The message is therefore accurately decrypted.

Players of this game can choose between two roles: the *transmitter* or the *receiver*. I have designed the procedural authorship of this project as the following:

Initialisation and game interface

1. On the emitter's player screen (figure 37), there is a text input, a button and a slider with a randomly defined value. When this user inputs a message into the text field and clicks on the *send* button, the text - as well as the randomly defined value on the slider - are sent to a *software modems* instance running in the background. Once this input is received, a *software modem* modulates the text into an audio signal using the value slider's value as the baud rate parameter.
2. On the receiver's screen (figure 38), an empty rectangle is displayed with a slider; again initialized with a randomly defined value. In the background, a *software modem* instance runs and listens for incoming modem signals to decrypt, using the value of the slider as its baud rate parameter.

Playing:

3. Both on the side of the emitter and the receiver, the action of changing the slider's value restarts a software modems process and changes its baud rate parameter. The goal of the game is to guess the modulation parameter used to transmit the message (figure 36, figure 38).
4. The game ends when the receiver player guesses the modulation parameter correctly and is therefore able to decipher the entire message sent by the transmitter player (figure 38).
5. Since modulation frequencies and baud rates are cryptic to most of us, the receiver player has no choice but to carefully slide the cursor with no clues regarding the baud rate to select. As long as the baud rate is not guessed by the receiver, messages sent over the network are received and displayed in corrupted form (figure 37).

3.4.1 - *MODEM_GUESSR (2018-2019):* RESEARCH CONTEXT AND RATIONALE

While the MODEM_BROWSER started as a dialogue with Ernst and Parikka's concept of microtemporalities, this project emerged from the theory work of Galloway (§ 1.11) about the internet protocols. Inquiring moreover how control is orchestrated on data when networks such as the internet are decentralized and distributed, Galloway asserts that protocols play a major role: being responsible for the connection handshake to perform successfully or not. Arguing moreover that each bit of this internet internet infrastructure "regulates flow, directs netspace, codes relationships, and connects life-forms"(Galloway & Thacker, 2007, p.74) during our data transmission processes, Galloway makes explicit the normative and political nature of protocols as embodying control and power. This assertion acted as the starting point for the MODEM_GUESSR (see MODEM_GUESSR logs 2018.08.01). Inspired by Galloway, I therefore started the MODEM_GUESSR with the desire to use the primitive nature of the modem platfrom's protocol as a frame to make this fact tangible (§ 1.16). With, moreover, this protocol requiring the same modulation frequency parameter on the *emitter* and *receiver* instance to accurately establish a connection, I was interested in the MODEM_GUESSR to use it as a metaphor for the "logics of modulation" (Galloway & Thacker, 2007) governing our internet built-space (§ 1.5, 1.6).

Drawing from this desire to make tangible this logic of modulation our data transmission processes are submitted to, I was also interested to explore how the modem's protocol logic could be used as a constraint for a game design project. From this perspective, I started the MODEM_GUESSR as a dialogue with Sollfrank's net.art Generator (NAG). Sollfrank's project was an inspiration for this project at the level of the connection it proposes between interface and protocol: allowing the visitor to interact with the protocol itself (e.g: the Google image API used for generating digital collages) by

directly inputting a set of parameters inside the interface. While in the context of other net.art projects users observe the alteration of a protocol in a non (or less) interactive way, I was inspired here by Sollfrank's will to turn the embodied logic of the underlying protocol into something users can manipulate directly. By extension, the design of this project was also inspired by Flanagan's *critical play* framework (§ 2.5), turning games into a medium for critical reflection (see MODEM_GUESSR logs 2018.05.24). Dawging moreover from the MODEM_BROWSER where the analog and temporal characteristics of the modem platform are detoured inside a playful context, my will was to focus here on the modulation aspect of the platform; turning these modulation parameters into the starting point (and initial constraint) for a game interaction.

At the level of this project, I have been inspired by two internet site-specific games and design interactions: *morsecode.me* (2013) made by Burak Kanber and It is as if you were making love (2018) by Pippin Barr . In these projects, the active role of the protocol to regulate the flow and code the internet's processes is made explicit. Kanber's project, on one side, consists of a simple chat app from which any visitor of the website can interact, input and receive data. However, between each user of the app, a specific protocol is encoding and regulating all communications: the morse system. This means that in order to communicate with other users and input textual data on the project's chat, the only possibility is then to press an HTML button so that signals can be generated. Based on the length of these signals that are at the same time interpreted and converted to morse code, the translation will then operate. Barr's project, on the other side, consists of an HTML slider that is positioned at the center of the page. With this game humorously mimicking the act of pleasuring a partner (Barr, 2018), the game takes the form of commands given by the game to users so that they can accomplish specific tasks in a specific time using nothing more than this slider element.

The *MODEM_GUESSR* draws first from Kanber's game at the level of the way it uses the primitive morse code protocol inside a game design setting. In the context of this project, it is moreover explicit that the process (and the execution) of data transmission explicitly depends on what

the morse protocol affords and restricts. While we do not usually have to interact with these underlying protocols in order to establish a connection and transmit data, Kanber's project places here the morse protocol as the central and visible stakeholder of the App's connection between users. With this strict protocol that follows a binary approach (e.g: with the handshake being either successful or rejected), users need then to abide by its embodied logic and rules so that they can communicate. In addition, this project also echoes with the tension emerging from the Kanber's minimal interface design paired with the primitive noises that are inherent from the morse. From this perspective, Kanber's project connects with media archeology - § 2.7 to 2.10 -, in the sense that it seeks to intertwine two different narratives and technologies together: the old, analog and error-prone one of the morse mixed with the new one of the digital app where the project is hosted.

The *MODEM_GUESSR* also draws from Barr's game at the level of its interface design; and more specifically of the way it uses the HTML range slider. With this primitive range slider, Barr's game is a blatant example where a creative constraint emerges from what a platform affords (§ 1.10); where the possibility and restrictions of a platform's element - the HTML slider - takes a central role inside this intimate digital experience. In opposition with our hyper-sexualised societies dictated by "jittery-schizoid intervals" (Greenfield, 2017), relying on this primitive object for making love online (Barr, 2018) creates here an interesting game experience; a game design tension between the subject of the game and the way it is designed.

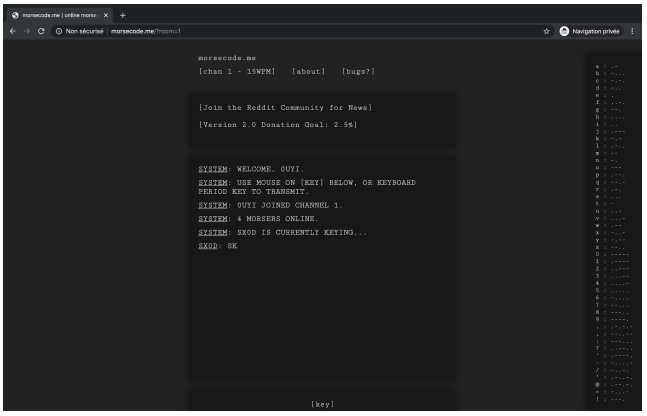


Figure 40: Burak Kanber, Modem chat. 2013.

