

Building glitchforest

■
online

Reflections
on
self-expression
between
online
& offline space

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Abstract

This thesis, as well as the accompanying practical project was developed and written between September 2021 and January 2023. It documents my thoughts about social life, self-expression, and music making online and offline during this time, which were influenced by the covid-19 pandemic that came to the Netherlands in 2020. A special focus is laid on the aspect of (sonic) self-expression in the digital space and how this can connect with digital audio processing methods and sonic characteristics resulting of sound travelling over digital infrastructure. The theoretical base for this thesis and project comes from writings by Legacy Russell, Wendy Hui Kyong Chun, Cornelia Sollfrank, Rob Horning, Julian Dibbell, Jonathan Sterne and Tara Rodgers, Johanna Drucker, American Artist, and others.

Table of Contents

Acknowledgements	2
Abstract	3
Introduction	5
1 Moving about in digital space	8
1.1 Constructing spaces in the digital realm	9
1.2 (In)visibility, self-expression, and community in the digital space	14
2 Thoughts about user interfaces & sound processing in the digital realm	21
2.1 Interfaces and metaphors	22
2.2 Layers, Walls & Voids: The interface as an artistic tool	29
2.3 Digital sound & signal processing in the context of online communication	30
3 Building glitchforest.online	37
3.1 Technical aspects, the role of the interface and methods of interacting with the system	38
3.2 Thoughts on self-expression, interaction and musical ideas at glitchforest.online	44
3.3 Future plans	47
Conclusion	48
References	49

Introduction

This thesis encapsulates my thoughts on how the internet has transformed in the last 15-or-so years and how this has influenced the practice of self-expression and human interaction online. I will focus especially on how sonic characteristics and processing methods implemented in existing online audio communication technologies can be used for artistic self-expression and a creative approach to communication. Furthermore I will explore what role the interface plays in the context of self-expression and interaction within communities. Along the research I am thinking deeply about how we can use — and possibly contribute to — open-source software in order to imagine and develop online communication platforms that enable us to interact in ways that go beyond what commercial social media offers us at the moment.

A lot of my artistic output is rooted in a feeling that is central to these topics: An ever-present tension between a drive for self-expression and a tendency to nervously hide from the world: “I want to be seen, but please don’t mind me.” Such contradicting feelings and confusions lent themselves perfectly to be lived out on the internet between around 2007 to the early 2010s. Through blogging, chatting, forum posting and playing silly little online games I experimented with different ways of being. Back then, the internet to me was mostly a place where I would go to either talk to strangers, or indulge in activities by myself as a form of *alone-time*. Now, in the year 2022, the internet does not feel as separate anymore from life in the corporeal world; Going online is seldomly alone-time anymore. The internet has become another layer of space and time in our lives. This has naturally changed the way I engage with the online space, but also the corporeal world.

Because I have had social anxiety for as long as I can remember, finding human connection and a space to experiment on the web has been important in my life. For this reason I am excited about the increasing interconnectedness of physical and digital space, as it has provided us with whole new ways of sharing, connecting and expressing ourselves. However, many digital communication technologies such as social media are in the hands of big corporations, which do not necessarily share the interests and respect the rights of society and its individuals. In part, this is shown by the reality that the digital technologies intertwined most with our lives are closed-source. An important aspect of my artistic project is therefore to experiment with open-source software as a way of reclaiming agency over digital technology. During the months of writing my thesis I have also become part of a few alternative online social networks, which prompted me to think more about what other ways there are to utilize the shared reality between on- and offline.

In addition to the already rapidly growing popularity of social media, a global pandemic that has lasted about three years (at the time of writing) has forced a big part of human communication onto the internet. This has led to changes in audio/video online communication systems. In a technical sense, connections have become more stable, and the development of audio processing algorithms such as noise and echo cancellation has gained speed and priority. Users do not have a lot of control over these algorithms: Unless one decides to self-host their communications infrastructure and learn about the technology, often the only choice users have is to (partly) switch on or off the audio processing. Both in terms of the user interface design and the implementation of audio processing, it is often assumed by the developers and designers of the software what the user wants and needs. During the one-and-a-half years of this research I have repeatedly come across two approaches: One I have primarily seen with musicians, which consists of trying to eliminate the sonic characteristics of digital audio communication, and another (engineering) approach that is often ingrained into web conferencing software, that tries to block out everything that is outside of the frequency range of the human voice. I find myself intrigued by what kinds of music and sonic interactions could emerge if an approach that lies between those two is chosen. One that allows for a playful interaction with the characteristics of sound travelling over digital infrastructures.

After having immersed myself in the field of sound art during my four-and-a-half years at the *Institute of Sonology*, the way I listen to my surroundings both on- and offline has changed in the sense that I have become a more attentive listener. Connecting this way of listening with the spirit of just trying things and *doing stuff* that I was able to nurture as a teenager in a queerfeminist punk-pop band, and my enthusiasm for open-source technology, I have been working on my own online space for audio communication: *glitchforest.online*. The aim is to offer tools for self-expression that accept and embrace the sonic characteristics caused by techniques and circumstances such as compression, limited bandwidth, and so forth. In the process I was also inspired by the implications of changing and altering one's voice, that are inevitably related to our individual expressions of gender, as well as modes of interpersonal communication. As a starting point I researched and experienced different approaches to building social spaces online.

On the following pages, I will elaborate on the findings of my research and explain the practical work in more detail. Chapter one aims to lay a theoretical base for the following chapters. It is split into two sub-sections: In section one I will start outlining an understanding of the terms *digital space* and *self-expression* that considers the role of gender — because in our society self-expression is often, if not always, linked to gender in one way or another —, and draws on the writings of Legacy Russell, Wendy Hui Kyong Chun, Cornelia Sollfrank, Rob Horning, Julian Dibbell and Johanna Drucker, among others. In the second part I will discuss the notion of self-expression online as well as briefly explain what I mean by *sonic self-expres-*

sion. Spread over three sub-sections, chapter two goes more deeply into some aspects drawn from theory and practice that are related to my artistic work. The first contains thoughts on the role of the interface in the context of online space. This is followed by a short text introducing an example of the interface in an artistic context. Part three rounds off the theoretical part of the thesis with a discussion on digital sound and signal processing in the context of online communication. In chapter three I will go into the process of making the practical work, discussing the most important points split over three sub-sections: Part one elaborates on technical aspects of the project as well as decisions regarding the user interface. The second part is about the role of self-expression and musical ideas in the work. In part three I will briefly outline future plans for the project.

I hope to raise some pressing issues of our current digital infrastructures, share my fascination for alternative approaches to digital technology, and connect these to my approach to sound art.

1

Moving about
in digital space

1.1 Constructing spaces in the digital realm

The notion of *digital space* has been interpreted in slightly different ways throughout the history of computers. While it has often been conceived as a “parallel world,” the perception of digital space has been shifting from being somehow separate from physical space (the corporeal world) to becoming more and more incorporated into it. Digital space often seems to be perceived, approached or marketed as a social space — a medium in which relationships are organized and connections are made between humans and/or (digital or analog) objects. This happens within various networks (and sub-networks) that operate in digital space, such as the internet and its platforms.

Today, a considerable amount of our lives takes place on commercial social media platforms such as *Facebook*, *Twitter*, *Instagram*, etc. There is enough reason to think critically about whether these kinds of platforms indeed foster connection and communication between humans or not. As many people have argued, the way we interact on today’s biggest social media sites does not necessarily come down to just connecting and staying in touch with others, or experimenting with self-expression, but mostly to representing, or even marketing ourselves in ways that are heavily influenced by the platforms’ algorithms and policies. (Horning 2014)

Since we access digital space via computers (including mobile devices) — made tangible through the use of various input/output devices such as screens, keyboards, speakers, etc. —, it might at first seem as if it was indeed some kind of parallel world that we can switch on and off by simply pressing the power button. I, along many other people, would argue that both early experiments of online social networking and current-day social media show us quite the opposite; events happening in digital space have consequences in the corporeal world, and can be *felt* by humans as something just as real and important as happenings in so-called “real” life. Think of Julian Dibell’s influential 1993 essay “A Rape in Cyberspace”, where he argues: “The commands you type into a computer are a kind of speech that doesn’t so much communicate as *make things happen*, directly and ineluctably, the same way pulling a trigger does. They are incantations,[...]” (Dibell 1993)

Another important take on this interconnectedness of life online and in the physical space comes from Legacy Russell’s *Glitch Feminism* Manifesto. Drawing on writings by Nathan Jurgenson, she uses the term *AFK* — an abbreviation for *away from keyboard* which has first surfaced somewhere in the late 1980s to early 1990s (Paez 2020) — in place of the often used *IRL*¹. (Russell 2020, 30) She argues that life online is *also* real and that we “journey the online to AFK loop” (Russell 2020, 14) when we move between digital and physical space. In her own words:

¹ Abbr. *in real life*

IRL falters in its skewed assumption that constructions of online identities are latent, closeted, and fantasy-oriented (e.g. not real) rather than explicit, bristling with potential, and very capable of ‘living on’ away from the space of cyberspace. Instead, AFK as a term works toward undermining the fetishization of ‘real life,’ helping us to see that because realities in the digital are echoed offline, and vice versa, our gestures, explorations, actions online can inform and even deepen our offline, AFK, existence. This is powerful. (Russell 2020, 43)

Following this way of thinking I too will stick to using the term AFK in this thesis instead of IRL. The digital space, and thus computation, is embedded in and in constant exchange with life AFK, and so the creation of new digital realities also creates and influences realities AFK. In her essay “On Software, or the Persistence of Visual Knowledge”, researcher Wendy Hui Kyong Chun shows that this has been happening ever since the very beginnings of computation. In this text Chun discusses how the act of programming computers has changed over the course of history, and what that means for the agency of the user. “Software produces users.”, she argues, and: “Importantly, the ‘choices’ operating systems offer limit the visible and the invisible, the imaginable and the unimaginable.” (Chun 2005, 43)

Design choices of digital interfaces and programming languages play a crucial role in how we interact with computers – and thus also how we interact with each other in the online space. They place restrictions on our actions and what information we can access. Therefore, researcher Johanna Drucker advocates for an understanding of the interface as a “constitutive boundary space”. (Drucker 2013, 216) In section two of this thesis I will elaborate further on different aspects of the concept of the interface.

