Block

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Block – All you need to know about Blockchain on one Block.

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Abstract

Emerging technologies have the potential to change the way we interact and relate to each other by disrupting economic and social systems or even transforming our concept of identity. *Block* has emerged from acknowledging the need to explore these changes and create resources that increase people's comprehension. It is an interactive installation that allows exploring Blockchain to develop an understanding of the technology and its application.

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Table of Contents

1 Introduction

What convinced you to buy the smartphone, the TV or the computer that you own? Was it the brand, the price, the design or maybe the promised features?

Did you ever ask yourself if the embedded technologies like Wifi, Bluetooth, GPS, Face ID or Fingerprint Authentifications have been misused?

What convinced you to create an account on Facebook, Apple or Google?

Why do you trust or mistrust these companies?

Whether you are sympathetic or suspicious of this admittedly very small selection of companies is of no importance to us.

Our question is, do you attribute your sentiment towards these companies to the technologies mentioned before?

Give it a little time. Is Wifi responsible for your love of or maybe your hate towards Apple?

Have you ever heard of Blockchain?

What is your sentiment towards Blockchain?

Have you ever heard of Bitcoin?

Do you attribute your sentiment towards Blockchain to the information you have about the use or misuse of Bitcoin?

Blockchain is on many people's lips and yet, almost no one seems to actually understand what it really is. Well, maybe not you in particular, but it was definitely us, until halfway through our Bachelor Thesis, and maybe even now at the end of it. We let you be de judge.

We are Baran Yüksel Güneysel and Gian-Carlo Huber, Interactions Designs Students at the Zurich University of the Arts. Sharing an interest in wanting to understand what Web 3.0 is all about and what promises it holds for the future, led us to tackle this bachelor thesis together as a team.

In the first half of the four months period, we obtained an overview of Web 3.0 actually is and what it only promises to be. For this purpose we studied respected blog posts, scarce scientific papers as well as magazine articles and tested our way through a large part of the rather limited services that are already functional in Web 3.0. Rather disillusioned with the actual state of the much-vaunted new Web, we proceeded to better understand what mechanisms and components comprise this new Web. For this purpose, we built different prototypes that helped us identify and comprehend the key elements in which Web 3.0 differs as well as which potential they hold.
We have conducted a series of different investigations with potential and active users and have come to the conclusion that it is not useful to apply our skills as interaction designers to the optimization of a particular aspect of this large structure that is Web 3.0 at the moment. We have identified that there is interest in how the Web is evolving and that blockchain can be used as an anchor point for creating digital literacy.

The following work is focused on our process from the first conceptual attempts to our finished product, Block.

2 Research

In this chapter, we are going to explore the topic of Web 3.0 and its underlying technologies in order to identify potential leverage points where interaction designers can put their skills to use. The chapter begins with a brief history of the web, followed by an examination of the ideology of Web 3.0. The technology behind Web 3.0, blockchain, will be explained in detail. To create comprehension of the explained concepts, we have integrated a tangible real-life concept, a concept of a vending machine which is connected to the blockchain. This concept was created by us in the very first stage of our research to make the usage concepts of Web 3.0 tangible, and create an entrance point into Web 3.0. All of our desk research findings led us to our research questions and hypotheses. We will then explain our motivation for contributing to Interaction Design. Next, we will list the methodologies we used to find our design solution for our intention and detail our approach to each point.

2.1 Background & Context

Beginning this bachelor thesis, it was our intention to explore the topic of Web 3.0 and its underlying technologies in detail, with the goal of identifying potential leverage points where we as interaction designers could put our acquired skills to use. We summarise our research in this chapter and provide an introduction to what we consider to be important topics, in order to strengthen the understanding of a person unfamiliar with the subject matter. Acknowledging that understanding the ideology of Web 3.0 requires a basic comprehension of the origin of the web itself, we will examine the history of the web beginning the next chapter. Gradually working towards the current and future state that Web 3.0 promises.

We prefer to look back at the history of the web's creation in order to understand the origin of the ideology for Web 3.0. For those who have actively followed the development of the Internet and the web over the past 30 years out of professional or personal interest and have witnessed its more or less organic transformations, a lot of the following may be evident. However, for those who are younger, as we are, or the majority of web users who have not been following these developments deliberately, this is an important history lesson that should not be skipped in order to understand that the ideologies contained within Web 3.0 are not anything fundamentally new.

Those who are already familiar with the web and would like to skip this, are welcome to skip to page 46.

It should be noted that there are no official versions of the Web. There was no one-time update and the web was on a different version, it was a “continuous organic evolution that was ongoing yesterday as it is today” (Interview, Evolution of the Web). Therefore, the following subdivisions should be understood as phases of the web and the mentioned years as general guidelines. In 2005, Tim O’Reilly came up with the term Web 2.0 to point out how newer web offerings were different from the older, “classic” websites (O’Reilly, 2005). This was the beginning of “versioning” the World Wide Web.

Web 1.0 | 1989-2005

Imagine working for a massive organisation whose 17,000 employees and volunteers are scientists conducting research in more than 100 different countries. Working on a report with other colleagues, you exchange results by phone, fax or email. You are fortunate enough that the organisation embraces advances in technology and provides workstations with personal computers, but all around the world your colleagues use “ […] lots and lots of information systems on different computers, on different networks, all incompatible.” (Berners-Lee, 2019) The organisation’s information management is structured in such a heterogeneous way that scientific collaboration is slowed down or even made impossible. Additionally, the different employees relocate quite frequently, which makes it hard to keep in contact by means of fax, email or phone. Furthermore, you don’t really know how up-to-date the data in the emails is.

This was the environment in which the computer scientist Tim Berners-Lee found himself as an associate of the European Organisation for Nuclear Research, short CERN, and he was not happy about it. He asked himself if it would be possible to have just one information management system available to all scientists working at CERN. As a result of this dissatisfaction, he composed a management proposal essentially aimed at making information available to everyone within CERN, which also laid the foundation for the World Wide Web, or short web, as we know it today. The proposal described a “web” consisting of interconnected electronic documents written in a certain language, called “hypertext”. Hypertext in essence allows writing documents in which so-called hyperlinks can be integrated. Hyperlinks either forward the user to a different section of the same document or to a different document. Hypertext also allows for information to be structured in a comprehensible

and standardised manner, so that for example headings and continuous text could be differentiated easily. The proposed web of Berners-Lee therefore is nothing more than documents whose interconnections create a web of information.
For these interlinked or interconnected hypertext documents, to be made readable for everyone, a software called “Web Browser” was needed that could render these hypertext documents containing text and images. To enable everyone to access the files, it was necessary to store or host them on a so-called “Web Server”. A Web Server is like a computer, but its whole purpose is to store documents and “serve” them to a user if requested.