Source: http://morsecode.me/?room=1

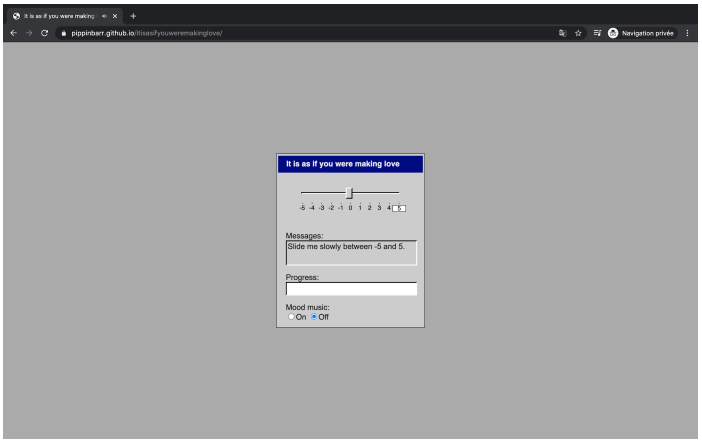


Figure 41: Pippin Barr. *It is as if you were making love, 2018.*

Source: https://pippinbarr.github.io/itisasifyouweremakinglove/

Merging Sollfrank, Galloway, Kanber and Barr together, I have therefore started this project with the intention to create a design context where this network's modulation occurring from user to user would be explicitly shown thanks to the primitiveness of the modem. In the same manner as Kanber's project, I have sought to create an interaction setting where the modem protocol would be the major *tangible* component in the process of establishing the connection between the two users. As an echo with this morse code project, I have moreover been interested to use the modem protocol in a non efficient and seamless manner, challenging the way data transmission protocols are implemented and marketed within the broader ideology of the cloud. This means therefore that while protocols are usually crafted to reinforce the illusion of connectivity - made explicit with Parikka's analysis of the packet-switching white papers (§ 2.8) - the MODEM_GUESSR game follows an opposite logic. It starts with a *disconnect*, forcing users to abide to the technical (and normative) implementations embodied inside the protocol so that they can establish a connection and communicate. Going back to Barr's project, this disconnection strategy within the MODEM_GUESSR is also caused by the limitation of the slider. While browsing the internet and interacting with its underlying technologies - based on logics of modulation (§ 1.5) - gives us the illusion of an effortless and distant process, the slider combined with the primitiveness of the modem platform creates the setting for an opposite

interaction context. More specifically, It forces the user to perform the physical gesture of connecting one network's node to the other: with the slider as the main interface.

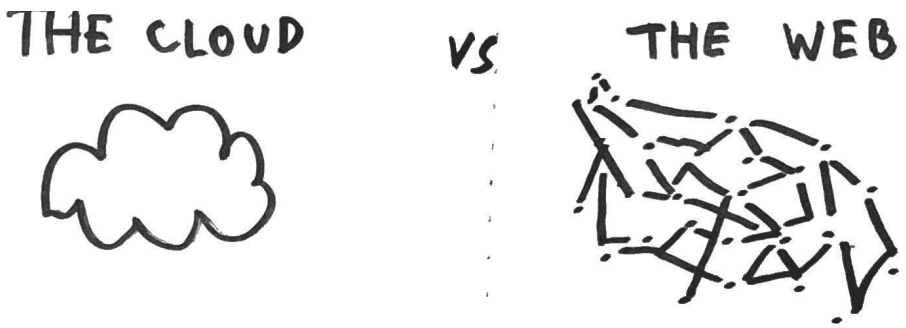


Figure 42: Rationale Drawing #10: The Cloud vs The Web.

In opposition to the obfuscating cloud, Berner Lee's metaphor of the web takes all its importance: with this entangled infrastructure being closer to the *internet materiality and design with these connections between the network nodes constantly modulated.*

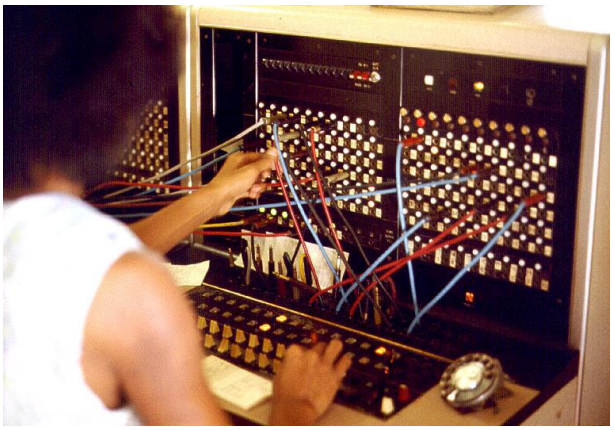


Figure 43: Telephone switchboards.

Under the media archeological framework, I have been interested in exploring older data transmission technologies and came across telephone switchboard devices. Used for establishing telephone calls between users, I have been inspired here by the way the process of establishing a connection required a tangible physical gesture: the one of manually connecting these electrical cords to the board.

Source: https://en.wikipedia.org/wiki/Telephone_switchboard

3.4.2 - MODEM_GUESSR: PROJECT'S EXPERIENCE, FEEDBACK AND TAKEAWAYS

The first observation when we play the game is this feeling to be submitted to the primitive logic and procedurality of the baud rate. While protocols are usually optimized over the network so that our data transmission processes happen in a frictionless manner - giving us therefore the illusion that these protocols are neutral and do not direct our data in a specific way, playing the MODEM_GUESSR game feels like the opposite. More specifically, it feels like we, as users, need to adapt to the way the modem protocol operates. Even though this is the case when we interact with technology in a non subversive way, the MODEM_GUESSR creates a game interaction context where this politicality of protocols - and of platforms we use on a daily basis - is explicit and tangible. When playing the game, this means that until the *receiver* player has not been able to guess the exact baud rate sent by the *emitter* player, the data received is entirely corrupted. Racing moreover against this disconnected protocol paired with the countdown timer, the experience of the game feels similar to when we try to establish a connection to a website and the website loads without interruption.

The main takeaway of this project that guided me in reframing my research creation process - as well as bridging gaps between different areas of my interests - emerged from its physical and material setting. Engaging both with the modem's temporality (MODEM_BROWSER) and normative characteristics as means of challenging these network narratives of atemporality and neutrality, I have been moreover eager to create settings that are more material, as a desire to show even further the materiality of the internet as it is: local machines, wires, routers, etc. Drawing in this context from the physical installation required to operate the MODEM_GUESSR project - two local machines that

need to be running at the same time and close to each other -, I have been then interested in pushing further this setting; as a mean of showing in an explicit way that data transmission always operate between two (or more) computers that are tangible and material (see MODEM_GUESSR logs 2018.08.01).

3.5.0 - 2X: PROCEDURAL AUTHORSHIP, VISUAL DOCUMENTATION

GITHUB REPOSITORY (EMITTERS): https://github.com/cyruslk/twitter_minimodem

GITHUB REPOSITORY (RECEIVER): https://github.com/cyruslk/twitter_receiver

PROJECT TWITTER ACCOUNT: https://twitter.com/2XTXMXTXT

PROJECT'S VIDEO DEMO (VERSION 1): https://vimeo.com/545298871

PROJECT'S VIDEO DEMO (VERSION 2): https://vimeo.com/558714898

2XTWEETSXMODEMSXTEXTXTWEET takes its roots from the MODEM_GUESSR project as well as its will to detour the modem's required modulation baud rate from the purely technical and use it in a game design context. Moreover, it combines this with the poetry movement known as OuLiPo (§ 1.15) and uses these modulation baud rates as a starting point for manipulating data streams of natural language: Tweets. By doing so, when the project's installation - composed of three Twitter bots - runs, it is simultaneously requesting, modulating, demodulating, uploading and manipulating two Twitter news feeds at the same frequency; resulting therefore in a quasi-gibberish/quasi-legible loop of data transmission and destruction.

Figure 44: 2X: Twit output (first iteration).

Figure 45: 2X: Twit output (second iteration).

Here, we can see the two original sources and hashtags (BBC + CNN) added at the end of the text.