Since digital space and physical space are now part of the same reality, the influence that interfaces, programming languages and their design have on us is not only restricted to digital space. After all, digital technology has been created by humans. One aspect that is important to me as a person that was assigned female at birth (afab) becoming active in the world of digital technology, is how gender roles have been coming into play both in early computing and the current-day situation of the field. The perceived shift in the image of a programmer from a female office clerk to a kind of male “priest” or “master” has influenced the way we see technology and what kind of people we imagine to be the ones in charge. (Chun 2005, 26-40) These kind of socially constructed notions of male *mastery* can be found in many parts of social life, for the so-called professionalization of a field often goes along with culturally coding it *male*. (Chun 2005, 32) For example, in a text by Jonathan Sterne and Tara Rodgers on signal processing — a subject that will become important in this thesis later on — they touch upon the same ideas when mentioning the image of a *masterful composer*, who gains control over

the so-called *raw* sounds by processing them. In general, *mastery* has been commonly associated with the male gender. Referring to a research by Paul Théberge, Sterne and Rodgers mention that music technology magazines and advertisements at the time linked electronic music machines to female sexuality, while the audience of these magazines and advertisements was assumed to be primarily young and male. (Sterne and Rodgers 2011, 37)

Similar to how Chun argues that gendered — perhaps made up, or exaggerated — command and control structures can be found back in programming languages, Sterne and Rodgers identify electronic music equipment marketed as something *female* to be taken control of. While these ideas do often reflect common images we have of different genders in history, it is important to not dismiss the agency of, in this case, women. Chun mentions in her essay that historical depictions of early computing might often paint a scenario where a male programmer commands a female assistant, while in reality the female programmers worked in pairs and had to come up with their own solutions to the computing problems. (Chun 2005, 36)

However, the way in which digital technology has shaped language and culture offline is not only related to ideas of command and control, or gender roles. There are many expressions and abbreviations that have first surfaced on digital networks (including early forms such as Bulletin Board Systems,² as well as still popular ones like multiplayer video games or social media platforms), and then made their way into physical space. Think of terms such as *LOL*, *GG*, or the beforementioned but perhaps less wide-spread *AFK*, or the referencing of *memes* in offline conversations.

All these examples make clear that the way we approach and document digital technology in history and present is influential for our relationship with it as humans; Nowadays, we do not think *with* computers only — i.e. in mathematical terms; trying to formulate problems in such a way that they can be solved by the computer, or in a behavioral sense, going about tasks in ways that the user interfaces of our devices suggest. The interfaces also give us access to the digital world (another layer of reality) and *change* the way we think, interact, express, go about our lives. There is an aspect that differentiates digital space from physical space, however: The toolsets we have to express ourselves. In the corporeal world we are limited by the physicality of things; we can only change our appearance to a certain extent. We might feel shy to express ourselves freely. In an (perhaps ideal) online space, we might still feel shy, but it is possible to express ourselves more “metaphorically” — we can make use of our own imagination and the one of the people with whom we interact in a way that is less bound to our physicality, and take on the forms of different mediums; we can be an image, sound, a

² Bulletin board systems (BBSs) were dial-up communication systems popular in the 1980s and 90s, that operated on switched telephone networks. Most of them were run by volunteer and often hobbyist system administrators (so-called *sysops*), who shaped the design of these systems and experience of the community of their respective BBS. Users could communicate with each other by posting and replying to text messages. (Driscoll 2019)

sentence in a story, a video game character,... Depending on the space's policy, we might even be able to remain anonymous to a certain extent or be a completely different person than we are AFK.

Even though we have our imagination, we are still limited when expressing and interacting online. Most, if not all software is made for a (more or less) specific purpose, to which specific abilities and actions are coupled. Furthermore, understanding a digital system in its entirety — from the physical parts of the system to the software components — takes a considerable amount of effort and time, which more often than not, people either do not have or do not want to spend on such things. Of course, such an understanding is not really necessary in order to participate in online space, nor does it take away our agency as users. It just shows that, like in the corporeal world, it is impossible to have complete control and/or freedom in the digital space. Furthermore, in a social context it is often necessary to accept certain limitations. For example, if implemented thoughtfully and with the right intentions, the existence of a code of conduct or other social rules can help with making a (digital) space comfortable and socially safer.

A much-discussed topic at the moment is how the algorithmical structures of online platforms influence our behaviour. On corporate social media for instance, the information we put in, as well as our actions get collected and translated to data, which act as proxies (Hildebrandt and Chun 2022) for what we supposedly want (to be sold), feel, stand for, and who we are or should be according to the system in question. This could be anything from a social media platform to an e-mail program on your desktop. As Cornelia Sollfrank has put it:

The function of data is reduction of complexity. Between the various steps of generating data and their interpretation in a human brain, they are subject to multiple possibilities of manipulation and bias. From biased algorithms to biased forms of visualization to the intentional control of who gets to see what under which circumstances, data are likely to serve existing power structures and imbalances in the distribution of resources. This makes data a perfect tool not just for the biased *representation* of reality but also creates feedback loops that *create* reality — be it in the field of politics, of economy or human desire. (Sollfrank 2022)

Often, the code which social media platforms or other digital systems are made of is not available to the end users, and it obviously introduces all kinds of problems. Sollfrank mentions concerning the widely known Cambridge Analytica Scandal of 2018:

Since then, the power of companies who combine misappropriation of digital assets, data mining, data brokerage, and data analysis with strategic communication during electoral processes is discussed as a threat to

democracy (Amer and Noujaim 2019; Kaiser 2019; Orlowski 2020) Still, there is little knowledge about the workings of those services who largely operate as black boxes and consider their techniques as trade secrets. (Sollfrank 2022)

The less the user knows, the bigger the power gap becomes between software developers and users. It is important that users are able to see the code any program is made of. For that reason it is crucial to support the development and to consciously use open source projects as much as possible. Of course, making the code public is not the only important factor of, let's say, distributing agency inside the online space. As briefly touched upon above, the construction of interfaces also plays a major role in what a user can do, understand, and access. Moreover, the culture around digital systems and networks has a big influence too. Over the years, the roles of users have become blurry. Referencing Chun's beforementioned essay again; users are also programmers, and programmers are users. (Chun 2005, 38) I will go into this topic further in chapter two.

Keeping in mind all the aspects discussed above, I will end this chapter with the question: How can we utilize the digital space to build as well as use existing digital infrastructures, tools and spaces to stimulate (artistic) self-expression and relationship-building with other humans? People have been asking themselves this question via projects such as the *Fediverse* — “[...] a common name for federated social networks running on free open software on a myriad of servers across the world”. (Fediverse.Party 2022) The *Fediverse* connects many different open source social networking projects. The main difference between a project like this and commercial social media such as *Facebook* is that the network is federated; thus anyone can use the open source code to create a social network by opening an instance on a (maybe their own) server. This results in a decentralization — and therefore wider distribution of control — of the online social networking. In my project I will specifically focus on this question in a sound art context. The goal is to create an open-source, web-based system that provides a space to experimentally engage with sonic self-expression and relationship building and/or maintaining. Attention will be devoted to how we experience sounds online and how that works in relationship with sound in the physical space. Inspired by many artists and writers, and especially by Russell's *Glitch Feminism*, I hope to further blur and explore the lines between online and offline, as well as users and programmers, because I think this provides a fruitful ground when it comes to being able to take initiative online, building (more) collective and individual online spaces for artistic expression and using the potential of existing and not-yet-existing infrastructures.

1.2 (In)visibility, self-expression, and community in the digital space

Just like the term *digital space*, the concept of *self-expression* suggests a broad variety of things to discuss. I will mainly focus on how the possible ways of *sonic self-expression* online can be utilized in relation to self-expression offline. I will also talk about how this can be a powerful tool to experimentally engage with oneself and build relationships with others. I will again draw on Russell's *Glitch Feminism* and other works, and talk about my own experiences. To provide context, I will discuss some aspects of self-expression online more generally.

Under *sonic self-expression* I understand self-expression by means of sound — both in an artistic context and an everyday context. Examples for sonic self-expression in an artistic context are singing, screaming, speaking, playing acoustic instruments or using electronic means of sound production, performing at concerts, producing records, etc. In an everyday context, it can be the way we speak with each other and sonically communicate (this can be subtle), or other ways of incorporating sound production into the everyday, like humming or talking to oneself, and so on. Of course all these things can also be unintentional — one does not always make a conscious choice to talk or hum to oneself, for example. The meaning of *everyday sonic self-expression* can even be extended to how one listens and reacts to what one hears. For example, how does a person react when their favourite song comes on in a bar? One could sing along loudly, or hum the melody to oneself, enthusiastically announce with words that it is one's favourite song, stay silent, etc. A person might also have a specific sound they make in order to show compassion, another to express excitement, yet another one to communicate disagreement, and so on.

Online, sound is mostly present in combination with (moving) image. This is true for both social media platforms and conferencing services, and in general there is a tendency in the digital realm to display information visually rather than sonically. I find the implications of transmitting sound over the web to be very rich, and I wonder what happens if we minimize the visual component in online communication as much as possible. Noise and echo cancellation algorithms, lags and time delays and audible glitches influence how we listen and communicate online. Some of these are consciously implemented to achieve a smoother user experience (noise and echo cancellation algorithms), others are characteristics of, and the result of limitations in digital infrastructure, or happen accidentally (lags, time delays, glitches). Often we are not aware of these sonic qualities when we use online communication, or maybe we try to ignore them, or get annoyed. But what happens when we pay attention and consciously incorporate them into our communication as tools of self-expression? What if we add on more processing techniques to alter our voices and sounding environments, and how does

that influence our relationships as humans/artists communicating with each other online? These are questions that were (and still are) central to the development of my project. To situate them in the context of online self-expression, I will discuss some points that Legacy Russell makes in *Glitch Feminism* and relate them to ideas and comments I have picked up elsewhere.

Russell argues that creating and experimenting with online, digital selves can help us understand who we are with more nuance. (Russell 2020, 31) She gives many examples of artists utilizing the online space in that way. One of them is Shawné Michaelain Holloway, who has been inspired by her *camgirl* experiences to explore topics like power dynamics or the experience of simultaneously consuming and being consumed. Her works have taken the form of *Instagram* portraits for example. (Russell 2020, 103) Also self-defined *cyborg*, artist and musician Juliana Huxtable utilizes various platforms to document herself online. (Russell 2020, 51)

Not only artists experiment in the digital space, but experimentally engaging with one's identity online is something anyone can try. Obviously, positing oneself into different contexts in life can generally be helpful in understanding oneself and others better. Personally, experiences like playing concerts in different places with my former band, surfing forums online anonymously as a child, trying myself out as a solo performer and working in different jobs with various kinds of people have contributed a lot to how I view myself and the world today. When I make artistic work, it often feels absolutely necessary to express a certain thing from my own point of view, and I am sure this goes for a lot of other artists as well. It depends on the work in question whether I need that thing I want to express to be understood by the audience: Self-expression can both be done entirely for myself — for instance to process emotions and experiences —, and to share something with others, as a way to open up, strengthen relationships or to bring across a point of view. Existing online adds another layer to how personalities develop — even if we are not aware of it. As Russell notes in her manifesto, becoming aware of this can open up important space though. Even more so if one doesn't seamlessly fit into mainstream society.

Today, popular social media platforms like *Instagram*, *TikTok*, or *Twitter* are very much entangled with our self-images. It makes sense; a lot of us have accounts, regularly check what is going on on there, and share messages, pictures, and other forms of content. However, these platforms are often commercially oriented and tend to reproduce existing societal norms and problems, and so many people have argued that what we are doing on these platforms is not *actual* self-expression.

An *Instagram* post by @versobooks cites a few polemic sentences from a book by Jonathan Crary. The first one is: "If there is to be a liveable and shared future on our planet, it will be a future offline." (Crary qtd. in post by @versobooks, April 18, 2022) Going through the comment section under the post, I read many critical voices. A user going by @crayfishfry points out that

while they “hate the internet for various reasons”, it is helpful for them to have internet access as a socially anxious person. They also point out that the internet is an important place for many due to accessibility issues. (@crayfishfry, April 18, 2020, comment on @versobooks 2022) As somebody, who experiences both social anxiety and a somewhat strong need for self-expression, I agree with this comment. In the attempt to get rid of my fears, it is crucial to expose myself to social life in the corporeal world, and for sure social media has the ability to amplify my anxiety. Still, having access to the internet in its many facets has played an integral part in getting to know myself better, which helps relating myself to other people. It is difficult to explain why, but it really feels like I have a deeper connection to online space because of my anxiety. It is important to note here that I don’t see the digital space primarily as a place to hide from the world, but rather a welcome extension, or another layer, that aids me in my process to open up.