Internet

One might wonder at this point, how this information can be exchanged at all. After all, there is no physical connection mentioned so far. This brings us to a fundamental differentiation that is not reflected in today’s use of language. For a start, the Internet and the World Wide Web are two different technologies. The Internet provides the necessary physical and material infrastructure, for example underwater internet cables or protocols, that makes the World Wide Web possible. “The internet is a global network of computer networks. It is the underlying technology that enables computers, phones, game consoles, smart home equipment, servers, and other network-capable devices to talk to each other, no matter where they are in the world.” (Stegner, 2021) Originally developed in military interest under the name ARPAnet, for the purpose of maintaining communications in the event of a nuclear strike, ARPAnet is the foundation of our Internet. One of its most important functionalities was to ensure communication among the remaining participants even in the event of a partial network failure. This was accomplished by means of using a decentralised network structure. This ARPAnet infrastructure was subsequently used by universities for academic purposes, and beginning in the 1980s, as the personal computer became increasingly popular, the network was eventually made available for commercial interest and use. Thus, the Internet is the infrastructure on which the World Wide Web has been built. If someone says they are going on the internet to look at a cat video, this is most certainly true, but most likely they are using the World Wide Web to access the information of the video.

Roughly speaking, the Internet is like a road infrastructure. On this road infrastructure, different vehicles or people can move in different ways. For example, if you are travelling by car, you follow the marked roads. If you ride a bicycle, you follow a bicycle path and pedestrians walk on the sidewalk. These are all users of this infrastructure, but they use it in a different manner. The World Wide Web is just an application running on the infrastructure the Internet provides.

Looking back, it's easy to see that the internet provides us with the means to access hypertext documents stored on web servers. Protocols are the set of rules governing how information is exchanged between computers on the internet.

Protocols & Open Standards

The most important aspect of Berner-Lee's concept was to ensure interoperability between different networks and different network participants. This required that standards for communication between various network participants had to be defined. These standards are called protocols. The Internet provides data by means of different protocols. The World Wide Web therefore appropriates certain protocols provided by the Internet and combines them with web specific protocols. For example, to ensure that a user requesting a Web Page from a Web Server receives the correct information, a connection must first be established between these two network participants. This task is performed by several protocols known as the Internet Protocol Suite (TCP/IP). Included in this suite is, for example, the Internet Protocol, which allows to address specific computers in a network by giving each device in the network a unique address and IP address. This address or protocol makes it possible to properly transmit data between two separate Network entities. Other protocols included in the suite, "[...] specify how data is exchanged over the internet by providing end-to-end communications." (Shacklett, 2022) However, the elaboration of these would extend the scope of this chapter beyond reason.

The World Wide Web also makes use of the Domain Name System (DNS). The Domain Name System is a standard, which translates between so called Domains and IP addresses. Simply put, Domains are nothing more than human readable or human friendly IP addresses. For example the domain zhdk.ch which one would either enter directly into the address bar of a browser or access using a search engine like DuckDuckGo, would be translated into the corresponding IP address of the Website of ZHdK for you. This makes the use of the Web a lot more convenient.

A Web specific and one of the more visible protocols, is the Hypertext Transfer Protocol (HTTP). It is visible, because it is shown as http:// in the address bar before the domain, most of the time. The Protocol initially created by Berners-Lee established the communication standard between Web Browsers and Web Servers. Using HTTP a Web user like you and me can request a certain hypertext document, also known as Web Page, which is located on a Web Server. Using the HTTP-Protocol the other way, the Web Server will transmit this hypertext document to your browser who will display it correctly. This Protocol is now commonly used in encrypted form as Hypertext Transfer Protocol Secure (HTTPS).

In contrast to this, there exist many different Email Protocols like the Simple Mail Transfer Protocol (SMTP), Post Office Protocol (POP3) or Internet Message Access Protocol (IMAP) which are examples of protocols that enabled the sending and receiving of email which are still used today. These are communication protocols that work without the web using the internet. So when you open your emails over the web, the browser just offers the interface to better manage your emails. The sending or receiving of an email, however, only takes place through these web-independent protocols.

Pros & Cons of Open Standards

The aforementioned protocols are all open standards, which means that anyone can use them to create an Application or Service using these protocols. The decision to use these open standards is the reason why you can still use your Gmail address in a different email reader like for example Mozilla Thunderbird, but it is also the reason why email is not encrypted. As these protocols were not encrypted at their beginning stage and many services that we use today are built on top of them it would need all services to update the protocols at the same time with the same encryption capabilities to guarantee that the services would stay interoperable. Since it is almost impossible to change the way such widely used protocols work, because adoption would be slow and compatibility would suffer, emails for example stays unencrypted.

Nevertheless, if changes had to be made to protocols, it was a decision made by the community that used and developed the protocol. Changes to such community governed protocols were regulated by community internal consensus mechanisms or processes like polls. The more people had a say in the development of a protocol, the slower its development became.

We now understand when using the World Wide Web, a user utilises a Web Browser to request a hypertext document by using different protocols contained in the TCP/IP Suite as well as the Hypertext Transfer Protocol (HTTP). The Requested hypertext document is then transferred to the browser of the user using the HTTP-Protocol. The Browser will then display the Hypertext Document as a Web Page containing text, images, hyperlinks.