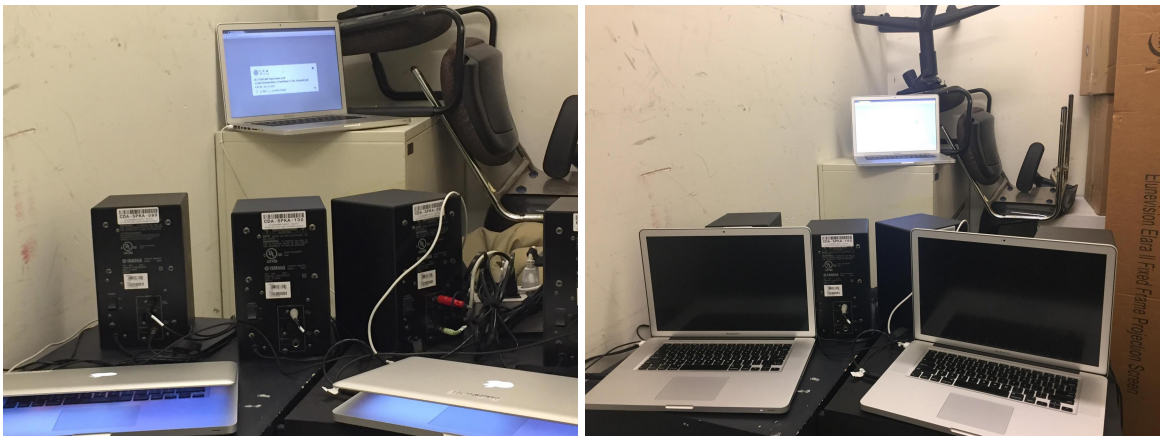


Figure 46: 2X: Installation Version 1.

Here, we can see that the installation uses an old macBook and displays them in this messy environment with boxes, stacked chairs and yellow light.

Figure 47: 2X: Installation Version 2.

Here, we can see that the installation makes explicit the starting point of the process (e.g: the #BBC and #CNN hashtags). Moreover, it makes explicit and puts more emphasis on the material setup of this data transmission process, showing the analog and digital circuit composed of: the speakers, the microphones, the soundcard, the analog signals being reprocessed, etc.

The procedural authorship of the project goes as follow:

1. Two *software modem* transmitters are connected to Twitter, streaming tweets to different Twitter accounts simultaneously. Each modem bot targets a randomly selected news provider based on their hashtags (e.g: #BBC, #CNN...). These two bots thus transmit news tweets to modem signals using speakers.
2. A third instance of a software modem listens to the incoming modem signals through a microphone. These signals are demodulated to textual data and posted as a tweet on the project's Twitter account using the same hashtag (on the 2X’s second iteration).

3. These three modem instances operate at the same baud rate, which leads to an intertwining of the data coming from Twitter.
4. The outputted data is thus generally received in a corrupted, only semi-legible format, with chunks of news coming from both sources intertwined and combined inside the same tweet alongside meaningless artifacts of transmission.
5. On the 2X's second iteration: Hashtags targeted during the initial modem transmission process are added back to the final tweet, which in turns connects these outputed tweets back to their original streaming source.

3.5.1 - *2XTWEETSXMODEMSXTEXTXTWEET* (2019): RESEARCH CONTEXT AND RATIONALE

I have developed the underlying rationale of the 2X based on five different aspects that I have sought to merge together. These aspects are in direct relation to the key inspirations of the project I detailed above.

Drawing first from the *Net Art Diagram*, the initial rationale I had for the project was to create a metaphorical setting where the Twitter cloud infrastructure would be exposed and made audible; where the computation and transmission of Tweets would be turned into a temporal and material process. In dialogue with Starosielski's assertion that 99% of all transoceanic internet traffic is carried through rusted cables (§ 1.23) and that data transmission does not therefore only operate through software but though a staked assemblage of hardwares, I was interested with the 2X to engage simultaneously with tweets and dial-up modem sounds. By doing so, I was eager to use this tension (between tweets and modem noises) as a frame to confront the Twitter platform with the materiality which it is built upon.

Drawing also from Bunting's project, the second rationale I developed for the 2X was to use these streams of data in combination with the modem platform for creating an OuLiPo-like poetry system. More specifically, I have been keen to create a system where these streams pulled from the platform would be transmitted together at the same data transmission baud rate, creating in turn a context where bits of language pulled from the platform would be intertwined together. Like Bunting's manipulation of language and creation of poetic associations based on the way the network's protocols operate, I have been in other words interested in placing the modem at the center of the project; turning the protocol into the major component responsible for the way these bits of language would be outputted. Finally, the 2X echoes also with Bunting at the level of its use of the hyperlink. Where the hyperlink creates in *_readme* a sense of invasion with each word being projected within the space of the network, I have been interested in using this feature - from which the Twitter *hashtag* emerges - to connect the 2X's outputs back to their original source. By doing so, I have intended hyperlinks to create a loop of language manipulation, pulling back from the streams what have been produced by the project.

Third, influenced by Metzger, I have been interested in adding a political tone to this project, connecting the 2X with DiSalvo's *Adversarial Design* framework (§ 2.5). Where Metzger proposes moreover to challenge the embodied narratives of modern science and progress instruments and techniques, I have been eager to contextualise the 2X as a critique of solutionism (§ 2.4); according to which Twitter's impact is only beneficial to modern society. In dialogue with this critique, I have therefore decided to engage with news providers in order to make a clin d'oeil to the *fake news* cultural phenomenon. Interconnected with Twitter in the way the platform amplifies false information, I have reframed then the 2X not only as an poetry platform but as an infrastructure for manipulating news in real time; as a metaphorical network in which protocols would modulate bits of information simultaneously to generate "fake" news.

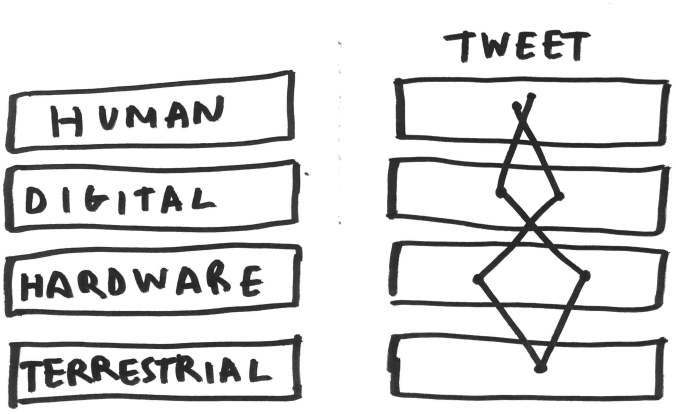


Figure 48: Rationale Drawing #10: the 2X's simplified OSI version.

Drawing from these research contexts and a desire to show the material sites of data transmission processes, I have therefore envisioned the 2X as a physical installation. I have developed two iterations of this installation. These two iterations differ at the level of the space where they are displayed as well as the material settings they engage with. While the first one only uses three MacBook local machines, the last one additionally adds microphones, speakers, a sound card and wires.

For the first iteration, I was inspired by images produced by news channels investigating the Russian Troll and fake news factory[28] that is proven to have interfered with the American 2016's elections. As one of the angles I have used to develop the underlying rationale of the 2X (as a fake news generator), I have therefore been interested in using these as a starting point for contextualizing my design decisions as well as the project's physical setup. In these images, we can observe the physical space where these fake news are produced. In accordance with assumptions, we can moreover see that these are produced in tiny spaces with low ceilings and artificial lights. This grounded the rationale behind my first 2X installation. By doing so, I have been eager for this

[28] More information about this factory, officially called the *Internet Research Agency,* can be found in this New York Times Article.

iteration to display these three local machines in a tiny closet-like environment; a small space with aggressive lights and dilapidated walls (figure 46).

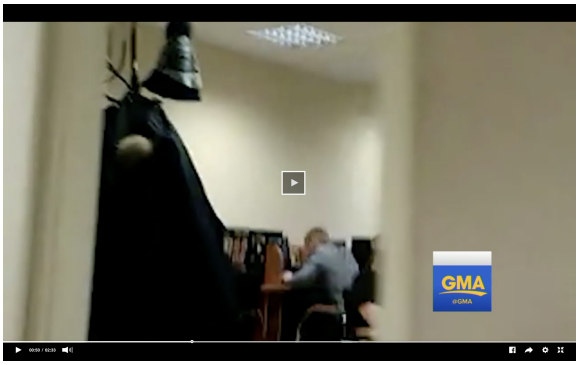


Figure 49: Stills from the ABC news documentary: A look inside a Russian 'troll factory'.