On another note, Legacy Russell points out that there are indeed ways to use the commercial social media infrastructures for actual self-expression. She searches for and identifies ways to deal with the reality we are facing on these platforms, such as seizure and reclamation, (Russell 2020, 135) and *encryption*. (Russell 2020, 85) She asks: “In rejecting binary gender, can we challenge how our data is harvested, and, in turn, how our data moves? *Can we become useless, too?*” (Russell 2020, 67) Rejecting, or not having the choice to exist according to established societal norms, becomes a way of simultaneously heightening one’s visibility and encrypting oneself:

The (de)coding of gender becomes as much about how it is constructed as whether it can or cannot be read. Readability of bodies only according to standard social and cultural coding (e.g., to be white, to be cisgender, to be straight) renders glitched bodies invisible, extends safety, keeps bodies unsurveilled. Glitched bodies pose a very real threat to social order: encrypted and unreadable within a strictly gendered worldview, they resist normative programming. Illegible to the mainstream, the encrypted glitch seizes upon the creation of a self that, depending on the audience, can at once be hypervisible and simultaneously unreadable, undetectable. (Russell 2020, 85)

In other words, one becomes *unreadable* by escaping any established classifications within a society. Also, the effects of this encryption depend on the context and the reactions of one’s social surroundings, which cannot always be forecasted. Russell mentions that this can lead to making oneself vulnerable and that there is a certain danger in that. People don’t always have the best intentions, and that is as much true on the Internet as it is in the physical space. It is a tricky balance to find between being out there and vulnerable, and maintaining

one's own private, to some degree safe, space. In my project, I will apply some simple strategies in order to address this, some of which are already common practice in many web conferencing systems. There will not be a feed such as there is on platforms like *Facebook* or *Twitter*, but rather the communication will happen in one-on-one settings. It is of course possible to reject an invitation to connect with somebody. Before the start of each session, the participants will have to accept a code of conduct and have the possibility to send some sentences to each other in written form about whatever is important to them for the upcoming session.

Even though this project is not about social anxiety, I briefly want to come back to it and touch on a few thoughts as it naturally influences my decision making. As a socially anxious person, I realized that both online and AFK I have benefited a lot from one-on-one conversations and interactions. They help to build confidence and nurture connections with others, since to me, in many situations *less people* means *less stimuli*, less things to overthink. At the same time I gain a lot from performing my music in front of audiences in the corporeal world. Even though playing a concert can be stressful and often involves having many eyes looking at oneself, the combination of it being a challenge, and the intimacy that can build up between the artist and the audience through the music can be therapeutic. The feed on social media platforms can be seen as a possible equivalent to the stage in the physical space but it seems to have the opposite effect. Is it due to a lack of feeling connected to each other? L. M. Sacasas writes about an online audience that is dispersed through space and time, and “simultaneously ever-present but elusive” and argues that current-day social media expands what Erwin Goffman calls our *front stage* while shrinking the *back stage*. What he means is that our feeling of having privacy (being in the *back stage*) is getting diminished by the constantly lingering audience on commercial social media platforms, stimulating us to think of our lives as material to be posted online. (Sacasas 2019) He concludes:

[...] the experience of the self always emerges in relation to the media used to express it. These media are neither neutral nor interchangeable in how they give particular form to the self and circulate it. The question we should ask, then, is whether the distinctive experience of the self implicit in how we now communicate is conducive to our flourishing and to the cultivation of a more just society. (Sacasas 2019)

For these reasons, and because of my own experience, I am sceptical as to whether having a feed in a social network contributes to the feeling of togetherness and stimulates self-expression. Therefore I decided to focus on one-on-one communication in my project, as well as possibly smaller group interactions in the future in.

Keeping these aspects in mind and coming back to the beforementioned concepts that Russell discusses in her book, it becomes clear how each of us has a multifaceted personality

that can be read in different ways depending on the situation and context, and how we adjust our behaviour according to the media we are using. In the previous chapter I already mentioned via Sollfrank's writing how the conversion to data abstracts and simplifies our complex personalities and actions. Digital data always aims to make something quantifiable in discrete units, to break down complex things into simplified categorizations. Given that this is both true on a technical and a social level, I see a connection between this and Rob Horning arguing that the culture on popular social media platforms leads to a *narrowing of the self*. Furthermore: "Self-invention in social media that is perpetually in search of 'feedback' is really just the production of communication, which gives value not to the self but to the network that gets to carry more data (and store it, and sell it)." (Horning 2014) And, referring to Big Data, he writes: "The more data you supply, the more the algorithms can determine your reality." (Horning 2014) Continuing this thread, Simone C. Niquille notes: "More information does not necessarily lead to a more defined image." (Niquille qtd. in Russell 2020, 136) Russell elaborates that for Niquille the collection of data is not the main threat, because there still remains the possibility of *encryption*, as discussed above. To summarize: Today's technology does not provide the tools and categories to "read" everybody's identities, and what is sold to us as self-expression online doesn't always actually correspond to that. Horning notes:

Social media offer a single profile for our singular identity, but our consciousness comprises multiple forms of identity simultaneously: We are at once a unique bundle of sense impressions and memories, and a social individual imbued with a collectively constructed sense of value and possibility. Things like Facebook give the impression that these different, contestable and often contradictory identities (and their different contexts) can be conveniently flattened out, with users suddenly having more control and autonomy in their piloting through everyday life. That is not only what for-profit companies like Facebook want, but it is also what will feel natural to subjects already accustomed to capitalist values of convenience, capitalist imperatives for efficiency, and so on. (Horning 2014)

At the moment many of us don't really have a choice to opt out, so there is definitely a need to find ways to navigate bespoke platforms. On the other hand, commercial social media do not resemble the whole Internet. I also simply think we deserve better, and more attention should be given to efforts that try to create alternative digital spaces. Next to the *Fediverse*, and many other examples not mentioned here, there are also communities forming on *Discord*,³ which has initially been popular among *gamers* and is gaining popularity spreading in other

³ *Discord* is not open source but still leaves a considerable amount of configurability to the user. One can easily spin up an instance (so-called *Discord server*), invite friends and create text, audio and video communication channels on the server. Furthermore one can make use of bots that offer all kinds of functionality, including various accessibility options.

communities as well. Instances on both the *Fediverse* and *Discord* often, but not always, have a connection to communities in the physical world too. Examples are the *Mastodon*⁴ instance *lurk*,⁵ which has its base in the media and sound art scene of Rotterdam and surroundings, or the UK-based *Discord* server set up by the art critic duo *The White Pube*⁶ for fans of their writings. While both online communities have a connection to communities in locations in the corporeal world, they also utilize the ability of the digital space to allow for connection and exchange with people less geographically close.

The urgency for alternative digital spaces becomes even stronger in the light of the recent covid-19 pandemic, which has pushed social interaction more onto online infrastructures than ever before. The more urgent need for all of society to access online spaces sparked by the pandemic, and the many failed attempts to build online representations of events that were previously happening in the physical space makes it even more clear that the power of digital space is not its ability to create isolated virtual representations of the corporeal world. What I am interested in are the spaces, events, ways of interacting, etc., that wouldn't be possible to happen or exist if we were solely living in an offline world.

Sadly, for the reasons I have elaborated above, the current most commonly used online platforms and services are not utilizing this potential. The open source community has been putting a lot of effort into creating alternatives, and recently these alternatives have seen a big increase in users. Even though it certainly has its own pitfalls, I am generally enthusiastic about the countless things that are to learn from the open source world and I see this project as my first, small contribution to it. In summary, my approach for working on this contribution is heavily shaped by my own background, which includes a connection to sound art, experiences as a socially anxious person, a fascination with the multiplicity of people's identities and an interest in digital technology away from Silicon Valley.

Following page: Figure 1.1 Poster showing a map of the *Fediverse* made by Lidia Pereira, Artemis Gryllaki and Bohye Woo

⁴ *Mastodon* is an open-source micro-blogging software that is part of the *Fediverse*. Each *Mastodon* instance can communicate with other instances running *Mastodon* or other compatible software via two protocols called *Activity Pub* and *OStatus*. See figure 1.1 for a map of the *Fediverse*. (Pereira, Gryllaki and Woo 2020)

⁵ See <https://lurk.org> for more information.