Browser

In 1990 the first Web Page address hosted on the worlds first Web Server was http://info.cern.ch/hypertext/WWW/TheProject.html. Besides information about the co-called WWW project, the site also contained instructions on how to build a custom Web Server. In other words, this meant that anyone could participate in extending the web by providing information on their own Web Server. The first ever browser developed by Berners-Lee, named WorldWideWeb, only worked on the NeXT computer platform. This greatly limited the number of potential users, but the developer Nicola Pellow working at CERN during her student work placement, quickly followed with the build of the line-mode browser, which could be used on various computer systems. line-mode was simple and couldn't be used with a mouse, but demonstrated the potential behind the idea of the web. In the same period the Hypertext Markup Language (HTML), the evolution of the hypertext language, was published. These HTML documents remain the backbone of the World Wide Web to this day. With HTML, digital documents with different content such as text, different media and links can be structured in a straightforward way and made easily accessible over the web, because every Web Browser can display them.

Since the work on further development exceeded the capacity of the small team at CERN, Berners-Lee launched a call via the Internet and invited people to participate in the development. In 1993, the first user-friendly and fast-growing browser called Mosaic was released by the National Center for Supercomputing Applications (NCSA). A subsequent update made it possible to use the browser on devices such as the Personal Computer or Macintosh, which allowed for the World Wide Web to be accessed not just through scientific computer platforms but from to the living rooms of regular citizens. In the same year, CERN made the source code for the WorldWideWeb browser publicly available as open source code. This underlined the mindset of the Web's developers that the web should be and stay an open standard, that could be used and built upon by anyone.

Decentral

These advancements, which have been made possible only by a community of devoted developers, have led to the web consisting of a number of over 10,000 servers by the end of 1994. "There was a lot of concern that people didn't want to pick it up, because it would be too complicated. A lot of persuasion, a lot of wonderful collaboration with other people, and bit by bit, it worked." (Berners-Lee, 2014) Everyone could set up their own server for commercial, scientific or private purposes. This made the web decentralised by nature, as one could control one's own data or information on one's own server. Everyone could publish what one wanted, if they had access to a server.

Search Engines

In the beginning Web 1.0 lacked a comprehensive search engine. But some users started to build Web Pages for indexing other Web Pages. These hierarchical directories were maintained by humans by hand. These pages allowed to browse for topics and get redirected to further Web Pages through the use of hyperlink. This is how Yahoo came into existence. Yahoo became famous for being one of the first companies to allow users to search for specific words or terms using their Yahoo Search. Instead of having to scroll and click through the whole hierarchical directory, Yahoo users would get curated results corresponding to their search term. The search engines of that time were far from being as reliable as we are used to today. The Web Crawlers, bandwidth and computing power used for this purpose were simply not as sophisticated as they are today, but being able to “search” for a specific topic was revolutionary.

Summary

Web 1.0 was initially meant to be used as an information management system, enabling the exchange of scientific information between different computer systems and Networks at CERN. By adopting Internet protocols and incorporating custom protocols in combination with a browser, it became possible to use the web from many different network-enabled devices. The web is an open standard and data storage was inherently decentralised by the fact that everyone could or had to have their own server. Even though it was difficult to find this scattered information in the beginning, because there were no search engines like Google, people started to index Web Pages by hand, which eventually led to the first search engines like Yahoo.

Transition to Web 2.0

In Web 1.0, composability prevailed. Software of other users could mostly be reused without needing the permission of the original developers, which enabled everyone to build things on top of already existing things. This meant that new products could be launched more easily, quickly and cheaply. Nevertheless, Web 1.0 content creators remained mostly developers who knew how to build Web Pages and maintain Web Servers. Most Web 1.0 users were only consumers of the information that others provided; it was static and read-only, a one-way dialogue. Web 1.0 was very cumbersome to use in the beginning and thus excluded many potential users. Certain companies began to simplify the use of the web once they realised that they could collect more data to optimise their service and ultimately capitalise on advertising by having more users. There began an era of emerging companies that built their services on existing protocols, but began to introduce their own standards and thus lock their users in. We are entering the second phase of the web, Web 2.0.

Web 2.0 | 2005-Today

Web 2.0 ist the web we all use today. Web 2.0 is often described as dynamic, in contrast to the static Web 1.0. This means that websites are still composed of a static Hypertext HTML file, but that this HTML file is dynamically filled with content based on data stored in a database. For example, on your Facebook feed you will most likely see other content than your friends, but the basic structure is the same.

Central Databases

Of course, this doesn't happen on its own. In order for Facebook to recognize and deliver this content to you, you need an account, which is also recorded in a database. This is a fundamental feature of the second phase of the web that distinguishes it from its predecessor. Users can now create accounts that allow storage of data related to that account using a combination of email and password. The Data that the users share is not on their own server at home in their basement or on the server at their friends house anymore. Users no longer have to deal with the hassle of maintaining their own server. Their data is stored centrally on a company owned server somewhere in the world. Simplified user interfaces and centrally stored databases now allowed the majority of people to publish personal content with a few and comprehensible clicks. Anyone and everyone was now able to become a content creator, an entity actively contributing to the growth of Web 2.0. Terms such as RSS, wiki, tagging, and blog (a truncation of "weblog"), slowly began to transform from technical terminology to everyday expressions. (Sharma, 2022) Many new companies were founded that allowed more and more people to access, publish, and interact on the World Wide Web.

Big Tech

Companies such as Google, Ebay, YouTube, and Amazon are just some of the successful companies and products that emerged during this time. Apple presented the first iPhone, which facilitated access to the Web by introducing a sophisticated mobile browser and particularly by introducing the idea of services through applications, so-called APPs. Apple's slogan "There is an app for that" (Apple, 2009) expresses this time rather eloquently.
Web 2.0 could also be equated as the web of social media or social web. Due to third party software it became quite simple for people without technical skills to create their own website and populate it with their own content. The ability to comment on content and share it quickly via email or within social media platforms with just a few clicks, made Web 2.0 a more vibrant space for exchange and communication. Social media is a product that builds on the development of Web 2.0. Social media simplified the sharing of one's own content and information to the extent that it already provided the whole platform to do so. It was no longer necessary to have a personal website, one could purely focus on creating and publishing content. Web 2.0 consists of closed platforms governed by one entity rather than open protocols that could be adapted and owned by anyone. Web 2.0 is more of a front end revolution. Web 2.0 harnessed the developments of Web 1.0 and improved them, made them more accessible or changed their look. Some areas of our lives have shifted or expanded into the digital realm. Many online shopping opportunities were launched in Web 2.0 through simplified and more secure credit card payment systems. Even though e-commerce already existed in Web 1.0, the experience changed from simply sending an order email through a tediously programmed button and weekly adjustments of prices to fully automated systems that reduced the process to a few clicks. Areas such as dating or banking have also been transformed by their digitalization, their

translation into a digital form, mostly making use of the Web.