Source: https://www.youtube.com/watch?v=Vhg-0Hiz3J8&ab_channel=ABCNews

The second iteration (figure 55) of this project has been inspired by Wim Delvoye's original version of his *Cloaca* (Delvoye, 2000) project, an artificial system that produces excrement-like matter by slowly digesting food. Cloaca takes the form of an ensemble of glass jars that are connected by plastic hoses. The artist's design approach here is therefore to recreate the detailed process of digesting food by isolating each one of its phases and making these visible via the use of the jars. Eager to make tangible the materiality of data transmission processes, I have been therefore eager to revisit Delvoye's project for the second iteration of the 2X. More specifically, in the same manner as *Cloaca*'s detailed (and scientifically oriented) process, I have been keen to play with the 2X's materials; making visible the network of components that are in use when the project operates.

Figure 50: Wim Delvoye. Cloaca Original. 2000.

Source: https://wimdelvoye.be/work/cloaca/cloaca-original-1/

3.5.2 - 2X: PROJECT'S EXPERIENCE, FEEDBACK AND TAKEAWAYS

Experiencing this project felt overwhelming for the public, creating in turn a sense of loss at the level of understanding its rationale and meaning. In the context of the first iteration of the project, this overload is due to the "noise" resulting from the action of manipulating the streams of data without explicitly showing the source from where these streams originate. This is also due to the minimalistic nature of the installation, with these computers simply displayed with no further context.

These observations motivated my decisions to create the second iteration of the 2X *(figure 45)*. It is from this standpoint that I have decided to reference in a more explicit way the post's original sources (by showing the two hashtags being processed) as well the connexion between the Twitter's streams and the outputed final tweets (by adding these two hashtags at the end of each generated Tweet). I also decided in this iteration to show in a more explicit manner the hardwares engaged in the data transmission process, as mentioned in § 3.5 However, this iteration was not successful in pushing my initial rationale's direction to engage with the internet's materiality. While I sought to create a design tension between the displayed embedded tweets paired with a more

extensive body of hardwares, this was not enough to support the rationale. This is due to the fact that these polished and manufactured objects I used still support the ideology of the cloud by their seamless design. From this perspective, the first iteration of the project inspired by the Russian "troll factory" aesthetics felt more promising. This takeaway also inspired me to further engage with objects and materials that are not engineered such as soil, water, rocks and so on. Inspired by Howse (§ 1.25) and developed further in the following modem project (§ 3.6) I will introduce, I have been eager to engage with these as metaphors of the internet's base materialy and earth layer (§ 1.24) emerging from the third narrative of my thesis.

Another important takeaway retrieved from the project is that it did not tackle all of its conceptual aspects I have initially intended and detailed above. First, due to the high volume of data being streamed, the project did not end up reprocessing its own tweets; as stated earlier in this project's objective in dialogue with Bunting's *_readme*. A solution to this would therefore be to target Tweets connected to streaming sources whose amount of content is less high. Based on these points, the overall feedback I have retrieved from the 2X is that the project has been too complex and dense conceptually to express ideas in a clear way. Although I have been keen inside my practice-based work to create projects that are not fully didactic and embed to a certain degree a sense of opacity and mystery, I have felt in other words that this project did not *speak enough by itself.* For this perspective, I have been eager to go back to the design of projects with smaller and more tangible interactions with more emphasis on human interaction and agency.

3.6.0 - FUTURE WORKS: PROPOSAL FOR THE *EARTH_MODEM_GUESSR*: INTENDED PROCEDURAL AUTHORSHIP

The *EARTH_MODEM_GUESSR* proposal, inspired by the *MODEM_GUESSR*, starts therefore from the same game design setting: users are asked to guess the correct baud rate so that the transmission process happens accurately and the message can be decoded. However, it expands from this previous project with two new components added into the transmission stack: a soil moisture sensor and soil chunks. More specifically, each player's local machine is wired to a soil moisture sensor, a hardware sensor that measures the soil's conductivity level. In addition, each sensor is inserted into a soil chunk and returns a fluctuated value to each player's local machine. When users move the sensor inside its soil chunks, the sensor's value changes. The goal of the game is to find spots both in the soil chunks where the electricity fluctuations are the same; which will in turn instantiate both versions of software modems to transmit and receive at the same baud rate. Using these chunks of soils as a frame to reflect on the active role of the earth acting as a protocol (§ 1.25) in the context of the internet, it is only with this configuration that the data transmission handshake will be enabled.

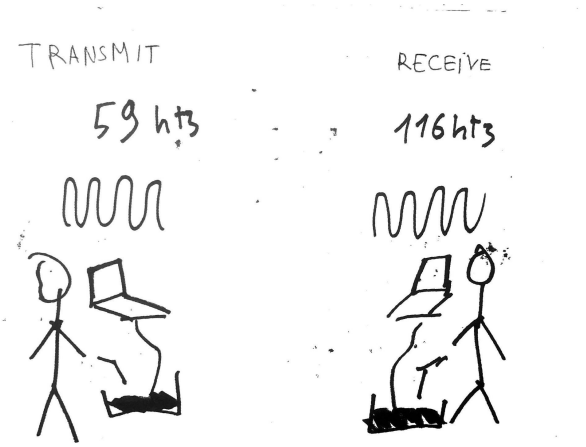


Figure 51: proposal for the EARTH_MODEM_GUESSR.

Here, we can see both players with the same design setup: a local machine connected to a sensor "plugged" into soil chunks.

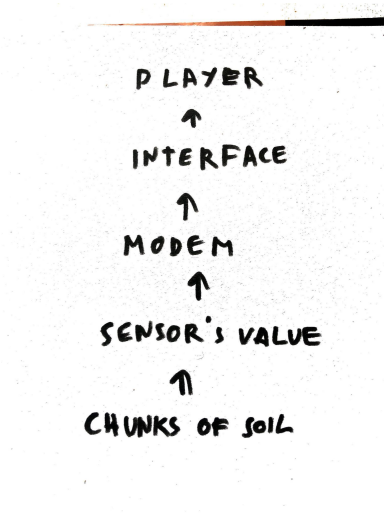


Figure 52: the EARTH_MODEM_GUESSR: data transmisson's stack.
Here, we can see the connection between chunks of soil and the player. Each chunk of soil returns a conductivity value through the sensor; this value is then used as the required input for the modem; the modem's value is displayed in the interface.

This game design proposal is as follows:

Initialisation

1. As in the *MODEM_GUESSR*, both players have computers with software modems running in the background. One player is transmitting (modulating) data; one is receiving (demodulating) data.
2. Each of these computers are connected to a conductivity and humidity sensor that can be plugged into the soil. These transmit electricity fluctuation data in real time to each computer's software modems instances and change their modulation parameters as the required baudrate.
3. On the transmitter's screen, there is a text input with a button. On the receiver's screen, an empty rectangle is displayed. As in the MODEM_GUESSR project, this project design

interaction consists of a chat: with the emitter player prompt to input a message.

Playing

4. When the *emitter* player transmits its message to the receiver, the message is transmitted through modem signals at the parameter emerging from fluctuation values of the soil chunk where the sensor is "plugged".
5. The *receiver's* modem listens for incoming signals using the same setup; and therefore listens to signals at the specific baud rates emerging from where its sensor is plugged.
6. The goal of the game is to find spots in both of the soil chunks where the electricity fluctuations are the same; which will in turn instantiate both versions of software modems to transmit and receive at the same baud rate.
7. Due to sensors reacting to small fluctuations of the soil being inherently unstable, the action of transmitting data is turned into a trial and error session, with players interacting with these fluctuations to successfully transmit their content via modem.

3.6.1 - SKETCHES FOR THE *EARTH_MODEM_GUESSR (2020-2021)*: RESEARCH CONTEXT AND RATIONALE

In dialogue with Howse's work I introduced above, this proposal introduces my current interests in engaging with technology in a more speculative manner. As with Howse, I am here less interested in making data transmission processes that are fully operational but in using computing to create design fictions, a term borrowed from the design theorist Julian Blaecker (2009). Likewise, using this approach to ask questions about the limits of software, such proposals serve as a way to speculate through design on the role of the earth's materiality in the context of the internet processes.