⁶ See <https://thewhitepube.co.uk>

Macroblogging

Video Streaming

Audio Streaming

Publishing

Microblogging

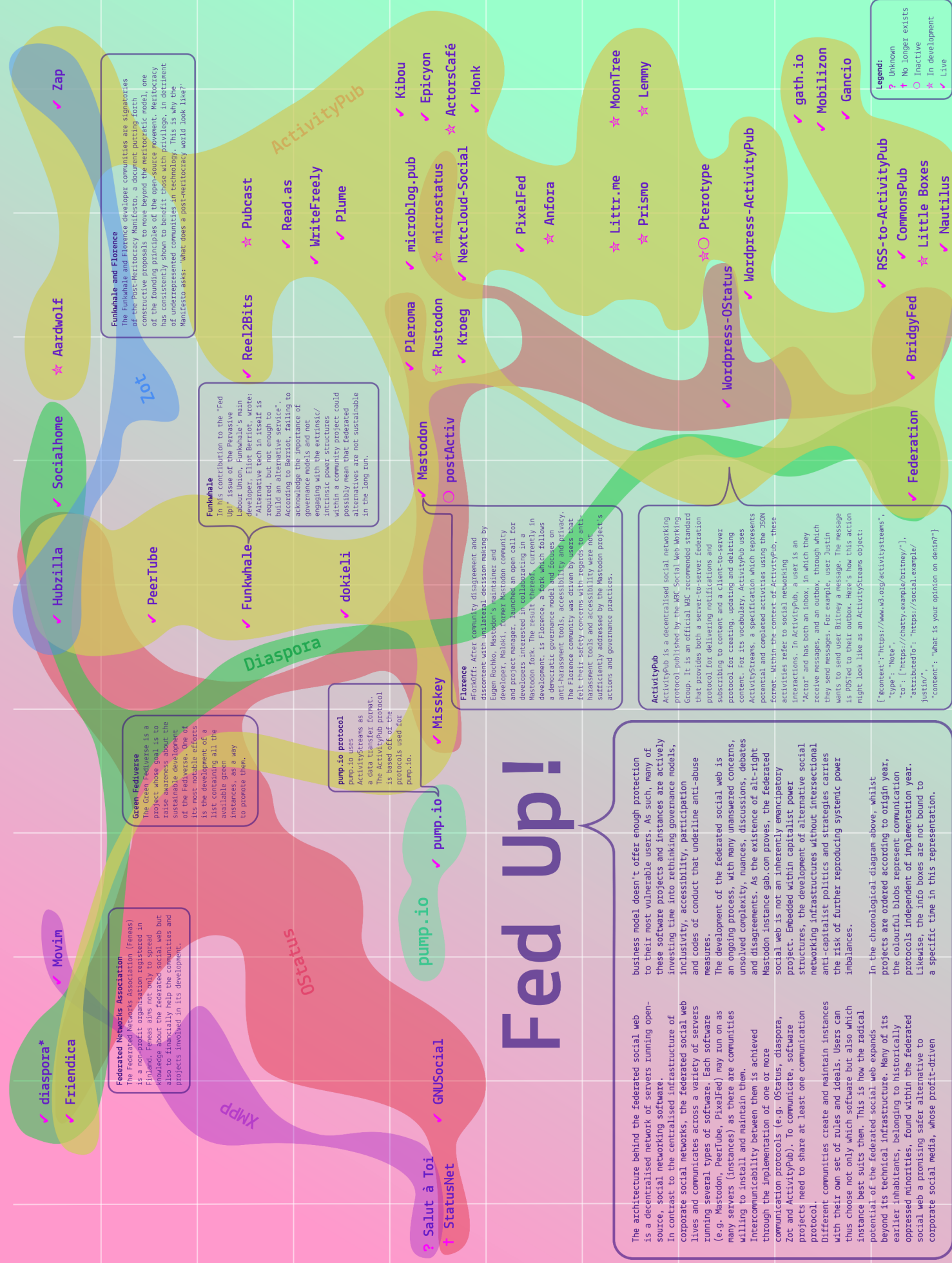
Image Sharing

Link Sharing

Plugins

Event Planning

Dev Tools



2

Thoughts about
user interfaces &
sound processing
in the digital realm

2.1 Interfaces and metaphors

In order to access digital space and therefore the internet, we have to make use of interfaces and programming languages. In interface design, especially when thinking about graphical user interfaces (GUI), the term *metaphor* comes up a lot. Though not always successfully, so-called *interface metaphors* aim to ease and speed up a user's understanding of the system in question. Simple examples are the metaphors of the *desktop*, the *hourglass* or the *trashcan*. (Richards et al. 1994, 73-74) Of course, a computer does not actually contain a desktop, nor are there any actual folders and files. Commonly, these terms are understood as representations of the respective AFK-objects and thus metaphors that are supposed to help the user understand what they can do with their system. (Drucker 2013, 113) However, the researcher Johanna Drucker argues that these terms — desktops, files and folders — are not so much representations as they are *behavioral cues*. We know that there is no folder in the computer, but because we know it as a physical object, calling a location on a computer's hard disk a *folder* helps us quickly understand what to do with it. (Drucker 2013, 215-216) Chun spells out: "Software provokes readings that go beyond reading letters toward the nonliterary and archaic practices of guessing, interpreting, counting, and repeating." (Chun 2005, 43) Drucker describes the notion of the interface as follows:

We have to understand interface as a constitutive boundary space, not just a place of mechanistic negotiation and exchange among elements. Interface is often defined as an encounter between systems. But that encounter need not be understood mechanistically. It could be understood ecologically, as a border zone between cultural systems, with all the complexity and emergent relations that suggests. (Drucker 2013, 216)

Furthermore:

Interface is a space of individual and collective subject formation. Our notions of privacy, property, identity, and even individual voice and self are modified constantly in the exchange, bound to the cognitive modeling of experience *through* experience. (Drucker 2013, 217)

This definition makes clear how an interface functions as a translator between two or more worlds, and at the same time creates new ways of thinking about and interacting with digital — or, thinking more broadly, cultural — systems. Even within a computer system there are multiple layers of interfaces: There is of course the GUI, as a way to translate between the digital and the human-readable. Another example would be firmware, which interfaces between the digital space and the physical hardware. Inbetween there are interfaces connecting

different programming languages and applications, such as an API (Advanced Programming Interface). In my project I will for instance make use of the *Web Audio API*, which interfaces between audio operations and the web browser. (mdn web docs 2022)

It is important to underline that while interfaces thus have a translating function, there is always something that gets lost in the process, and something else that is generated. Chun argues that “[...] for computers to become transparency machines, the fact that they compute — that they generate text and images rather than merely represent or reproduce what exists elsewhere — must be forgotten.” (Chun 2005, 27)

The choices made when designing a user interface play a crucial part in what kind of digital space we are constructing. What kinds of interaction will take place in it, and how? Who will feel addressed and “seen” by the interface, and comfortable to use it? As Drucker mentions, using an interface is a constant exchange between cultural systems. Similarly, Chun argues that “software produces users.” Not only are we conditioned by interfaces — Chun gives the concrete example of operating systems — to behave and interact in a certain way, but whole cultures, identities, and stereotypes are (re-)produced at the same time: We have a different image of a Windows user from a Mac user, or a Linux user. (Chun 2005, 43) Naturally, the designers of user interfaces, programming languages and digital systems in general, have a major influence on how this unfolds.

In *Glitch Feminsim*, Russell also brings up a series of sculptural artworks and an accompanying essay called *Black Goopy Universe* by American Artist,⁷ which are relevant for this thesis as well. The work addresses a prominent issue within the world of digital technology and specifically GUI design: It is populated and influenced mostly by white cis men. In their work, American Artist takes a look at the history of computing in the U.S. through the lens of Black Studies. In an interview about *Black Goopy Universe*, they explain:

To imagine something I considered in opposition to technology as we know it, I focused on qualities that stood in contrast to what we associate with our current devices ‘black goopy [is] antithetical to the values of the white screen. Black goopy might then be a platform of slowness (‘dragged time’, ‘colored time’), refusal, thought, complexity, critique, softness, loudness, transparency, uselessness, and brokenness.” (Artist 2019)

⁷ *American Artist* is the legal name of the artist. According to Russell, they changed their former name to introduce a degree of anonymity and to turn upside down the bias of Google’s “search engine optimization” algorithm, which prioritizes certain search results over others, pushing already established artists to the top. A search with the term *American Artist* previously yielded results like Andy Warhol, Jackson Pollock, Jeff Koons and the like — it is still the same now, but Artist’s website shows up right at the top. (Russell 2020, 114-115)

Revisiting two widely-known points in the history of the GUI — Douglas Engelbart's *Mother of All Demos* and Apple's later version of the graphical interface — which have been distinguished for their different aims, (Artist 2019) Artist argues:

The Mother of All Demos is extremely famous because it was the first example of a demo, and it displayed technologies that were extremely innovative at the moment. But these two eras, that of Apple and SRI are united in their humanistic approach which effaced subjectivity for an early form of freedom in technology. Though Steve Jobs and Engelbart were working at different moments they share a similar subjecthood by being white men in tech who are major proponents of 'innovation' as an inconsequential benevolent pursuit. The reason I associate them with one another in *Black Goopy Universe* is because the tools that Engelbart designed were eventually co-opted into the Apple Lisa. Their differing intentions are only significant under a framework that takes for granted the similarities they share. (Artist 2019)

Since there is no *general* in people, American Artist identifies the aim for objectivity in computer systems and their GUIs as a problem. This prompts the question: How can an interface be made to embrace subjectivity? Talking about their work, American Artist notes:

The decision to depict the user as unknowable to everyone visiting the gallery was to abstract what unknowability looks like, which wouldn't have happened if I had made a computer that was meant to only be used by Black people, for example. First of all, what would that even look like? Second of all, people would see it and assume they understood it. I wanted to convey this other space outside of our collective knowledge of how a device is supposed to be, that upholds its own eloquent logic that viewers want to understand. (Artist 2019)

Rather than going on the impossible pursuit to create a system that serves everyone, it seems more feasible to accept one's own subjective gaze, be conscious of it and address it in the process of designing a user interface. Through this kind of acceptance, I see a possibility for interesting ways of interaction made possible in the digital space; subjectivity does not have to be a negative thing, as long as it recognizes itself as such. Inevitably we are accessing the world around us through the interface of the subjective gaze; we can not turn that off, but we can become aware of it. American Artist states:

I agree that 'inclusion' is not an end-all method of attaining justice or repair, I'm just thinking about decolonization in the realm of technology, which reflects the patterns of society at large. While I agree that decoloniz-

ing technology as such is impossible I don't think that it shouldn't be thought about or even attempted. I think being dismissive toward any possibility of reconciliation also precludes whatever realities we might discover through that process. I would rather the designers of Silicon Valley drive themselves into a hole trying to reconcile their practices than to dismiss it as a non-viable option. I think the only ethical position in this moment for people with various privileges is a position of embarrassment or discomfort — the discomfort of acknowledging your privilege, the discomfort of knowing that reconciliation may not be possible, and the discomfort of attempting it anyway, that's what people should be prepared for. (Artist 2019)

Of course, my endeavour here is of a much smaller scale and different nature than what is worked on in Silicon Valley. However, the potential of artistic work to reflect on these points is big, since there is not really a (alleged) need for objectivity or universality in the first place. In fact, one thing I appreciate a lot about a work of art is learning about the artist's personal experience, and view of the world. As American Artist mentions in the interview, our individual positions in society influence everything we do anyways — we cannot escape it, and attempting to establish some kind of universality (in the sense of a *universal user* or *universal audience*) works rather alienating than unifying.

My position as a white, middle-class, socially anxious, afab⁸ and femme-presenting (however quite confused about gender), and queer person attempting to engage with the world of digital technology calls for a reflection on both my privileges and the obstacles I may find in my endeavour. My privileges offer me a considerable degree of ease in what I can do and which spaces I can access, but my anxiety and queerness, and sometimes femininity, can give me a simultaneous feeling of being out of place, which is hard to pinpoint. Applying this to my relationship with the world of digital technology, I think about the following: White middle- and upper-class people are overrepresented there, but women, queers, and non-binary people are not. So, for me, though I do not feel completely alienated, there is often something that does not feel quite right when moving about in the world of digital technology. Part of the reason is that some aspects of my background do not always match up with the “standard” user or developer defined by the predominant groups of people working with digital technology. At the same time, the privileges I hold are significant. Even though I cannot explain exactly why something *does not feel quite right*, it motivates me further to question the status quo and reality as it is at the moment, and engage with digital technology in a critical, experimental, sometimes uncomfortable and confusing way.