However, the simplicity of the services, the fact that they can usually be used free of charge, and the convenience provided by central databases, comes with a major disadvantage that only came to light after a few years.

Data

Typically, the data of the users, which most of the time contains way more sensible information than an email address, is stored by the companies and claimed as their property. Managed, evaluated and often sold. This may not sound problematic at the beginning No, it may even be very helpful if one suddenly receives personalised content on one's feed that is tailored specifically to one's personal interests. However, this data also allows conclusions to be drawn about political attitudes, behaviour and preferences, which can be exploited by these companies in a systematic manner. Also, most of these companies have once adopted open protocols and customised their standards to such an extent, that users are trapped within their service, because they can no longer simply transfer their data to another client. Although it has to be said that, the centralization of an open protocol does not necessarily have to be bad. It allows for faster advancement if only one or few entities decide over the next steps to be taken. “A sure recipe for success has been to take a 90's protocol that was stuck in time, centralise it, and iterate quickly.” (Rosenfeld, 2022)
Getting one's own data out of centralised protocols is tricky or even impossible. These companies are the reason why you cannot use WhatsApp to write with your friends on Signal. These companies are not interested in preserving the open, decentralised internet of Web 1.0, based on community-governed open protocols. These companies are interested in a monopoly, offering platforms

based on their own centrally controlled protocols. This does not mean that these services are not useful. On the contrary, they have made Web 2.0 the thriving, widely available place it is today.

Privacy & Profit

Nevertheless, from a rather decentralised world of Web 1.0, Web 2.0 has evolved into a centralised big tech world, where data breaches, tracking and loss of control over one's own data are part of everyday life. Most of the time, it is the user who is most affected by the consequences of such incidents. The monopolies of a few companies have grown to such an extent over this short period, that they dominate most of the world market and can only be forced to enforce certain standards in their protocols, through legislation. "Powerful technology companies have shifted much activity from open, distributed, egalitarian and empowering web to closed online walled gardens or proprietary, read-only applications that among other things kill the conversation. Corporate forces have captured many of these wonderful peer-to-peer, democratic, and open technologies and are using them to extract an inordinate share of value." (Tapscott, 2018) A "the winner takes it all mentality" prevails and it seems that using these services can only come with a loss of privacy. "Convenience comes with a price: privacy. Those who say "privacy is dead-get over it" are wrong. Privacy is the foundation of free societies." (Tapscott, 2018) There is no cooperation between the companies and users, the companies have full control over the centrally stored data of their users and abuse it for their own financial profit. Not only does this data benefit The Companies, but it also provides a goldmine for intelligence agencies and other bodies of miscellaneous governments. The revelations of Edward Snowden demonstrated this clearly. (Snowden et al. 2018) They led to trust in governments and companies being at an all-time low.

Web 3.0 I | The Semantic Web

Even dough Tim Berners-Lee already stated in 1999 that his dream for the Web would be to make it machine readable, a semantic web, that would allow computer to not just deliver information, but also understand it, this dream hasn't come true in the way he and the World Wide Web Consortium imagined it to.

The Idea behind it was, that as a further evolution of the web, Web 3.0 should allow machines to understand the semantic meaning of the information contained within the web pages. If computers could better comprehend what meaning we are looking for instead of what information, it would be much easier to provide us with relevant results or even fulfil tasks for us. In contrast to Web 1.0 consisting of static interconnected documents, Web 3.0 would consist of interrelated data of many different web pages, that is continuously updated when new information is added. The idea of the semantic web gained little traction due to the additional work and the complexity associated with semantic markup. Semantic Web technologies were complex and opaque, made by academics for academics," he adds. "[They were] not accessible to many developers, and not scalable to industrial workloads." (Wynings, 2017)

Furthermore, the latest developments in the field of artificial intelligence have reached the point where the concept of the semantic web is obsolete. "In essence, AI and Machine Learning are now capable of doing everything that the Semantic Web originally aspired" (Wynings, 2017)

Web 3.0 II | Web3 | web3 The post-Snowden web

Not only Berners-Lee but also other computer scientists like Dr. Gavin Wood reflected on the future of the web and defined his concept of Web 3.0 in a blog post published in 2014.

> “Web 3.0, or as might be termed the “post-Snowden” web, is a reimagination of the sorts of things that we already use the Web for, but with a fundamentally different model for the interactions between parties. Information that we assume to be public, we publish. Information that we assume to be agreed, we place on a consensus-ledger. Information that we assume to be private, we keep secret and never reveal. Communication always takes place over encrypted channels and only with pseudonymous identities as endpoints; never with anything traceable (such as IP addresses). In short, we engineer the system to mathematically enforce our prior assumptions, since no government or organisation can reasonably be trusted. [...] ay ‘hello’ to Web 3.0, a Secure Social Operating System” (Wood, 2014)

Gavin Wood’s vision for the next iteration of the Web not only addresses the technical aspect of better information processing, but rather denounces the current use of the Web as a dystopian structure of our own making, referring to Web 2.0 as a carbon copy “[...] in therms of the social architecture [...] the power architecture. It’s a carbon copy of society that created Web 2.0.”

(Wood, 2022) In the real world this refers to large Institutions that own and control important services like banks, insurance companies and so on. On the Web we are talking about Services like Facebook, Google, Twitter, Amazon and Co. Gavin Woods' key topic ist trust. “We are having to trust the people behind these services, we are having to trust the owners of the companies that run the service and we are having to trust many of the employees with very important stuff that I think we are only just coming to realise how important it is.” (Wood, 2022) In Woods vision, Web 3.0 should provide services, that are hosted on a peer to peer Network, not owned by one provider company, but “algorithmic things” (Wood, 2022) that can be hosted by everybody that wants to. This strongly reminds uf of the basic idea of Web 1.0.