Drawing from the *2X* and a desire to use design as a frame to reflect on the internet's materiality, I have been therefore interested to engage further with materials and objects that act as metaphors for the internet's physical layer. Like Starosielski connecting the rusted undersea cables (§ 1.23) to the shiny and seamless platforms of the internet, I have been keen, in other words, to intertwine objects that both relate to how we understand the internet (e.g: top-level web interfaces) with the foundational earth matter from which the network is built (Bratton, 2016).

From this perspective, the fundamental inspiration for the *EARTH_MODEM_GUESSR* was the work of Martin Howse (§ 1.25) connecting computation to the earth's processes and foregrounding the intersection between software and the material world. In Howse's work, local machines and other internet components are placed in direct relation with fragments of soil, rocks, water and other non-manufactured materials. In doing so, Howse seeks to create data transmission infrastructures where these different human, software and terrestrial materials and forces are codependent and intertwined. In dialogue with the work of internet theorists such as Starosielski, Bratton or Hu (§ 1.20, § 1.24), this contributes to breaking the narrative of immateriality. Echoing Starosielski's assertion that local material disruptions (e.g: tsunamis, earthquakes...) have an impact on the overall internet infrastructure, Howse expands this idea further, explicitly turning the earth (and its micro-modulations) into a computational platform necessarily impacted by fundamental material concerns.

In this project, I have been also influenced by Sarah Grant's workshop *Plant-to-Plant Protocols* (Grant, 2019). Grant's project proposes to turn gardens into a hybrid technological infrastructure where computing and nature are intertwined together, attaching radio nodes to plants in order to transmit data "as modulated pulses of light between plant nodes" (Grant, 2019). In doing so, Grant's project creates a context in which data transmission processes are dependent on terrestrial activity, where glitches are "introduced to the data whenever the sun would come out from behind the clouds, or the stems would sway in the wind" (Grant, 2019).

Figure 53, 54: Sarah Grant. Plant-to-Plant Protocols. 2019.

Source: https://wimdelvoye.be/work/cloaca/cloaca-original-1/

Inspired by these references, I have therefore been interested in this design proposal to create work where unpolished raw matter, analog data transmission and web interfaces are intertwined together, and where this assemblage would be used as a metaphor to encourage critical reflection on the internet's materiality. In dialogue moreover with the internet's OSI layer (§ 1.7) as well as the *2X*'s takeaways, I have been interested to engage further with this simplified version of the internet's materiality. Following critical engineering's (§ 2.5) approach of creating small scale models of data transmission processes in order to demystify the way they operate and to make them more tangible, I have been interested to use this simplified human/digital/analog/material stack to conduct my inquiries. However, building on Howse, I have approached these projects inside a speculative design

framework, allowing from my perspective a less didactic approach to foster critical reflection.

In dialogue with the takeaways of the *2X* where the complexity of the project may have alienated in turn humans from the transmission process, I have been also eager for this game proposal (and this new body of work) to create interactions where both the temporal, political and material characteristics of this alternative infrastructure would be tangible and accessible. Likewise Howse's *earthcode* project (§ 2.16), in which users physically plug a computer into the ground to boot his speculative OS, I have been interested in designing smaller processes and interactions that engage with users in a more explicit way.

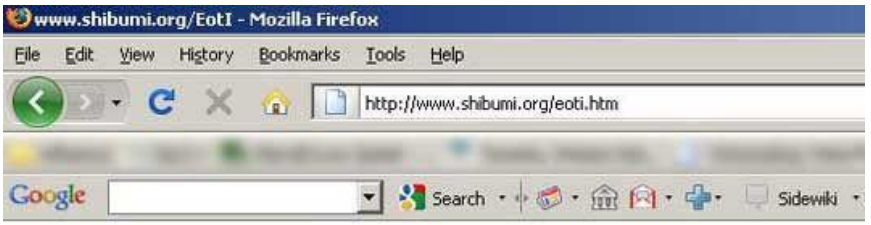
From this perspective, this game proposal draws from the design setting of the MODEM_GUESSR. I have been interested to revisit this project for two specific reasons. First, because of its potential for creating a *tension* between users and the politicality of the protocol, fostering a direct path between the way the modem protocol operates and the affordances and restrictions it enables for the players. Second, the amount of effort and physical implication required by each player in MODEM_GUESSR. Like Flanagan's *giant Joystick* that cannot be controlled alone (§ 2.5), the protocol becomes a component users need to abide by; making tangible the fact we need to adapt to the way it operates - and not the other way around. While protocols are, in other words, usually designed in a seamless way in order to serve the illusion of connectivity that is embodied inside the network, the HTML slider (paired with the *screeching* modem sounds the platform outputs) changes the level of involvement in a fundamental data transmission process needed from the user. This echoes with the fact that the project starts with a disconnect with a protocol that is not operational and not optimized for a seamless user experience.

3.6.2 - SKETCHES FOR THE *EARTH_MODEM_GUESSR (2020-2021)*: INTENDED PROJECT'S EXPERIENCE

Through the realisation of the project, I seek to use critical game design as a frame to research on the intersection between the earth and our data transmission processes. Drawing from the work of Bratton asserting that the earth acts as the foundational platform from where the internet emerges and operates, I am therefore interested at the level of the project's presentation and setup to give here to the players the feeling that computing cannot be separated from the earth's raw matter, since it is used to make the internet's hardware devices (silicon, hafnium, aluminum, copper, zinc - § 1.23). Drawing also from the work of Starosielski asserting that the internet cannot be seen in isolation from the earth's atmospheric, thermodynamic, geological, and biological (§ 1.23) processes, I seek through this project's setup to create a context where players would experience a data transmission process that is explicitly intertwined with fluctuations of the earth and of the soil. Likewise our internet undersea cables transporting our data yet covered by layers of rust and erosion, I am interested moreover to use this setup as a way to make the players reflect on how the internet's infrastructure intertwines inside the same setup both seamless data and raw matter.

By forcing the players to find spots in both of the soil chunks where the electricity fluctuations are the same, I seek also to create here analogies with local disruptions occuring on the internet infrastructure and on the internet's interface layer by the activity of the earth: strong oceanic currents, attacks from sharks, seismic events (§ 1.23). In dialogue with these events that have an impact on the internet's connectivity and interfaces, my will is here to give the players the feeling that our data transmission processes are inherently linked and codependent with the earth's small fluctuations and events - whether inside the ocean or in the game's soil chunks.

CONCLUSION



The End of the Internet

Congratulations! This is the last page.

Thank you for visiting the End of the Internet. There are no more links.

You must now turn off your computer and go do something productive.

Go read a book, for pete's sake.

Following the OSI model

Overall, my research-creation thesis follows the same structure as the OSI model (§ 1.7), the technical diagram used by engineers and internet service providers to theorize the internet's materiality. Inside this structural approach, I first contextualise my research inside a network of artistic and theoretical references. Whether from Meireles' practice for non-digital infrastructural hacking to net.art, critical theory on the internet and Howse' speculative earth computing works, my research expands from these artists and theorists. In dialogue with these, I develop my rationale for using my object of study: software dial-up modems. Moreover, I use these references to introduce the reader to the three internet narratives from where my research-creation thesis triangulates. From this perspective, my thesis is structured around three main clusters that follow my research questions. These echo with the OSI's layered hierarchy and are the following:

Flow: *Application, Presentation*

On the top level of the OSI sits the application layer that enables web interfaces. Interfaces are structured around an illusion of connectivity and flow, giving us the impression that we can navigate from platform to platform without delays or crashes. This layer thus embodies the internet narrative of *atemporality* that is the first narrative my thesis addresses. By giving us the impression that data within the internet flows between nodes with no time of transmission, interfaces are the visual embodiment of the metaphor of the cloud. By being minimalist, playful and easy to understand, such interfaces obfuscate the way the internet's infrastructure operates and handles data transmission. The first research question of my thesis critically addresses this illusion of network atemporality and asks how can software dial-up modem be used as a counterexample to deconstruct and critique the metaphors and illusions of the flow and the cloud. In dialogue with the work of net.artists such as Lialina (§ 1.13) and scholars such as Soon and Sprenger (§ 1.19), I seek to contribute to the conversation around the fact that the internet, even though its distributed infrastructure give us the

illusion that it does not follow a linear approach, still produces and manipulates time as well as our understanding of time at the level of its protocols. By extension, I assert that, in opposition to this illusion of data transmission flow, the network starts with a disconnection due to its network of interconnected nodes and protocols.