⁸ Abbr. Assigned female at birth

Coming back to American Artist's thoughts, I want to take note of another aspect of digital technology that connects to the notions of not being addressed and *non-standardness* in the context of user interfaces, which is *brokenness*. In *Black Goopy Universe*, Artist talks about inhabiting a space of brokenness. They give the example of using *iPhones* with broken screens, even though society tells us to get a new phone instead. (Artist 2019) Maybe it could also mean using buggy software, or making use of applications in initially unintended ways, such as using office programs to create visual artworks and designs. (Morishita-Leitner 2022) In the realm of interface design, one often stumbles upon the idea that a good GUI has to hide the underlying code, that it should be *robust*, and *easy* to use. (Kendrick 2005) *Robust* in this context means allowing "[...] for systemic function even when there is local failure," (Kendrick 2005) and *easy* refers to the interface being a self-explanatory, effortlessly functioning system. (Kendrick 2005)

In a recent article, Laura Maw compares web development and design to architecture in the physical space. Borrowing the term *horrible architecture* from Comaroff and Ker-Shing's book with the same title, she discusses the notion of brokenness in both realms:

Applying their suspicious gaze to the internet, familiar sites begin to suggest something sinister. Horrible architecture might best be read as an aesthetic framework for interrogating all contemporary structures; for identifying what Comaroff and Ker-Shing call the 'creeping unease' at the center of modern design, namely the anxious intolerance of deviance. By looking at this deviance directly, we become more alert to the mechanisms used to conceal it; and to the internet's fallibility, disposability, and ultimate mortality. (Maw 2022)

From the aforementioned book, Maw specifically re-uses the term *partially dead* — "structures that are partly inhabited, partly abandoned" (Maw 2022) — to describe the decay of online sites. A well-known example is the *404 page*: A part of an "alive" website, standing in place for something which is no longer there, or, *dead*. Maw, just like Comaroff and Ker-Shing, argues that capitalism is the cause for buildings and websites to partially die. Empty rooms in shopping malls indicate insolvent businesses — which are likely to be the smaller, independent ones, rather than big chains. Websites often become vacant for similar reasons: maybe nobody has time to maintain them, or there is no way to sustain them financially. (Maw 2022) In order to avoid content overload, web designers often try to conceal both these partially dead traits and the structure behind the graphical layer in general: "We are accustomed to this minimalist, uncluttered design [...] and jarred when the 'revolting technical interior' is exposed; minimalist design only renders the contrast between interior and exterior more pronounced." (Maw 2022) According to Maw, exposing the interior of a website reveals its

mortality and reminds us that, even though we tend to take the internet for granted, it needs lots of maintenance to keep running. Drawing on *Horrible Architecture*, she argues that when we are willing to look at *what lies beneath*, we recognize the machine; “what was already there, and what architects have scrambled to hide from view: chaos, uncertainty, and disorder.” (Maw 2022)

Could this revealing of underlying structures, which could be understood both as a *glitch* (Menkman qtd. in Maw 2022) and as *brokenness*, improve the relationship between humans and digital technology? A great amount of effort has been put into making human-computer-interaction as seamless as possible, removing the need to really understand what is happening inside the machine, but also maybe taking away a lot of curiosity that could be developed when interacting with digital systems. I wonder if getting accustomed with a less seamless digital space can make us feel less alienated with the machine. Yes, *less seamless* would mean that we might get distracted by errors, strange messages, and exposed chunks of code. Not everything might always work out of the box; things will take longer, and be tenacious. I have experienced these things while working on *glitchforest.online*, and while that has been frustrating at times, it has also made me learn a lot and let my gaze at digital technology and its social aspects change continuously. Of course, in some situations, such as medical applications, a software that does not work seamlessly is a huge problem. However, when it comes to social interaction, does it really have to be an issue? The physical space is not seamless either, after all, and neither are social interactions in general. I do not think that one approach is better than the other. Nevertheless, there is definitely a lot to explore in the less seamless realm. Glitches and/or more exposed workings of the software can be an opportunity for users to not only engage with each other, but also with the software itself, and maybe through this engage with each other in a different way, allthewhile learning more about the machines we use everyday.

One last aspect to touch upon in this chapter is the emphasis on the visual inherent in most user interfaces. If sound is part of an interface it usually either has a signifying function (Chun 2005, 43) — such as indicating errors or announcing the startup of an operating system — and/or is reaffirming what we see on the screen. In a reflection on Walter J. Ong’s thoughts in relation to media ecology, Paul A. Soukup argues that the audible — “[...] leaving us simultaneously more anxious and more connected to others.” (Soukup, 2005) — is less predictable than the visual. According to him, a distance between the visual object and the viewer is required in order to experience it, a separation, which Soukup states gives us more control. He writes that this “[...] emphasis on control leads us to a world of things [...], rather than a world of presence.” (Soukup, 2005) Closing our ears is far more difficult than closing our eyes, after all. An interface that unexpectedly makes sounds can feel eerie to the user, and often this results in trying to prevent the sound from happening again. I am guilty of this myself, having

all the sounds of my operating system turned off. *glitchforest.online* does not have any system sounds either in order to keep distractions for users at a minimum.

In the online space, apart from being integrated into an interface, sound also appears as *content* on social media platforms and other websites (i.e. in video snippets on *Instagram*, or music uploaded to *Bandcamp*), or as a communication medium (i.e. calling or sending voice messages). Obviously, the latter plays an important role in my project. I found myself surprised when someone told me in conversation that they were not aware of how everything sounds differently when we communicate online via commercial conferencing software, as opposed to in the corporeal world — is this also an effect of the aim to “smooth” and ease the user’s experience when interacting with digital systems, of hiding the software’s workings and establishing a widely unquestioned status quo?

As mentioned already, the world has been impacted by a pandemic recently, which resulted in most people having to stay home for long periods of time. This has led to a rapid improvement or, for that matter, increasing *smoothness* of commercial and open-source web conferencing services. Thinking back to my experience with these platforms pre-pandemic I remember that using them felt way more unstable. Glitches, time delays, and frequent disconnection constantly reminded me that what I was hearing in the digital space was very different from what I had heard if the conversation had taken place AFK. Connecting with other people online still feels fragmented in time. However, this fragmentation has become less *in your face*. The amount of experienced fragmentation or continuity of the user has influence on the overall atmosphere of the call itself and the software in question. This does not only depend on things such as network quality, glitches, etc., but is also influenced by decisions of the developers and designers of the software. For example, if a user has an unpaid account on the video conferencing platform *Zoom*,⁹ they can only host meetings of 40 minutes at a time. Therefore, longer meetings are being split up in smaller units.

With some softwares, such as *jitsi*¹⁰ and *BigBlueButton*¹¹, users can also choose to host their own instances for personal or even public use. This requires more engagement with the underlying code and the general working of online communication itself, which results in much more time spent engaging with the software. For my project, I have also tinkered with the set up of a server. Hosting my own server gives me more options to test out different softwares and development approaches. As I will explain in more detail in chapter three, finding out which software and APIs to use was not a smooth process though, and after a long time trying to implement my ideas with an instance of *jitsi*, I decided to build my system using use

⁹ A proprietary web conferencing software. See <https://zoom.us>

¹⁰ An open-source web conferencing software. See <https://jitsi.org>

¹¹ An open-source web conferencing software mainly designed to function as a virtual classroom. See <https://bigbluebutton.org>

the *WebRTC API*,¹² which made it easier to implement the most audio processing features that I wanted to include in the project. Similarly, at first I planned to host a physical server at home, but ended up renting space on a shared machine via the provider *digital ocean*¹³. Again, this has made it simpler to set up and maintain the server while leaving enough freedom to implement my system.

2.2 *Layers, Walls & Voids*: The interface as an artistic tool

Put into a broader context as suggested by Johanna Drucker and discussed in part 2.1, the notion of the interface can take on many forms. A more conceptual understanding of the term, rather than thinking of the interface as a *thing*, can be a fruitful tool in artistic work. In *Layers, Walls & Voids*¹⁴, an around 33-minutes-long audiowalk I made in 2020, sound is used as an interface to alter my experience of the environment around me. During that time, a hypersensitivity to sound combined with having to stay at home due to the pandemic resulted in an insufficient ability to sleep. This put me into an unpleasant mode of experiencing my surroundings. Because there was no way to escape the situation in the short term, *Layers, Walls & Voids* became a way to deal with it. The work is supposed to be listened to on headphones at a volume that lets the listener hear their physical surroundings as well. Over the course of

Instructions

Feel free to use your whatever headphones are available to you. (preferably open ones)

Make sure you can still hear the sounds in your surroundings while listening to the soundwalk.

There is no universal starting point. Just start in any location you want to.

Please listen for the amount of ticks in order to identify the number of the instruction.

Press play.

1. Find a comfortable spot (inside or outside) and take a few minutes. Look around you — what do you see? Can you hear any things familiar to you, or any new sounds? Try to listen and watch less and less attentively.
2. Start walking around. You can head towards any direction, or just run around in circles.
3. Sit down and wait.
4. Is that a bee flying around your head? Let's follow her!
5. Stop and close your eyes.
6. Start walking back to your initial point of departure.

Figure 2.2 Instructions for listeners of *Layers, Walls & Voids*

¹² An open-source *JavaScript* API that is used to build real-time communication systems that run in the browser. See <https://webrtc.org>

¹³ A provider of cloud computing mainly aimed at developers. See <https://www.digitalocean.com>

¹⁴ The full soundwalk is included in the *sound_examples* folder. See *layers_walls_voids.wav*.

the piece its sounds merge with, block, or leave space for the sound of the listener's environment, hopefully turning annoying noises into interesting rhythms and soundscapes, drowning them out, or drawing the listener's attention to noises they had not recognized before. Not only does the finished piece interface between the sonic environment and one's experience of it, but also the process of working on the audiowalk allowed me to approach the sounds of my surroundings differently. The difficulties did not vanish of course, but by being in the process of developing this sonic interface I could approach my environment in a slightly different way. Rather than "accessing" the sonic environment directly, I began hearing first and foremost through the ear of a sound artist (the interface), and only secondly as someone overwhelmed by sound.

2.3 Digital sound & signal processing in the context of online communication

Both in the worlds of online communication and sound art, signal processing plays a central role. While in sound art it is mostly applied to explore creative possibilities, in online communication it is both a necessity and a way to enhance user experience. When we start making sound art or playing music together over the network, this role is often reversed: echo cancellation, noise suppression and filtering — which are intended to improve speech intelligibility in web conferencing systems and prevent audio feedback from happening — start to interfere with the music and behave in unexpected (as well as expected) ways. An example: As stated in a post in the *Microsoft Tech Community Forum*, the video conferencing software *Microsoft Teams*¹⁵ seems to only let the loudest person at a time be heard in a meeting with a large number of participants. (EmmaLewisMHPA, March 25, 2020) Most, if not all online meeting applications have some kind of noise suppression and echo cancellation algorithm implemented, which in some cases can be turned off, in others not, and most of the time it cannot be modified or adjusted. Furthermore, network issues and time delays that always happen in online communication affect the sound that travels over the network, leading to glitches, decrease in audio quality, or layering of different voices.