> “We have managed to architect ourselves into this somewhat dystopian version of what the world could be.”(Wood, 2022)

For the purpose of developing his idea further, Wood founded the Web3 Foundation, with the mission to deliver Web 3.0 as a new Version of the Web in which users control their own data, their identity and fate, without having to trust anyone.

Terminology

There is quite a bit of confusion around the terminology of the term Web 3.0. For example, the Foundation is called Web3 Foundation and not Web 3.0 Foundation. However, the term Web 3.0 is used in their statements. In social media, the term Web3 or stylized web3 is currently gaining acceptance. For the sake of consistency, we will continue to use the term Web 3.0 in the following to refer to the re-imagined version of the web in the sense of Wood and others.

Community

Others like the artist and researcher Mat Dryhurst, who specialises in technical and ethical protocols emphasise that Web 3.0 brings with it a whole new spirit of collective thinking and tools for acting on the future of our Web. He supports the ideology of Web 3.0, suggesting it is the community that will decide on protocols and standards again. The ideology that Web 3.0 is owned by the people that agree on their future of the web, not by companies that decide for theirs.

> “[...] rather than any attempt to engage in the chaos and subtleties of web 3 communities is that there is a novel kind of collective spirit forming around web 3 and NFT communities that is actually very beautiful and heartwarming once you get over the cooties. WAGMI. We are going to make it. Now I am going to make it. We. This is a monumental departure from web 2 independence hustle dynamics [...] people grew up in.“ (Dryhurst, 2021)

Criticism

However, this exciting new idea of the web is also being strongly criticised. For example, Matthew Rosenfeld, also known as Moxie Marlinspike, who among other things co-founded the open messaging service Signal, is rather critical of the developments made in recent years.

> "I don't think it's on a trajectory to deliver us from centralised platforms, I don't think it will fundamentally change our relationship to technology, and I think the privacy story is already below par for the internet (which is a pretty low bar!), but I also understand why nerds like me are excited to build for it. It is, at the very least, something new on the nerd level – and that creates a space for creativity/exploration that is somewhat reminiscent of early internet days." (Rosenfeld, 2022)

Jack Dorsey, the inventor and co-founder of the blogging platform Twitter, known for his positive attitude towards the cryptocurrency Bitcoin, also voiced criticism regarding the major providers of funds for Web 3.0.

> You don't own "web3."
>
> The VCs and their LPs do. It will never escape their incentives. It's ultimately a centralised entity with a different label.
>
> Know what you're getting into… (Dorsey, 2022)

He refers to large venture capital firms (VCs) that have collectively invested close to $30 billion (Rai, 2022) in Web 3.0 and blockchain companies during 2021. Essentially, thereby buying control of these different entities that make up or will make up Web 3.0. In this way, he dismissed the hopes of users or small investors, on a Web owned as well as controlled by the many and framed the promises of Web 3.0 as a lie.

A matter of awareness and trust

Not only is criticism coming from the ranks of successful tech moguls, but also from academia. Whereby this criticism expresses itself in somewhat different terms. The question arises as to why so many resources are being invested in the development of new blockchain protocols that will make it possible to operate at a scale that enables several million simultaneous interactions when there are currently only a few ten thousand active users. It is a vanishingly small percentage of the population that has real experience using blockchain and Web 3.0 technology. “Given this lack of experience, most people who have heard of blockchain and bitcoin are working on secondhand information. And, unfortunately, most of the loudest voices in the public sphere fundamentally misunderstand what these technologies really are. They think it’s just for money, they think it’s anonymous, and they think that the story begins and ends with bitcoin.” (Keil, 2019) The knowledge of most potential users is clouded by Bitcoin and associated stories such as the illegal marketplace Silk Road, where one could purchase drugs, weapons, and other forbidden items using Bitcoin. The Web 3.0 underlying technology of blockchain has a big problem, it does not seem trustworthy. “This may strike some blockchain evangelists as sobering news, but it should clarify the task before us. The first step to solving a problem is admitting you have one. Blockchain has a trust problem. Developers need to realise that they need to look and care not only about the advancement of the technology, but also about its communication. If we can’t admit our own shortcomings, we’re bound to overpromise and underdeliver—a great recipe for continued mistrust in the reliability of our promises.” (Keil, 2019) In his Publication Building Trust in a post-truth world, researcher Christian Keil proposes 3 challenges that need to be overcome in order to make consumers trust blockchain technology (again).

Awareness

People need to know that the technology exists and which new opportunities it could provide for them.

Education

Digital literacy in the area of blockchain and Web 3.0 is vital to combat misconceptions and put false narratives to rest.

Influence

Reporting and discussions about the technologies are full of hypotheses, half-knowledge and lies. Voices are needed that can be trusted to be correct in what they say. These voices have to be given more attention.

Sounds nice, but I don’t get it!

You might say to yourself: “Nice summary, but if I am honest I still don’t understand what this Web 3.0 is actually made of!?” Don’t Worry, we had the same feeling. It felt too abstract and intangible to really make sense of just by reading about it. That is the reason why we developed a theoretical first prototype involving an everyday object. A simple prototype that introduced us to the different technologies within Web 3.0 and helped us understand their functionality.

The Vending Machine Prototype

The Interaction Design Studio at ZHdK is stuffed with projects and materials. Among other things, they also accommodate a vending machine named Turbomat offering chilled drinks. The machine is supervised by the student body and has been tinkered with for some time. Among other things, a touch screen has been integrated into the door. As our heads were spinning with terms like decentral, wallet, hash, and so on, we decided that it would be a lot easier to understand the different technologies that make up Web 3.0, if we found an actual use case. That is when we decided to transform the vending machine into a Web 3.0 entity that would allow us to think about all the components needed to make it Web 3.0 suitable.

fig. 1 vendig machine at Interaction Design studio

Tokens

A simple first iteration of the prototype was to translate physical value, in our case 2 CHF into a digital value or asset. For this we propose the use of a so-called token that can be used for a variety of different use cases within our ecosystem. One should be quite familiar with tokens from everyday life in general. For example, plane tickets, casino chips or supermarket loyalty points can also be considered as tokens. Tokens have a certain value and usually a certain functionality, but they are not a currency. There exist different forms of tokens in Web 3.0, each with different functionalities. Most of the tokes one encounters have multiple use cases.