This disconnection is the key underlying rationale of the *OROBOROGRAM* (§ 3.2). I have attempted in this project to make visible how platforms craft the illusion of data transmission *flow* by connecting content with the help of these content's metadata. Detouring this metadata package to create abstract images, I have sought to hijack the illusion of data transmission *flow*: by explicitly adding noise, glitches and anomalies into our seamless scrolling feeds. Drawing from the *OROBOROGRAM*, I then created the *MODEM_BROWSER* (§ 3.3). This project explicitly seeks to challenge the illusion of atemporality by using an analog dial up modem within an interaction circuit. In doing so, this project subverts our usual interactions with the internet, turning the act of browsing into an experience that is explicitly temporal and error-prone. In the context of my research through design approach, this project serves as a way to critically answer the first question I ask in the introduction of my thesis. Moreover, it acts as a frame for creating situations where users will reflect on the way the internet and its protocols manipulate time - as well as our perception of time.

Temporality, neutrality: *Session, Transport, Network*

Below the application and interfaces, the OSI model lists five data transmission layers: from the *presentation* to the *data links*. These are the stack of layers where data transmission operates through the internet's protocols. Located below the minimalist interfaces that characterise our internet, their role and importance is obfuscated. The fact that we cannot see these protocols - and how they handle our data - gives us moreover the illusion that these are neutral and do not have an impact on the internet's processes. This is the starting point of the second aspect of my thesis: questioning the narrative of network and protocol neutrality. In dialogue with artists such as Bunting (§ 1.15) or

Sollfrank (§ 1.17) and paired with key internet scholars like Galloway (§ 1.11), I deconstruct this illusion. Moreover, I reinforce that the internet acts as a distributed power structure in which data transmission processes are modulated and manipulated from node to node following these protocols embodying logics written by their programmers.

Through research-creation, I address this narrative with the MODEM_GUESSR project (§ 3.3). The MODEM_GUESSR draws from the MODEM_BROWSER project in sharing the same desire to use the analog dial-up modem platform for structuring my research projects. In addition to using this data transmission platform for its explicitly temporal characteristics (§ 1.14), I use it here as a means of making tangible the way it modulates and controls data based on its primitive logic and operation (§ 1.16). Borrowing from the critical game design framework (§ 2.5), I created a context in which protocols are displaced from their purely functional and optimized logic and thus are disrupted from supporting the internet embodied narrative of neutrality. More specifically, I create a design situation where protocols become adversarial to the players, where players need to abide by the embodied logic of these modem's protocol for actively playing the game. In addition, I also created the 2X installation (§ 3.5), where the embodied logic of the modem protocol serves as a starting point for creating a poetry generator. Inspired in this context by OuLiPo where poets are interested in the creation of logical-driven poetry rules for manipulating language, I created this installation composed of three local machines that are connected to Twitter streams. Intertwining these streams at the same modulation baud rate, this project serves again as a way to make visible the politicality of protocols using the modem as an analogy, showing that - like other web protocols - the modem is defined by this logic of modulation (§ 1.5) that is responsible for validating or rejecting data transmission processes. Circling back to the second research question I introduce in the beginning of my thesis, the MODEM_GUESSR and the 2X serves then as frames for asserting *through design* that internet protocols are not neutral but are defined by a logic of modulation that is normative and impose on us a specific way to communicate.

Materiality, earth layer: *Data link, Physical*

The material setting of the 2X leads me to the third narrative I seek to deconstruct: the illusion of data transmission's *immateriality*. In dialogue with media artists such as Grant and Vasiliev (§ 1.20) and scholars such as Hu (§ 1.20), Starosielski (§ 1.23) and Parikka (§ 2.10), I assert that the internet emerges from its physical and material base defined within the OSI as the *physical layer*. Acknowledging that this physical layer is crucial for our data transmission processes, I expand on these references to break the illusion of immateriality emerging from the metaphor of the cloud. Where our mainstream understanding of the internet is driven by the omnipresence of software, I make visible the importance of the material base that supports and handles our data. Building also from the theory of Bratton (§ 1.24) and the speculative work of Howse (§ 1.25), I expand on the intersection between this material base and the earth itself. In contrast to the metaphor of the cloud, this enables me to further deconstruct the illusion of data transmission immateriality, grounding infrastructure in the activity of the earth itself and positioning the earth as the foundational platform on which all OSI layers are built.

In my research-creation projects, I expand on this narrative in my proposal for the EARTH_MODEM_GUESSR (§ 3.6). Drawing from the MODEM_GUESSR and inspired by Howse's engagement with inserting non-manufactured and raw earth materials for the creation of speculative computing circuits, I introduce my current research-creation direction. In a more direct way than previous projects, I expand here in a direction for projects that are speculative, that ask questions that are more open-ended about the nature of the internet's materiality. Operating under this frame, this project also pushes to its limit the way we understand computing: offering alternatives to its incentive of operationality and efficiency. Using here the modem device for creating speculative design proposals where the internet is entangled with the earth's activity and processes, the EARTH_MODEM_GUESSR tackles here the third research question of my thesis: how can we create

design situations to speculate and reflect on the connexions between the earth and the internet's data transmission processes? Moreover, it inquires through design how the earth can be seen as a protocol that has an impact on the internet's data transmission processes as well as how we perceive connectivity.

In addition, this thesis is also a meditation on research-creation and on academic practices operating under the research *through* design framework. It is moreover an exploration of new methods better suited to tackling design issues that emerge from the entanglement of the built-space and its human and material context.

Infrastructural Hacking and subversion

As a way to work with - and through - the internet, I have been first interested to draw from practices of infrastructural hacking. From this perspective, I have been keen to engage with the hacker's terminology of *exploits*, *holes*, and *insertions.* Engaging with this world has been the starting point of the foundational reference of my thesis: Meireles' *Insertions Into Ideological Circuits* (§ 1.8). In dialogue with Meireles, I have been interested to revisit this form of infrastructural hacking. Where Meireles draws from this field for creating his political art project, I have been keen to contextualise this in the context of my research tackling the internet (and data transmission process) narratives. Where the importance of Meireles resides in the fact that he not only inserts noise but also a political and agonistical (§ 2.5) message inside the infrastructure, I have been searching for ways to deconstruct these internet narratives by creating my own internet *hole;* and operating from it. As a c*lin d'oeil* to the Ouroboros greek figure (§ 1.9), I have been in other words interested to *exploit* this internet hole for developing a critical discourse on the materiality of the internet itself. The internet *hole* I have been keen to exploit emerges from the internet's materiality. It comes moreover from the fact that all our data transmission processes can be - at the level of interfaces - intercepted in their digital form, converted to analog signals, transmitted, and converted back to digital. This means

therefore that data transmission processes can be detoured; that analog technologies can be *inserted* into these "seamless" processes in order to change their material characteristics.

Media Archeology as a means to inquire about the internet narratives

In dialogue with Meireles, I have therefore been interested to pair this form of data transmission *hacking* with my critical inquiries into the false narratives of the internet. More specifically, I have not only sought to insert noise or entropy within these processes but an agonistic discourse; a discourse that would conflict with the ideologies these seamless processes embody. As a result, I have operated under the framework of media archeology (§ 2.7 to 2.9). Media archeology has been a valuable asset to contextualise my research. With this desire to explore media history as a non-linear narrative and to revisit its forgotten discourses, I have used this research frame to seek for analog technologies that would contradict the central narrative of the network "cloud" as well as its sub-narratives of data transmission atemporality, neutrality and immateriality.