Another signal processing method that is important for communication technologies and pervasive throughout various kinds of media is compression in its various forms. In networked audio communication, compression is necessary to preserve bandwidth, so that large numbers of users can communicate at the same time. As is outlined in a text by Jonathan Sterne, there are two different kinds of compression in the realm of audio signal processing:

¹⁵ A proprietary web conferencing software for corporate contexts and since the start of the covid-19 pandemic widely used in schools and universities. See <https://www.microsoft.com/en-us/microsoft-teams/group-chat-software>

data compression and dynamic range compression. Data compression refers to how much data can be stored in the transmitted signal or file in order to represent the original signal. Dynamic range compression refers to the relations between different amplitudes within the signal. The former can be used to keep a signal as lightweight as possible, while the latter makes it possible to increase the overall volume of a signal without increasing its peaks, which can cause clipping, and therefore gives the signal a more uniform amplitude. Sterne puts it simply: compression accommodates a signal to use a certain infrastructure. (Sterne 2015, 34) For example, since we are at the moment still dealing with bandwidth limitations (especially as regular users with internet subscriptions at home, or data plans for our phones), we need to make sure that the transmitted signal doesn't exceed a particular amount of data. He adds that compression not only gives *signals* the ability to travel over certain infrastructures, but it also transforms the *infrastructures* themselves through giving them the (new) ability to transmit these signals, without having to change the infrastructure as such. (Sterne 2015, 34)

However, compression is not always implemented merely as a necessity: The audible effects caused by it can be used as an artistic tool as well. Fellow *Sonology* student Alec Gordon has already explored what can be done with this idea. In his master's thesis he writes about his first experiments with the matter: "[...] The result is some kind of disturbed version of *I Am Sitting In A Room*,¹⁶ however what we are drawing out is not an invisible fragment of physical space, but the aesthetic decisions involved in the definition of a compression software. What is heard is instead the fragments of arbitrary decisions about exclusion [...]" (Gordon 2021, 44-45) He describes that after applying multiple layers of compression to a recording ripped from youtube, "[...] silence becomes white noise. In some versions the higher pitched notes turn into square waves, and analysis of the waveforms show them becoming more simple and regular. As degradation increases the voice sounds like more of an outline of a voice, recognisable through symbolic association [...]" (Gordon 2021, 44)

Recordings I made myself via the web conferencing software *Zoom* showed further characteristics of compression and noise cancellation in the context of online communication. In these recordings, I started a *Zoom* call between my computer and my phone. I then set up my computer to record the call and took my phone outside on a walk. Since the recordings do not feature a main conversation, but a lot of background noise from the street and the supermarket, I could hear effects that I hadn't heard before on regular video calls. For example, I realized that the recording alternated between a moment of cancelling out all sound and another moment of letting sound through at a constant rate. It resulted in a kind of frustrating pulse

¹⁶ *I Am Sitting In A Room* is a widely known piece in the field of sound art and experimental music by Alvin Lucier. The piece consists of Lucier recording himself while reading aloud a text, and subsequently playing the recording over speakers in the room, which is recorded again. He repeats this until his voice is not recognisable anymore and what is left are only the resonating frequencies of the room.

switching between loud noises and complete silence (Figure 2.3). There are also a lot of artifacts in the recordings, and of course, anytime there was a clear human voice appearing on the call, the software would cling onto it.¹⁷

In the context of the development of digital technology, progress is often associated with being able to capture, store and process high amounts of data in order to digitally represent corporeal reality as clearly as possible. According to this narrative, compression does not contribute to “realness” in digital technology. However, as Sterne argues, this notion of reality persistent in the narrative of technological progress has less to do with reality itself than with *realism*, and: “[...] realism is not reality [...]”. (Sterne 2015, 33) Sterne mentions an earlier idea by Marshall McLuhan: “Intense experience shaped by limited definition,” (McLuhan qtd. in Sterne 2015) where *definition* corresponds to the amount of data in a signal or file. McLuhan developed the notions of *hot and cold media*, where *hot media* refers to *high definition* (= lots of data available to represent something in the signal), and *cool media* to *low definition* (= little data available). He explains that while high definition is “[...] the state of being well filled with data,” low definition leaves varying degrees of space to be filled in by the perceiver. (McLuhan qtd. in Sterne 2015) Therefore, *cool media* can make possible an experience that might not accurately represent reality as we know it from the corporeal world, but one that asks from the user to give their own input and interpretations of what they are presented with. From this point of view, *cool media* can make us aware of how digital technology shapes and creates reality, rather than just representing it.



Figure 2.3 Close-up of the waveform of the example recording depicted in Audacity

Sending audio over the internet in real-time communication systems always adds some uncertainty and instability, and it is not always possible to know what the person on the other end hears exactly. This uncertainty is further influenced by the choice of software and the technical equipment — such as headphones, speakers, and microphones — used by the participants of the conversation. While this can be quite annoying when one wants to have a work meeting or play a piece of music, in terms of having private conversations or more experimental ways of playing music together over the web, it is less of a problem and can even become an interesting part of the exchange. Many artists appreciate glitches and unexpected behaviours anyways, and it can be interesting to figure out with the call participants how and what everyone is hearing over the network.

¹⁷ See *example01_1_zoom.wav* and *example01_2_zoom.wav* in the *sound_examples* folder. Pictured is *example01_1_zoom.wav*.

An example of artistic work that embraces in particular the time delay (latency) that occurs in networked performance are the projects of my teacher Rebekah Wilson. She has worked on multiple types of academic and artistic work around the topic of latency and *togetherness* in networked performance. Her composition *F not F v3* involves two pianists (including herself) in different locations playing together via a custom *WebRTC* application. They follow a digital score, which involves a machine listening algorithm that listens for specific phrases in the music and whether both musicians are playing these approximately at the same time. Whenever such moments are detected, the machine triggers parts of a soundtrack. Because of the time delay of the signal on each receiving end, the harmony of the piece differs depending on the location one is listening at. Therefore, Wilson explains, there are two equally valid versions of the piece each time it is performed. She notes that for the musicians the score functions as a facilitator of trust and gives them “a sense of being together in time”. (Wilson 2019) While Wilson openheartedly accepts and incorporates the inevitable existence of latency in networked music performance, in *F not F v3* she does appear to aim for *high definition* in the sense that the performance is conducted over a connection with high bandwidth and as little compression as possible.

Especially since the covid-19 pandemic happened, artists have been looking for ways to achieve the highest sound quality and as little interference/processing as possible in their online music performances. In my project, I will accept the conditions of the network while trying to keep as much control as needed (and as I am able to exert with my limited experience) to keep the system running. Part of this acceptance is trying to make the most of the use of the online space in a way that distinguishes itself from the AFK realm, rather than trying to

**INFODESK
PROGRAM
CONFERENCE
WORKSHOPS
MAINSTAGE
EXHIBITION
FOOD
PATIO
AMRO20**

AMRO 2020
OF WHIRLPOOLS AND TORNADOES
May 20th–23rd, 2020

ALL DIGITAL EDITION
This year AMRO will take place in dedicated online spaces! All talks and performances will be livestreamed, while workshops will be taking place in BBB.

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Figure 2.4 Screenshot of the AMRO 2020 festival website

mimic corporeal world communication and performance. On *lurk*, Alex McLean recently initiated a conversation about online events: He argues that the covid-19 pandemic has made them less enjoyable because the ambition of these events to mimic offline gatherings often results in “exhaustion with overloaded programmes ‘moved online’ often in an inhumanely intense way.” (@yaxu@post.lurk.org, May 18, 2022) I am sure most people, who have experienced days of online lectures and meetings during the pandemic would agree. I think part of this exhaustion is caused by the software trying to not put itself to the foreground: Users are not stimulated to engage with it, it is rather just a means to an end, or even an annoying barrier inbetween us. While in my opinion this is true for most web conferencing software — and amplified by monitoring features such as *MS Teams*’ function to export an attendance list that shows for each participant when they have joined the call, and how long they stayed — there are also examples that have succeeded in creating engaging environments for events in the online space. In 2020 I attended the *Art Meets Radical Openness (AM-RO)*¹⁸ Festival for example, which included live-streamed presentations and concerts on their website, a chatroom to hang out in during the streams, workshops given via *BigBlueButton*, an exhibition in a custom-made online environment as well as recipes for a festival menu that participants were invited to cook at home each day. (See Figure 2.4) Due to the covid-19 pandemic the whole festival was happening online and to my surprise, it succeeded in taking my mind off for a bit of the circumstances at the time. The combination of different digital environments utilized in the festival definitely contributed to making it an engaging experience. In 2022, another edition of the festival¹⁹ was held in a similar manner both offline in Linz, Austria and in the digital space. Another example is the recent *UnTechCon uncoference* organized by *Geeks for Social Change*. As their website states as of December 2022, they are a research and development studio with a priority laid on digital inclusion. The *unconference* took place on the studio’s *discord* server and distinguished itself from a usual conference by not having a pre-planned line-up of talks and presentations. Rather participants were encouraged to write down topics and projects they would like to talk about into a timetable on the morning of the event. The timetable was editable by all attendees. This allowed for an informal atmosphere and the chance to formulate and discuss both open-ended thoughts and completed projects. The advantage of having the *unconference* happen on *discord* were the software’s accessibility features (such as real-time speech-to-text transcription), the possibility for people with an internet connection from anywhere in the world to join, and since *Geeks for Social Change* use their server also outside of the *unconference*, attendees could stay and keep in touch with the community. (Geeks for Social Change, 2022) These two examples underline once more what Sterne has outlined in the beforementioned text; namely that a *high*

¹⁸ See <https://gateway.radical-openness.org>

¹⁹ See <https://art-meets.radical-openness.org/program>

definition approach, in whichever sense possible, does not automatically contribute to making an experience feel *real* and graspable. Therefore, I am not afraid of audible glitches and a kind of sonic “roughness” in my work, on the contrary. Based on my experiences I think while encountering these imperfections is often frustrating, accepting them and consciously incorporating them into artistic play and work can open up another way of connecting with each other in digital space.

Finally, I would like to focus a bit more on digital signal processing in a musical context. Outside of the realm of making music, there are not many wide-spread use cases of signal processing that is implemented in online real-time communication for creative experimentation rather than speech intelligibility or other technical reasons. Some gamers and youtubers use so-called *voice modding software*²⁰, which allows them to modify their voice in order to represent a certain character. For example, there are youtubers, who live-stream themselves making a prank-call on defrauders. They use voice modding software to for example invoke the impression that they are seniors, since older people are often the target of online frauds. This use case does not really serve a purpose of self-expression though, since the user applies the software to slip into a character rather than exploring parts of their own self.

An example in which signal processing is used in an online context, that comes closer to what I am envisioning when thinking about *glitchforest.online*, is Caroline Polachek’s 2020 performance²¹ at 7 by 7, A.G. Cook’s pre-release online event held via *Zoom* for his album 7G. In the video — it is not clear if she was recording herself or calling in live, but the latter seems to be the case — Polachek is seen walking through the streets of a city singing to herself and the audience through the microphone of her headset. Not only her voice can be heard, but also sounds appearing in her environment, such as screaming ducks in the park that she screams back at. About halfway through the performance, audio processing is introduced on the signal picked up by the microphone, effortlessly expanding the narrative of Polachek walking through the city and interacting with the surroundings by trying on different voices and wrapping the sonic environments in different atmospheres. Polachek’s choice of microphone makes the performance feel intimate and almost casual, while the vocals she is performing and the applied processing simultaneously make it sound flamboyant.

During my own try-outs, there surfaced a tendency of microphones built into some devices such as laptops and cheaper headsets to pick up sounds with a large high-frequency content. Furthermore, the microphones themselves often introduce noise and are not

²⁰ The first example on my *Google* search for voice modding software was this: <https://www.voicemod.net>

Even though the company advertises the software as a tool to express oneself, I have mostly witnessed such applications being used as a gimmick rather than an environment that invites to play with one’s self-expression. However, I do not preclude that the software is used for self-expression as well.

²¹ See <https://www.youtube.com/watch?v=wtdbqKVd5cA>

particularly directional, thus pick up a considerable amount of environmental sound. My headset's microphone also tends to introduce a considerable amount of distortion. Obviously, in the case of listening on speakers, there is a moderate to high chance of audio feedback involved depending on the distance of the speakers to the microphone. Sometimes this results in a reverb-like effect. All these aspects, as well as the sonic characteristics and glitches mentioned earlier in this chapter, function as limitations in my work on *glitchforest.online*, as well as a musical roadmap that has inspired the choice of processing methods to be incorporated into the project that will be outlined in chapter 3.2.