Tokens, Coins or Cryptocurrencies?

Tokens are often mistakenly referred to as cryptocurrencies, sometimes abbreviated to crypto or coins, but most assets that are generally referred to as cryptocurrencies or coins have far more functionalities than that of a currency. As we intend our token to be used as more than a currency it will form now on be referred to as a token. We name it TONI-Token, as the building in which the ZHdK is located is generally also referred to as Toni-Areal. In relation to Bitcoin, in principle, one can speak of a cryptocurrency, because it is used only as a digital means of payment. However, the term should be used carefully, because “[...] unlike fiat currency, cryptocurrency does not (yet) fulfil the functions [of means of payment, store of value and unit of account]”. (Egloff and Turnes, 2019)

fig. 2 TONI token ecosystem

Non-Fungible Tokens

Non-Fungible Tokens, better known by the abbreviation NFTs, are understood as a kind of property rights for a real physical or digital asset. They are currently used mainly to make it more difficult to counterfeit digital art or to reward digital artists for their work. Non-Fungible Tokens can be traded and resold like normal tokens, but they are not subject to any regulations. The most famous example for NFTs would be CryptoPunks. CryptoPunks is a collection of 10000 different algorithmically generated digital artworks. Their fame comes from the fact that they are rare due to the restriction to 10,000 units. They have also become a sort of status symbol for people who are active in the crypto sphere. There seems to be a lot of interest in using CryptoPunk as avatar images on social media.

Platform Tokens

Platform tokens use the infrastructure of an already existing blockchain, such as Ethereum, and build different decentralised applications (DApps) on top of it. The advantage of building on an existing blockchain is that transactions can be carried out in a compatible, simpler and more secure manner. These tokens are subject to predefined standards defined by the underlying blockchain. A widely used standard for platform tokens on the Ethereum Blockchain is the Ethereum Request for Comments 20 (ERC20) token standard.

fig. 3 CryptoPunk

Security Tokens

Security tokens are digital assets that represent ownership of a real or physical asset. They are stored on a blockchain and can be traded. Different countries have different regulations governing the trade of security tokens. These regulations are enforced through the use of smart contracts. This distinguishes security tokens from non-fungible tokens, which can be traded freely.

Transactional Tokens

As the name suggests, Transactional Tokens are used for transactions of currency, goods and services. In most cases, these are payment instruments similar to traditional currencies, such as Bitcoin. However, these tokens offer the advantage that they can usually execute these transactions without the need for middlemen, as is usually the case. Not all transactional tokens are a currency, as evidenced by those used in the transport industry. These tokens use the immutable blockchain to secure transport routes and make them fully transparent and traceable.

Utility Tokens

Utility tokens are an integral part of a protocol existing on a blockchain. These tokens are mostly used only in their designated ecosystem or protocols for access as well as specific purposes. Therefore, in order to take advantage of a certain ecosystem, one usually needs to purchase a certain amount of these Utility Tokens first.

Governance Tokens

Due to the reintroduction of community governed protocols, these protocols also need certain ways to reach consensus. This task is performed by so-called governance tokens. They enable blockchain-based voting to democratically determine the future of the protocol.

Digital tokens usually have no physical representation. They exist only as code. Therefore if someone is to exchange 2 CHF for 1 TONI we would need a way to record, verify and store this transaction using a ledger. This is where Blockchain comes into play.

Blockchain

In 2008, at the time of the financial crash, unknown developers under the pseudonym Satoshi Nakamoto published a white paper in which they developed the model for a blockchain. A white paper is a formal document that presents a problem and provides a proposed solution. This protocol was developed for an electronic peer-to-peer cash system with a cryptocurrency. This was the birth of Bitcoin. Nakamoto had the idea of creating a peer-to-peer version of electronic cash that would allow online payments to be sent directly from one party to another without going through a financial institution. (Nakamato, 2008)

A human-friendly explanation is that the blockchain is a decentralised public database managed by multiple participants across multiple connection points, resp. nodes. Transactions are recorded with an immutable cryptographic signature, a hash. Once written, data cannot be changed. When we speak of a database, the image of an Excel Sheet appears in our mind. But Blockchain takes the form of a linked list instead of a traditional sheet. Each block, or series of transactions, that is added to the blockchain, must refer to the previous block. This allows for a linear history of each transaction, transparency and trust.

Blockchains require consensus in order to validate transactions. All participants must agree on the validity of a transaction before it can be considered valid. Blockchains are also mostly proven, meaning that all participants are aware of the asset's origins and how ownership has been transferred. Individuals retain full autonomy over their funds via their cryptocurrency wallet. No personal information is required to create a wallet. Each wallet has a private key for the owner to access their assets and a public key that they can share with others to receive assets. Public blockchains like Bitcoin, Ethereum, Monero and so on are decentralised. They are not owned by one organisation and cannot be deleted. A single blockchain is runned by different nodes, and each node has the identical copy of the entire history, resp. transactions. All these nodes communicate with each other and vote on the state of the blockchain. Since each participant in Blockchain maintains and verifies their own copy of records, it enables a trustless ecosystem, where third parties are not needed. Transactions are time-stamped. On a public blockchain, if more than 50% of the nodes are controlled by one group, the status of transactions can be changed and the blockchain is no longer decentralised or secure. In July 2014, a mining pool called gHash.IO exceeded 51% of Bitcoin computing power. The pool voluntarily reduced its share of the network and declared in a statement that it would no longer reach 40 % of the total power in the future. (GHash.io - Wikipedia, 2022)

Blockchain allows us to record and verify transactions using the TONI-Token. Since it cannot be modified, it acts as a secure ledger for transactions and thus also ensures that the tokens, which are only available in digital form, cannot be tampered with.

Trust

When it comes to blockchain, an especially relevant question is how the network can be trusted. For example, it is trusted to actually convert the 2 CHF into 1 TONI. For this purpose rules are predefined, they are coded into the blockchain. These rules are protocols which cant be changed after starting a blockchain. So you can assume that if 100 people before you have received 1 TONI for 2 CHF, you yourself also get 1 TONI, because the *mechanisms are fixed mathematically and always proceed in the same way. These mechanisms for verifying a transaction are commonly referred to as consensus mechanisms. These mechanisms create trust in a blockchain.*

Consensus Mechanisms

A consensus is reached when a general agreement has been made. For example, if a group decides to go to a certain restaurant and there is no disagreement about the choice, then a consensus has been reached. Consensus mechanisms are used to regulate the validation and agreement of the blockchain state. Today, this is mostly done by two protocols: Proof-of-work and Proof-of-stake.