It is for these reasons that I decided to engage with the primitive technology of dial-up software modem. In dialogue with the narrative of the cloud, I used this technology as a metaphor for creating alternative data transmission circuits that would be explicitly temporal (§ 1.14), political (§ 1.16) and material (§ 1.22). *Temporal* due to the analog nature of the modem that produces a signal output; which in turn makes this temporality explicit since we can hear through the speakers. *Political* because the modem makes explicit the normative nature of the internet infrastructure and of its protocols we must follow so that our communication processes occur. *Material* due to the fact that it depends on the material context where the transmission occurs, from the quality of the speakers and microphone to the acoustic and sonic characteristics of the space.

Expanding on critical technical practice and research-creation methods

In order to contextualise my research navigating between critical theory, art, design and technology, I have been also interested in searching for academic frameworks engaging with - and

through - design in a critical way. From this perspective, my first approach has been to contextualise for a broader audience the concept of research-creation: which is the initial ground from which my research originates. After expanding on the concept's historical context (§ 2.2 to 2.3), I have connected my research with a form of design practice known as *discursive design* (§ 2.4). Operating under this frame has been crucial in defining my actual research as a design practice that operates outside of the market-driven incentives of operationality and functionality. More specifically, I have contextualised my work *through* design as a form of critical and speculative design practice: design used to create experiences enabling critical reflection (§ 2.5) and to ask more open-ended and foundational questions about design and technology (§ 2.16).

In addition, I have explored how my critical design approach could be paired with academic methods for rigorously grounding my project's rationale and my research outputs. In this context, I have been interested to draw from Schön's *reflection-in-action* (§ 2.4); in which the practice of design is approached outside its tacit characteristics (§ 2.3). Paired with discursive design, Schön's concept then becomes a way to turn this discipline into hybrid practice enabling practitioners to reflect on their design decisions while making it.

Starting from reflection-in-action, I first connect my research with the method known as prototyping (§ 2.13). Throughout my research, prototyping has been a way to quickly embody my research interests into the materiality of the internet I seek to deconstruct; and to produce alternative data transmission circuits as a means to challenge these three narratives that are central to my thesis. Engaging moreover with and through the internet using the modem, prototyping serves as a way to develop my research-creation process in an iterative format, building on top of these iterations to ground my research directions.

In order to reflect on these prototypes while doing them, I also connect my work with Khaled, Barr and Lessard's MDMA method (§ 2.14). Using the affordances of *Git*, I engage with this method for the creation of a digital diary. For each project, this diary becomes a way to centralize my references and detail my research trajectories. In addition, I also engage with this method and the Git

software for its feature known as *branches* (§ 2.15). Enabling programmers to develop different versions of the same software simultaneously while at the same time keeping a trace of these versions, I explore this method in my OROBOROGRAM (§ 3.2). Here, the branch feature becomes then a way to operate in a more rhizomatic way; developing in parallel different design embodiments through the project.

Finally, and as in echo with chapter three of my thesis that expands on my own actual research interests through the EARTH_MODEM_GUESSR proposal (§ 3.6), I introduce the reader to my desire to build on top of MDMA to foster new research methods. Starting from the theoretical insight of the internet scholar Hayles in which she defines programming languages as bilingual (§ 2.15); I brainstorm on ways to retrieve meaningful information inside software-specific projects by directly engaging with the code itself.

Key contributions of my thesis to knowledge

The first key contribution of my thesis relates to the connection between the media archeological field (§ 2.7 to 2.10) and my work with modems. Using this old and primitive technology as a means to deconstruct our mainstream understanding of the internet, I propose in my thesis to combine media archaeology with critical technical practices (§ 2.5), questioning the internet outside of its purely operational and market-driven realm. Moreover, I argue that media archeology is foundational to approach the internet's infrastructure outside of its present form and to find objects from where critical discourses can be built. Inside my thesis, this quest is materialized with the software modem technology. From this perspective, the first contribution to knowledge I develop here is the use of the modem technology as a frame to question within the same device these three narratives and illusions of atemporality, neutrality and immateriality emerging from the internet cloud.

The second key contribution of my thesis to knowledge relates to the connection between net.art and these three narratives of data transmission atemporality, neutrality and immateriality. While

these net.art projects are conducted by artists producing these standalone artworks, my thesis connects them to a broader context of analysis inquiring the internet's materiality and narratives. Moreover, in dialogue with the Open Systems Interconnection (OSI) model (§ 1.7), it argues that the net.art movement in inherently connected and developed in relation with these three research angles and clusters of data transmission temporality (Lialina, § 1.13), neutrality (Bunting § 1.15, Sollfrank § 1.17) and immateriality (Shulgin, § 1.10). From this perspective, this key contribution consists in asserting that this artistic movement is a valuable artistic corpus from which critical questions about the internet's materiality can be extracted.

Third, another key contribution of my thesis to research-creation knowledge relates to the use of internet platforms for critical technical work inquiring about the internet's materiality. In this context, this contribution emerges moreover from my engagement with APIs (§ 1.18) that I approach as central assets for engaging in a critical manner with the materiality of these platforms; and by extension of the one of the broader internet infrastructure. As an echo with tactics of infrastructural hacking (§ 1.8) or the ouroboros (§ 1.9), I assert moreover that engaging with these APIs is foundational in developing platforms specific critical and adversarial design (§ 2.5) projects inside research-creation. This means therefore that, via the use of these entry points, artists and researchers can *insert* embodied critical discourses inside these ecosystems in order to create situations serving critical reflection on the internet. In the context of research-creation inquiries that deconstruct the purely functional and presentist illusion of the network, operating from these APIs is also valuable in creating situations where old devices can be juxtaposed with new platforms. By doing so, this critical use of APIs allow design researchers working on internet platforms to bridge hacking with media archeology in a hybrid and practice-based way.

Finally, the last contribution of my thesis to research-creation knowledge consists in my proposals to extend the MDMA method at the level of the code itself, from the use of function names to code comments (§ 2.15). Expanding on the method's desire to bridge tacit game design projects with academic research, I argue that these extensions are valuable contributions in extracting data and

knowledge one step closer to the materiality of the source code itself.

Plan for future works

I am now eager to further develop two aspects of my thesis. The first aspect extends from MDMA (§ 2.14) as well as the will to continue in bridging the gap between tacit design projects and academic discourses on design. Drawing on the *research-creation* epistemological framework, I am moreover eager to push further and materialise the two propositions I introduced earlier. These are the use of function names and code comments (§ 2.15) in the context of software creation; turning these bits of code into valuable insights that can be used to further ground my project's conceptual rationales and ideas. In dialogue with Sengers' understanding of Human Computer Interaction (HCI) as a conversion between critical reflection and the practice of technology design (§ 2.5), I am in other words eager to further explore how these hybrid (both human and machine) forms of languages can be used to gain more information about my project's processes and trajectories. Likewise MDMA, I am eager to make these methods reusable through the creation of a technical procedure; as well as disseminating these with the broader academic research-creation community.

Using these methods, the last aspect of my future works extends from Howse (§ 1.25) and from its speculative interaction design approach. Here, Howse serves as a foundational starting point for my future research-creation projects for two main reasons. The first angle relates to a desire to push critical computing into the realm of the speculative, and create infrastructures that evade the market-driven purely operational and efficient incentive of technology. I argue that this posture is foundational for asking questions outside the way technology usually "works" and for extending the boundaries of the technical. From this perspective, I am also interested in drawing from Howse's body of work to focus on the third narrative of my thesis tackling the physicality of the internet. Starting from the EARTH_MODEM_GUESSR (§ 3.6), I am eager to create more speculative data transmission processes that engage with materials that are not engineered and emerge from the earth's

activity and processes. Inside the practice-based research framework, making these projects will further serve as frames to research on questions that I consider as underdeveloped inside the critical internet academic world. These ask how the internet's data transmission processes are impacted and altered by the activity of the earth. Using again the OSI model (§ 1.7) to structure my research, these ask moreover how does this activity of the earth need to be seen as a protocol impacting the internet's physical layer and modulating in terms of how we interact (and understand) the network. I consider these questions of core importance for inquiring about the internet megastructure in the light of our anthropocene shift.