Figure 2.5 Still of Caroline Polachek's performance at 7 by 7 (Screenshot taken from YouTube)

3

Building

glitchforest.online

3.1 Technical aspects, the role of the interface and methods of interacting with the system

After the long struggle with trying to implement my idea with *jitsi*, I decided to get rid of it entirely and build the system²² with the following parts: All code I had to write myself was written in *JavaScript*, *HTML* and *CSS*. All matters related to establishing and maintaining a connection between users are taken care of by the *WebRTC API* as well as a *websocket*²³ server that runs in a *Node.js*²⁴ environment. If the circumstances allow it, users can connect to each other peer-to-peer. In case this is not possible, *Coturn*, a *STUN/TURN* server²⁵, takes care of maintaining the connection. The website is served to the user by *Nginx*, which is a widely-used webserver software. All this software is open-source. In order to set up all these things, I followed several tutorials²⁶ and used some code examples²⁷ I found online.

The audio processing on the client side happens via the *Web Audio API*, where the processing happens in so-called audio nodes. I used both existing nodes that come with the API as well as an implementation of a phase-vocoder by other developers²⁸, which I am planning to adjust in the near future to be able to produce other interesting sounds. In chapter 3.2 more attention will be given to the audio processing methods used. The *WebRTC API* also makes it possible to choose between different audio codecs before starting a call, and define limits for bandwidth and bitrate.

Building *glitchforest.online* has also made me aware of problems in open source. The process of figuring out which softwares, APIs and programming languages to use has taken very long. One reason for that is that while a large amount of open source software is freely available on the internet, in practice it is not always easy to understand how to use those resources. Sometimes a software is so far developed that for someone unexperienced, there are too many layers to uncover in order to modify it. It also makes a big difference how structured

²² The website can be accessed via <https://glitchforest.online>.

²³ The *WebSocket* protocol is a protocol for bidirectional communication between devices. In order to establish a peer-to-peer connection between two users, the *WebRTC API* makes use of a technique called *signaling*: the client devices send data to the *WebSocket* server, which in turn establishes the connection. It is also possible to use other protocols for signaling. (mdn web docs 2022)

²⁴ *Node.js* is an open-source asynchronous and event-driven *JavaScript* runtime that is popular in networked applications and makes it possible to write back-end code in *JavaScript*. (Node.js, n.d.) See https://www.w3schools.com/nodejs/nodejs_intro.asp

²⁵ A *STUN/TURN* server is necessary when the connecting devices are behind a *firewall* and/or *Network Address Translator (NAT)* — in other words, any device that sits behind a router.

²⁶ Among others, I followed https://developer.mozilla.org/en-US/docs/Web/API/WebRTC_API/Signaling_and_video_calling and <https://homebrewserver.club/server-support-for-audio-video-calls.html>

²⁷ For the most influential code examples, see <https://github.com/mdn/samples-server/tree/master/s/webrtc-from-chat> and <https://webrtc.github.io/samples>

²⁸ See <https://github.com/olvb/phaze>

and extensive its documentation is (or if there is one in the first place), and if there are forums or other channels that are welcoming for people to ask questions. Another very important aspect: who is actually making use of the resource? One issue I ran into when trying to work with *jitsi* for example was that I could not find anyone else with a similar approach or mindset. It makes sense, since it seems that *jitsi*'s main use cases are work meetings, online classes and the like. In general, most things that have to do with digital audio communication are built and talked about with an engineering mindset rather than an artistic one. Furthermore, knowing which questions to ask in order to find out what is the best software, APIs, libraries, and other components to use in one's project is a skill of its own right. The user forums of open-source projects are often not the friendliest places to be, especially not as a beginner, which makes it harder to figure out where to start. Also, the open source world as well as the realm of software development in general comes with its own way of describing systems — including the words themselves but also the logic behind them.

Coming back to the technical decisions I settled with: Changing my toolbox from a fully built software such as *jitsi* to a set of lower-level components has made it easier to implement own ideas; while in a software like *jitsi* things are done according to a certain way of thinking, this is also the case with for instance the *WebRTC API*, but they are less set in stone because it was made for people to build their own audio/video communication systems, rather than being a fully developed package ready to deploy on one's server.

The design of *glitchforest.online*'s user interface is heavily inspired by the command line/terminal. In order to implement this in *JavaScript*, I used and adjusted some code that was made available online.²⁹ The decision to implement a terminal-like user interface was influenced by multiple considerations. First of all, it was a main priority to keep the visual aspect of the website as simple as possible in order to move the user's focus to the sound aspect. In a live performance, the performer's screen could be beamed on the back wall in order to give the audience some context about what they are hearing. In this case it is also important that the visual does not distract too much from the audible. The perfect scenario for me personally would be if the listeners at first watch what is happening on the screen, but then gradually lose interest in what is going on visually. The screen can be there as a backbone, a place to come back to and (re-)gain an overview of what is happening, but it should not be the protagonist of the performance.

Secondly, a terminal-like approach also naturally eliminates the need to use a mouse. I often find typical motions that come with the use of a mouse counter-intuitive when it comes to live music-making. An example is having to move a cursor to the top of a button in order to click it — unless the motion of the cursor is linked to some kind of change in the sound, I ex-

²⁹ See <https://github.com/Apthox/Javascript-Terminal/blob/master/terminal.js>

perience it as a tedious extra movement. I also have a personal affinity with the command line – working with it has become a hobby throughout the past years. The final push to decide on this approach came from a workshop I attended in September 2022 at *Varia*, which was focused on plaintext protocols. (Berends and Tirthdas-van der Kleij 2022) The main aim of the workshop was to try out and learn about old and new ways to communicate with each other via plaintext. In a communal session on the terminal, we looked at various protocols and browsers that can be used to chat, play games and publish writing.

One of these protocols, the *Gemini protocol*, especially caught my attention. *Gemini* is a “modern-day” version of *Gopher*³⁰ and accessed via command line browsers or GUI clients. We discussed how its development radically differed from that of the nowadays widely used *HTTP* and *HTTPS*³¹ for instance. While the creation of *HTTP* was started at *CERN*³² and subsequently evolved through an institutional process of *IETF* and *W3C*³³ members submitting, reviewing, and eventually implementing so-called *RFCs* (requests for comments)³⁴, the development of *Gemini* was started by just one person, with a bit of input from the community. Anecdotaly, its initial developer and “benevolent dictator” (Project Gemini 2021) *Solderpunk* had a somewhat strong vision of how the protocol should look like and would prioritise this vision over user requests. (Danny Tirthdas-van der Kleij and Manetta Berends, Conversation with author, September 16, 2022) While the decline of *Gopher* has been partly attributed to a similiar attitude by its developers, (Lee 1999) *Gemini* is increasing in popularity at the moment. Maybe it is due to the different era during which it has been built? *Gemini*’s lack of certain features that are deeply integrated into the space that we currently access via *HTTP* – think for instance of tracking users’ activity, “[...] pop-ups, obnoxious adverts, autoplaying videos and other misfeatures of the modern web” (Project Gemini 2021) – facilitates a completely different atmosphere and modes of interaction than is commonly associated with today’s *WWW*. Similiarly to *Gopherspace*, navigating *Geminispace* to me feels more like accessing a big filesystem or exploring the floors of a large building rather than the experience of browsing the web, which is shaped by using search engines and social media. Also, due to the limitations inherent in *Geminispace*, there are less distractions to fall for.

³⁰ *Gopher* is a protocol that – in contrast to *HTTP*, which is built around the *HyperText Markup Language (HTML)* – operates in plaintext and was popular before *HTTP* became the main protocol for information exchange over the Internet. While *HTTP* makes it possible to link any webpage or file from any other page, *Gopherspace* is navigated via so-called *Gophermaps*: sepearate menu files that contain pointers to different documents in the network. (Lee 1999)

³¹ *HyperText Transfer Protocol* and *HyperText Transfer Protocol Secure*

³² *European Organization for Nuclear Research*

³³ *The Internet Engineering Task Force* and the *World Wide Web Consortium* are standards organisations for the Internet.

³⁴ The practice of *RFCs* was established by researchers at the *Network Working Group*. They were involved in the process of building the *ARPANET*, which predecided the *World Wide Web (WWW)* as we know it today. *RFCs* were meant to structure the process of sharing and agreeing on ideas while preserving some informality. (Abbate 1999)

Something I enjoyed about the workshop was how the digital and the physical were brought together. When I started writing this thesis, I saw the connections between online space and offline space most clearly between life on social media and life in the physical world. During the workshop we, the participants and the facilitators, were all in one physical room together and accessed digital space each on our own computer — however we had all joined a communal session in the terminal, which meant that we could observe each others' movements in the digital space. Sometimes it was possible to tell who did what action on the terminal, or sent a message to everyone, but sometimes it was not, which brought up a kind of humourous mystery. Because we were also physically together, the back and forth between digital and corporeal was more immediately graspable than usually.

When someone visits *glitchforest.online*, the users most probably will not be together in one physical space (even though it is possible of course). However, since there is no echo cancellation or noise reduction enabled by default, the users should be able to hear each other's sonic surroundings to a certain extent, depending on how loud the sounds of their environment are.

The choice for a terminal-like user interface is also a compromise between keeping some familiar elements in the design and completely reimagining what an interaction between a user and an audio communication software can look like. Although during my research I found out about a few projects that were implementing an audio communication application on the terminal³⁵, I haven't yet come across such a software that is actively being used by a bigger or smaller user-base or has some kind of culture around it. For now it is a bit beyond the scope of my project, but I am curious to see how other people will use my system, and how often, or if it will just as remain my own little niche-thing. What I find relevant to note here is that on the one hand, like *Solderpunk*, I am also making decisions largely by myself. On the other hand, I am building my system from scratch but started from algorithms, code examples and APIs that other people have made. As many people have said before, these collaborative aspects and interdependences are integral to developing an open source project and open source culture in general. By deciding about which code to integrate into my project, I also accept certain decisions that have been made by others, which in turn shapes the system I am making.

The limitations of *jitsi* caused it to not be usable for my project because the way it accesses the users's microphone signal proved too difficult to modify for me. Therefore I could not add any audio processing algorithms. Using the *WebRTC API* made implementing the processing much simpler, but other things more complicated. For example, my current implementation only allows two people to establish a connection at a time. This limitation is much less problematic, especially since the serverspace I am renting would easily become over-

³⁵ See <https://github.com/guisousanunes/sipcmd2>

loaded by more users, and there are other considerations about having one-on-one sessions as outlined in chapter 1.2. Furthermore, establishing a connection between two users with my *WebRTC* implementation has proofed to be more tricky than via *jitsi*.

Unfortunately, I did not entirely succeed in escaping big tech, since the *WebRTC API* — even though it is open source — was initiated and written by *Google*, *Ericsson* and others. (World Wide Web Consortium 2021) For now, I am accepting this trade-off because it has allowed me to learn about the technology and start building a system according to my own ideas. Because I have almost no experience with web development, I probably could not have finished the first version of the project in time without this API. While I am not completely sure yet what my position is concerning the fact that the *WebRTC API* was made by big tech companies, for future iterations of *glitchforest.online* it is my goal to find out what other ways there are to make online audio communication systems that are not based on code developed by big tech companies.