Proof of Work | PoW

Before Bitcoin, the proof-of-work concept was just an idea. In 2009, Bitcoin became the first implementation of this idea. The proof-of-work concept was built to prevent the problem of double-spending. This protocol requires computers that can validate transactions and make a copy of them to reach a consensus. This consensus allows for a trustless network and prevents bad actors from taking over the network. This protocol requires a significant amount of computing. The two biggest public blockchains, Bitcoin and Ethereum, currently use Proof-of-work consensus. Ethereum is planning a switch to Proof-of-stake consensus because it is much cheaper, doesn't need big computing power, and is faster.

Proof of Stake | PoS

Cryptocurrencies mined based on Proof of Stake require less computational power and are thus more cost-effective. Instead of requiring computational power to solve mining puzzles for securing the network in PoW, PoS requires validators to lock in funds for a specific period of time to propose or vote on new blocks. However, the chance that 51% of the funds will fall on one hand is much greater than with the Proof-of-work concept.

What is yours & What is mine?

In our current ecosystem, we can receive 1 digital TONI for the input of one physical 2 CHF piece. Thanks to consensus mechanisms, our transaction is recorded in the blockchain, and our value is digitally stored. But how can we access this value? How does the blockchain even know to whom this value belongs?
This is where digital wallets come in. A digital wallet is a piece of software that enables us to interact with the blockchain and therefore access our digital TONIs. It also stores our public and private keys, which the blockchain uses to identify us as the owners of our digital TONIs. Using cryptography, wallets make it possible to attribute assets to an entity, namely to a Wallet Address on the blockchain.

Wallets

In order to interact with a Blockchain, one needs a so-called Wallet. However, the term wallet is unfortunately chosen, because the wallet does much more than manage one's digital currencies or tokens. Furthermore, one's assets are not stored in the wallet at all, rather the wallet only allows one to access one's assets, because cryptocurrencies or tokens never leave the network, they are only associated with different wallet addresses. Perhaps now it is possible to understand why there is a need for a blockchain containing all the transactions that have ever been executed. A bitcoin only exists on your wallet if there is a transaction in the blockchain that confirms that a bitcoin is associated with your address.

A wallet can have different digital and physical forms. There are digital wallets that can be used on a desktop PC as a plug-in in your browser, as an executable program or as a mobile app on your smartphone. These wallets are called hot wallets. They are hot, because they are connected to the internet. As you may now suspect, there are also cold wallets. These are physical wallets. They come in the form of paper wallets, usually with a QR code that allows access to a digital wallet. When you purchase a currency at a cryptocurrency ATM, you usually receive it in the form of a paper wallet. Another and very popular form of cold wallet is the so-called hardware wallet, usually a small device that resembles a USB stick. Popularity of this wallet can be explained by its increased security compared to the other wallets. The most popular brands are Ledger and Trezor. When a person talks about a Ledger, it can be assumed that they mean their hardware wallet. A hardware wallet offers extra protection because the private key is isolated from the Internet, so it cannot be accessed by anyone other than yourself. Additionally, transactions through a hardware wallet are usually to be confirmed by entering a pin or passphrase on the hardware wallet itself. It ensures that no one can move funds without consent.

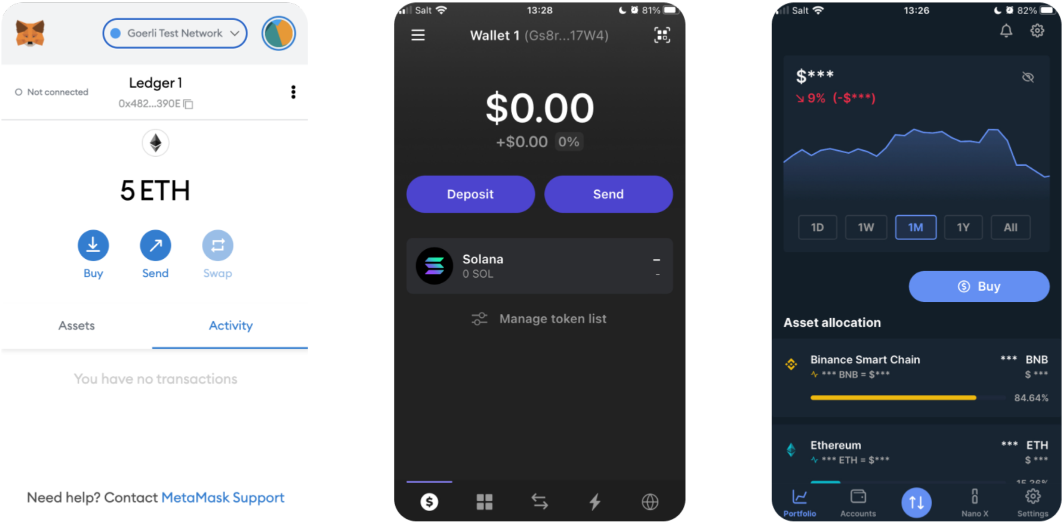


fig. 4 mobile wallets

As mentioned above, wallets are used for more than just managing access to funds. For example, they also serve as an anonymous log-in for DApps. Just by connecting your wallet to the DApp, the DApp recognizes that it is you. Whether your personal data is involved depends on the DApp and you. Furthermore, wallets allow data or information to be encrypted or signed. When using smart contracts, a signature is usually expected on their part. However, if your wallet is linked to your real identity, it can also be used to officially sign legal documents.

How do Wallets work?