REFERENCES

Chapter 1: Artistic and theoretical context

Abbate, J. (2000). Inventing the Internet (Inside Technology). Cambridge, MA: MIT Press

Agamben, G. (2009). “What Is an Apparatus?” and Other Essays. Stanford, Calif: Stanford University Press.

Bogost, I., & Montfort, N. (2009). *UC Irvine Plenaries: After Media-Embodiment and Context Title Platform Studies: Frequently Questioned Answers Platform Studies: Frequently Questioned Answers*.
Retrieved from: https://nickm.com/if/bogost_montfort_dac_2009.pdf

Bratton, B. H. (2016). The Stack: On Software and Sovereignty. Cambridge, MA: MIT Press

DiSalvo, C. (2015). Adversarial Design. Cambridge, MA: MIT Press.

Deleuze, G. (1992). *Postscript on the Societies of Control, October, Vol. 59* (Vol. 59). Retrieved from: https://www.jstor.org/stable/778828?seq=1

Easterling, K. (2014). Extrastatecraft : The Power of infrastructure space . London; New York, NY: Verso.

Funkhouser, C. T. (2007). Prehistoric Digital Poetry: An Archaeology of Forms, 1959–1995. Tuscaloosa, AL: University of Alabama Press

Galloway, A. R. (2004). How Control Exists after Decentralization. Cambridge, MA: MIT Press

Galloway, A. R., & Thacker, E. (2007). The Exploit: A Theory of Networks. Minneapolis, Minn: University of Minnesota Press

Hu, T.-H. (2016). A Prehistory of the Cloud. Cambridge, MA: MIT Press

Latour, B. (2005). From realpolitik to dingpolitik. *Making things public: Atmospheres of democracy*, *1444*. Retrieved from: http://www.bruno-latour.fr/sites/default/files/downloads/96-MTP-DING.pdf

Mathews, H., & Brotchie, A. (2005). *Oulipo Compendium*. Los Angeles, Calif: Make Now Press

Misa, T. J. (1988). How Machines Make History, and how Historians (And Others) Help Them to Do So. *Science, Technology, & Human Values*, *13*(3–4), 308–331. Retrieved from: https://doi.org/10.1177/016224398801303-410

Oliver, J., & Vasiliev, D. (2016). NETworkshop Lightning in the Age of Cloud-Computing. *The Critical Engineering Working Group*. . Retrieved February 11, 2021, from https://criticalengineering.org/courses/networkshop/

Parikka, J. (2012). Forum: New materialism new materialism as media theory: Medianatures and dirty matter. *Communication and Critical/ Cultural Studies*, *9*(1), 95–100. Retrieved from: https://doi.org/10.1080/14791420.2011.626252

Soon, W. (2017). Executing Micro-temporalities. *Executing Practices*. Retrieved from: https://www.academia.edu/32663026/Executing_Micro_temporalities

Sprenger, F. (2015). The Politics of Micro-Decisions: Edward Snowden, Net Neutrality, and the Architectures of the Internet. London: meson press

Starosielski. N. (2015). The Undersea Network. Durham, NC: Duke University Press.

Williams, A. (2015). *Control Societies & Platform Logic. New Formations*. 84/85, 209-227. Retrieved from: https://openaccess.city.ac.uk/id/eprint/16763/1/

Winner, L. (1980). Do Artifacts Have Politics? *Daedalus, Vol. 109, No. 1, Modern Technology: Problem or Opportunity?* (Winter, 1980), pp. 121-136. Retrieved from: http://www.jstor.org/stable/20024652

Zizek, S. (2006, November 13). *DESIGN AS AN IDEOLOGICAL STATE-APPARATUS | ICoD*. International Council of Design. Retrieved May 09, 2021 from: https://www.ico-d.org/connect/features/post/236.php

Chapter 2: Design and methodological framework

Auger, J., Smyth, Mi., Helgason, I., & Hanna, J. (2019, July 30). *SpeculativeEdu.* Retrieved May 09, 2021 from: https://speculativeedu.eu/other-worlds/

Avanessian, A., & Topfer, A. (2014). Speculative Drawing: 2011–2014. Berlin: Sternberg Press

Brandt, J., Guo, P. J., Lewenstein, J., Dontcheva, M., & Klemmer, S. R. (2009). Opportunistic Programming: Writing code to prototype, ideate, and discover. *IEEE Software*, *26*(5), 18–24. Retrieved from: https://doi.org/10.1109/MS.2009.147

Buchanan, R. (2001). Design Research and the New Learning. *Design Issues*, *17*(4), 3–23. Retrieved from: https://doi.org/10.1162/074793601526810 56

Dunne, A., & Raby, F. (2009). *A Manifesto: a/b*. Retrieved May 09, 2021from : http://dunneandraby.co.uk/content/projects/476/0

Dunne, A., & Raby, F. (2013). Speculative Everything: Design, Fiction, and Social Dreaming. Cambridge, Massachusetts; London: The MIT Press

Foucault, M. (1972). The archaeology of knowledge. London: Tavistock Publications.

Goddard, M. (2015). Opening up the black boxes: Media archaeology, ‘anarchaeology’ and media materiality. *New Media & Society*, *17*(11), 1761–1776. Retrieved from: https://doi.org/10.1177/1461444814532193

Greenfield, A. (2017). *Radical Technologies: The Design of Everyday Life*. London: Verso.

Hayles, N. K. (2004). Print is flat, code is deep: The importance of media-specific analysis. *Poetics Today*, *25*(1), 67–90. Retrieved from: https://doi.org/10.1215/03335372-25-1-67

Hertz, G. (2009). *What is Critical Making?* Retrieved May 09, 2021: https://current.ecuad.ca/what-is-critical-making

Khaled, R., Lessard, J., & Barr, P. (2018). Documenting trajectories in design space: A methodology for applied game design research. *ACM International Conference Proceeding Series*. Retrieved from: https://doi.org/10.1145/3235765.3235767

Metzger, G. (1966). *Auto-Destructive Art*. 1959-1960, 1960.
Retrieved May 09, 2021from : http://radicalart.info/destruction/metzger.html

Morozov, E. (2013). *To Save Everything, Click Here: The Folly of Technological Solutionism*. New York, NY: PublicAffairs.

Papanek, V. (1972). *Design for the Real World: Human Ecology and Social Change*. London: Thames and Hudson.

Ratto, M. (2011). Critical making: Conceptual and material studies in technology and social life. *Information Society*, *27*(4), 252–260.
Retrieved from: https://doi.org/10.1080/01972243.2011.583819

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169. Retrieved from: https://doi.org/10.1007/BF01405730

Ryle, G. (1945, January). Knowing how and knowing that: The presidential address. In *Proceedings of the Aristotelian society* (Vol. 46, pp. 1-16). Aristotelian Society, Wiley. Retrieved from: https://www.jstor.org/stable/4544405?seq=1

Schön, D. A. (1983). The Reflective Practitioner: How Professionals Think in Action.

Sengers, P., Boehner, K., David, S., & Kaye, J. (2005). Reflective design. *Critical Computing - Between Sense and Sensibility - Proceedings of the 4th Decennial Aarhus Conference*, 49–58.
Retrieved from: https://doi.org/10.1145/1094562.1094569

Tharp, B. M., & Tharp. Stephanie M. (2013). Discursive Design: Critical, Speculative, and Alternative Things. Cambridge, MA: MIT Press

Chapter 3: Case studies, future works

Bleecker, J (2009). Design Fiction: A Short Essay on Design, Science, Fact and Fiction | Near Future Laboratory. Near Future Laboratory. Retrieved from: https://drbfw5wfjlxon.cloudfront.net/writing/DesignFiction_WebEdition.pdf