Another aspect I want to elaborate on is the choice of implementing the project as a web-site that is to be accessed from a browser via *HTTPS*, as opposed to having a stand-alone client or simply having the software run on the command line itself. Something that is important to note upfront is that it was not necessarily the goal to one-on-one replicate the command line in the browser. I wanted to have the option to integrate elements into the interface design that one wouldn't normally find on the terminal, such as the ability to place elements freely and not always having to follow a strict top-to-bottom timeline. Also, the idea of the terminal brings with it a certain language, which I was not eager to use but is common in programming; A language borrowed from the military or a factory unit — think of the words *command*, *execute*, *function*, *shift*, and so on. (Murray-Browne 2022) Thinking about which terms to use instead of the beforementioned is an ongoing process because I am myself used to this lan-

<i>wander-off</i>	←	leave the conference/hang up the call
<i>invite</i>	←	invite someone onto the call
<i>yes</i>	←	accept the call
<i>no</i>	←	reject the call
<i>action</i>	←	command related to the call/the connection between users
<i>movement</i>	←	command related to the audio processing
<i>forest/space</i>	←	the room/conference

Table 3.1 List of terms used in *glitchforest.online*'s user interface

guage. Table 3.1 shows the expressions I came up with with for now, as well as their corresponding meanings in typical web conferencing or programming terms.

When presenting the project to an audience, it will be an advantage to have the client run in the browser, because having audience members load a website in a browser often needs less troubleshooting than installing a new software on a personal device. Another thing to note is that, having grown up with websites and browsers, I am myself somewhat more familiar with that kind of technology rather than the workings of clients that run outside of the browser. It is also important to mention that the website aims to be accessible to both people experienced and less to non-experienced with digital audio processing. There is a glossary that can be opened with the ? key, and when initiating a processing method, a short explanation appears on the “terminal”. Throughout the experience of navigating the site, there are textual instructions and explanations guiding the user.

As far as aesthetic decisions are concerned, I chose a black background as is typical for terminals, as well as neon green lettering and icons. The green colour is also a small hint towards the domain name and project title *glitchforest.online*, which is a general inspiration for the atmosphere of the site. The typeface I used — *Atkinson Hyperlegible* — is different than the usual monospace fonts displayed on command lines. (Figure 3.1) The font was created by the *Braille Institute* and is free to use for anyone. As the institute’s website states as of December 2022, the typeface was designed with low vision readers in mind insofar as it focuses on letterform distinction, which makes it easier to differentiate between characters. (Braille Institute, n.d.)

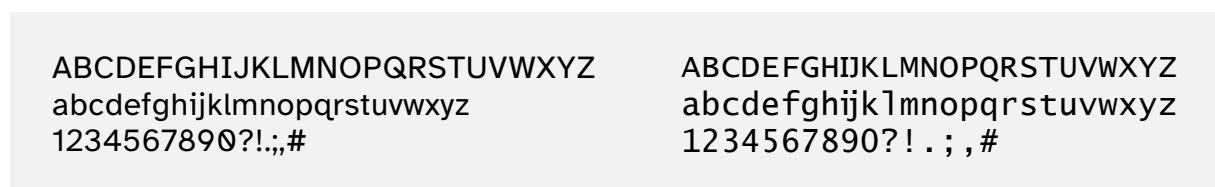


Figure 3.1 Comparison of the fonts *Atkinson Hyperlegible* (left) and *Lucida Console*, a typical monospaced terminal font (right)

As mentioned above, the users are guided by texts that appear as one navigates the site. Most of the interaction between the user and the interface happens via typing actions and movements, submitting them with the enter key and adjusting some parameters with the arrow keys. There is no option to view or send a video stream or images, so users communicate only via sound. There is a hidden function to send text messages, which is used at the start of a session to share wishes, boundaries or needs with the remote peer. I decided not to document that function in the glossary, nor mention it anywhere else on the website, so that users really focus on making sound. The written instructions encourage the players to not only experiment and communicate with their voices, but also incorporate other acoustic sound sources as well as their sonic surroundings.

3.2 Thoughts on self-expression, interaction and musical ideas at *glitchforest.online*

In the process of building *glitchforest.online*, it has become apparent that I have not only been working towards making a space to experiment with sonic self-expression, but the system itself is a way of expressing myself too. When designing the website I had to make decisions which influence what kind of interactions and sonic possibilities are available to the user. Giving up *jitsi* was an important step in that process, because it helped with freeing the project of the idea of a *conferencing software*. Since I am myself heavily influenced by the terminology of web conferencing softwares, I have also been struggling with how to refer to my system. Calling it a “glitchforest” might seem a bit random at first, but it made it easier to find more playful terms to refer to possible actions happening in the system. Now it is not a conference hall, nor an office or a school, but a forest waiting to be filled with of hidden pathways, plants and streamlets.

On the topic of expressing oneself through developing software, I was inspired by a blog-post titled *An App can be a home-cooked meal* by Robin Sloan. He describes how he developed an app called *BoopSnoop* to stay in touch with his family members, who live on different continents. He compares his relationship with coding to cooking and declares: “I am the programming equivalent of a home cook.” (Sloan 2020)

“The exhortation ‘learn to code!’ has its foundations in market value. [...]
‘Learn to code’ offers economic leverage, professional transformation.



Figure 3.2 Screenshot of the welcome screen of *glitchforest.online*'s first version

[...]

But let's substitute a different phrase: 'learn to cook.' People don't only learn to cook so they can become chefs. Some do! But many more people learn to cook so they can eat better, or more affordably. Because they want to carry on a tradition. Sometimes they learn because they're bored! Or even because – get this – they love spending time with the person who's teaching them.

[...]

Well, it's the 21st century now, and I suspect that many of the people you love are waiting inside the pocket computer you are never long without, so I will gently suggest that perhaps coding might be tangled the same way.”
(Sloan 2020)

Developing *glitchforest.online* has been precisely this kind of experience for me – I made it with my friends, family (and other people close to me in one way or another) in mind as the primary users, and it does not feel at all like providing a professional service or serious task, but rather a self-made space that I want to share with them. Obviously, I will also make this first version of the project open source so that others can take the system and adjust it to their personal needs and wishes. I am determined to write a more detailed guide after graduation, that combines in one place the documentation and information about all the different technical pieces that *glitchforest.online* is made of.

An important aspect that has influenced the musical decisions for the project became clear to me only one month before the deadline for the project: I had been listening to a lot of music of, or affiliated with, the *hyperpop* genre. It is often said of the genre to have a strong connection to and existence on the internet, and modifying the voice through pitch-shifting, distorting, vocoding or auto-tuning is common practice in this music, as well as mixing and mashing up (processed) samples of pop music and countless other genres. Many artists use these techniques to express and play with identities, and often the aspect of gender plays a part as well. For example, an album that has unexpectedly touched me in the beginning of the covid-19 pandemic is called *Reestablishing Connection*.³⁶ It was initiated by the musician *Sega Bodega* and consists of eight covers of more or less well-known songs, that were recorded as duettes with eight different fellow artists over online audio calls. Most of the original songs I had not heard before, so listening to them first as their cover versions gave me a bit of a different view on them. While the originals often uphold stereotypes of interactions between cis men and cis women, the covered versions twist these narratives through processing the

³⁶ See <https://soundcloud.com/segabodega/sets/reestablishingconnection>

singing voices. Even though the lyrics have not been changed, they suddenly tell different stories because the self-expression of their narrators resembles a less clear, less stereotyped picture. I do not know if this effect was intended or the main goal of the artists, or if it is just something that naturally happened in the process, but nevertheless; re-listening now to those songs has made me understand better what draws my interest to processing the voice as a means of self-expression. Pitch-shifting is therefore one of the methods incorporated into *glitchforest.online*.

The phase-vocoder algorithm mentioned in the previous chapter performs pitch-shifting by converting the signal into the frequency domain, then performing the processing in question (in this case shifting the peaks in frequency), and subsequently converting the signal back to the time domain (so that humans can hear it). This technique does not only allow for pitch-shifting, but also other methods such as spectral freezing, which I plan on implementing in future versions of the project.

Among the processing techniques I have already implemented is a dynamic range compressor available in the *Web Audio API*, of which users can adjust threshold, knee, and attack and release time. The *WebRTC API* makes it possible to switch between codecs, and dynamically set bandwidth and bitrate limits (this of course depends on how much bandwidth each user has at hand in the first place). I am planning on implementing the first in the near future and have already implemented the latter. A brief test³⁷ showed that such restrictions begin introducing a noticeable change only at lower maximum bandwidths (which essentially limit the bitrate) when the transmitted signal is only voice. When I played some music from my phone through my laptop's microphone and listened back to the transmitted signal, the change was already very perceptible at a maximum bandwidth around 10 kbps.

Further implemented processing methods are a high pass filter and a lag effect, that can be used to create layers of one's own voice.

³⁷ See *example02_webrtc_bandwidth.wav*. The test was done using an example from the official *WebRTC samples* (see <https://webrtc.github.io/samples>), which I modified in order to work with audio rather than video. I first recorded my voice with no bandwidth restriction (the signal was transmitted from my laptop to another instance on my laptop), and secondly with a maximum bandwidth of 10 kilobytes per second (kbps). I repeated this using a piece of music played from my phone through the laptop microphone.



Figure 3.3 Screenshot of *glitchforest.online* with the opened glossary

3.3 Future plans

After graduation I want to build a second iteration of the system. The plans for the near future are to implement a log-in system, collaborate with more other artists, improve the website's reliability when it comes to connecting two players, work on the website's storyline, and to improve the its usability on mobile devices. The latter will involve reconsidering the terminal-like approach. (which relies on the existence of a keyboard) There might be a need for different kinds of interfaces for different devices, especially when the physical keyboard is replaced by a touchscreen. Having the website work well on mobile devices would be an advantage since it makes it easier to move around in the physical space, and therefore widens the array of possible sound environments to play with. I will also dive deeper into the possibilities of the phase-vocoder and find/develop more audio processing methods for the system. Furthermore, I want to research tools and techniques other than the *WebRTC API* that can be used to build audio communication systems, as well as deepen my technical understanding of those. I will also work on a more detailed glossary page with links to tutorials, texts and other resources that have helped and inspired me to build *glitchforest.online*. Continually, I want to invite others to play with me via the website and use these exchanges as a base for further adjustment, experimentation and development of the system. A longer-term plan is to think about what other ways there are for artistic work to address the sonic, social, and artistic implications of communication networks than what I have done in this project.

Conclusion

Over the past one and a half years I have gathered a lot of impressions concerning life in the online space. This thesis has been an attempt to put all these impressions into one place, and create a base for further development of *glitchforest.online*. The work on this project has taught me many lessons about web development and the social aspect of digital technology, but also issues related to accessibility in open source as well as aspects related to project- and time-management. Having spent a long time trying to fix technical issues I encountered, I ended up having less time to develop musical ideas, so unfortunately, I have not yet arrived at a musical and artistic outcome that is satisfying to me. However, I am happy to have built a technical structure and achieved a basic understanding of online audio communication that will allow me to devote more time to the further exploration of sonic aspects in online communication. I will also continue thinking about the theoretical backbone I have introduced in chapters one and two, since my point of view and position as an artist and a person continuously shifts as I spend more time pondering, researching and exchanging with others.

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