When creating a wallet, a process that is usually undergone immediately after installing a plug-in or app, a Key Pair is created for you. In most cases, a Mnemonic Phrase or popularly known as a Seed Phrase is generated for you. It consists of a 12, 18 or 24 randomly composed word sequence. This Mnemonic Phrase is the master password for the wallet. If this Mnemonic Phrase is lost, all the assets, logins and anything else associated with it will also be lost. It should be noted, however, that the Mnemonic Phrase is a human-readable and memorable form of the so-called Private Key. The Private Key can be derived from the Mnemonic Phrase. It is the binary seed of the Mnemonic phrase, consisting of 256 characters. From this private key, a public key is derived. This public key allows other wallets in the network to interact with your wallet. From this public key, the so-called address can be derived, which is needed, for example, if one wants to send Bitcoin to a friend’s wallet. Since the key pairs are derived from each other, it is possible to decrypt a file encrypted with its public key, using its private key, but only the associated private key can do this.

fig. 5 hardware wallet of brand Ledger

To transform a wallet to another device or application, without being limited to how many devices. you want to have this wallet on, you only need to know the seed phrase or the private key. Therefore, it is of utmost importance that these two pieces of information are kept secret and it becomes clear why a hardware wallet uses the private key isolated from the Internet.

Access to a wallet, now allows us to give the vending machine a destination to which it should send the 1 TONI to. In other words, with which address it should let the blockchain associate the 1 TONI with. In most cases, scannable QR codes are used for this as addresses tend to be quite long.

That's it, we have successfully exchanged 2 CHF for 1 TONI. Of course we could also have exchanged 10 CHF and have 5 TONI now, so we could get a drink for every day of the working week without having to think about cash. But how do we get a drink out of the machine?
One might think that we just need to send 1 TONI to the Address of the vending machine. Let's think about this for a moment. Let's say your friend has two beers and is willing to give you one if you transfer 1 TONI to his wallet address. It may depend on how you choose your friends, but it may be that even if you have transferred the token, your friend will refuse to give you the beer. To prevent such situations, our society has invented contracts.

The possibility of setting up such contracts is given on certain blockchains, such as the Ethereum blockchain, through so-called smart contracts. These smart contracts can be programmed by developers and likewise associated with an address on the blockchain.

family pulse fever circle artwork fall
page silk vicious offer injury fatigue

3d08aa180de31e6c9676d2bc4be879da5576c10f996d563c34d61e5945d9fa8e

fig. 6 Mnemonic phrase of a MetaMask wallet & corresponding private key

Ethereum & Smart Contract

Ethereum is an open source, globally decentralised computing infrastructure that executes programs called smart contracts. (Antonopoulos and Wood 2018). Ethereum enables blockchain-based contracts that can hold digital assets and transfer them according to pre-set rules, to a general-purpose computing platform. Anyone can interact with the Ethereum network and participate in this digital economy, without the need for third parties. The peer-to-peer concept enables for a decentralised, more private and censorship-resistant network.

The birth of Ethereum started in 2013, when a young programmer Vitalik Buterin started to think about further extending the capabilities of Bitcoin and Mastercoin. Mastercoin was built on top of the Bitcoin blockchain. The white paper suggests that Bitcoin can be used as a protocol layer on which new currencies with new rules can be built without changing the underlying layer. After spending some time with the Mastercoin team, Buterin published a paper as an alternative way of specifying Mastercoin contracts. It specialised purely in what Mastercoin was trying to specialise in already, namely two-party contracts where parties A and B would both put in money, and then they would later get money out according to some formula specified in the contract (eg. a bet would say “if X happens then give all the money to A, otherwise give all the money to B”) (Vitalik, 2017). Although Vitalik’s idea was impressive, the proposal was too radical to fit into their development. He then published the whitepaper of the idea behind Ethereum. Ethereum is still in the very early stages, but it’s the most used programmable Blockchain network in the World.

Smart Contracts

The term “smart contract” goes back to the US-American computer scientist and lawyer Nick Szabo. He had already described the concept of legally relevant computer programmes at the end of the 1990s. Web-based computer protocols are intended to map or verify contracts and to provide technical support for contract negotiation and/or enforcement. Smart contracts are programmes on the blockchain that work on the basis of an IF-THEN logic, so that when a predefined event (so-called trigger) occurs, a predefined action (e.g. a transaction) is automatically executed. Smart contracts are written in high-level programming languages such as Solidity and Vyper. The state transitions are processed by Ethereum Virtual Machine (EVM). It is a stack-based virtual machine that executes the logic defined in the smart contracts and processes the state changes that happen on this globally accessible state machine. A stack-based virtual machine uses a pushdown stack to store temporary values during program execution.

Why smart contracts matter

Traditional forms of transactions need the third parties that are involved in the process, even when automated. Smart contracts allow validation of the agreement between two parties without the need for validation by a third party. Smart Contracts are transparent. Once a smart contract is published on blockchain, it can be read by anyone who has access to the chain. Smart Contracts are immutable. Immutability is, when a smart contract is deployed, it cannot be changed and is guaranteed to work identically no matter when it is called. This allows smart contracts to act as reliable, trusted third parties.

Since no individual controls the smart contract, it can act as a financial intermediary, trusted automated market maker or much more by guaranteeing impartiality.

A good example for smart contracts is PoolTogether. PoolTogether is a no loss lottery protocol, based on Ethereum, Polygon and Avalanche blockchain. It enables individuals to deposit money and the opportunity to win a prize. Even if they don't win any prize, they keep their money. In 2019 someone deposited $73 into PoolTogether, and in April 2021 they won $43,760 just by saving their money. How is it possible that no one loses their money but can win prizes? Where does the prize money come from?

This process is regulated by a smart contract. When a deposit is made into PoolTogether that deposit is automatically routed to other decentralised finance protocols like Aave to begin earning interest. Protocols like Aave are "fully liquid" meaning deposits can be withdrawn at any time. Additionally interest accrues every ~15 seconds. Anyone who borrows from Aave must deposit collateral that is greater in value than what they are borrowing. This ensures that loans are never defaulted on ("What Is Pool Together? | Pooltogether" 2022). The winner's ticket will be selected randomly after the draw and their Ethereum account will automatically deposit the earned interest. The deposited amount can be withdrawn again from the Smart Contract.

Assuming our vending machine ecosystem runs on an Ethereum based blockchain, it would make sense to create a smart contract to which one would send 1 TONI to in order to receive a beverage. This smart contract would trigger the machine every time the requirements of the contract, such as the receiving 1 TONI, would be met. A Smart Contact is immutable.

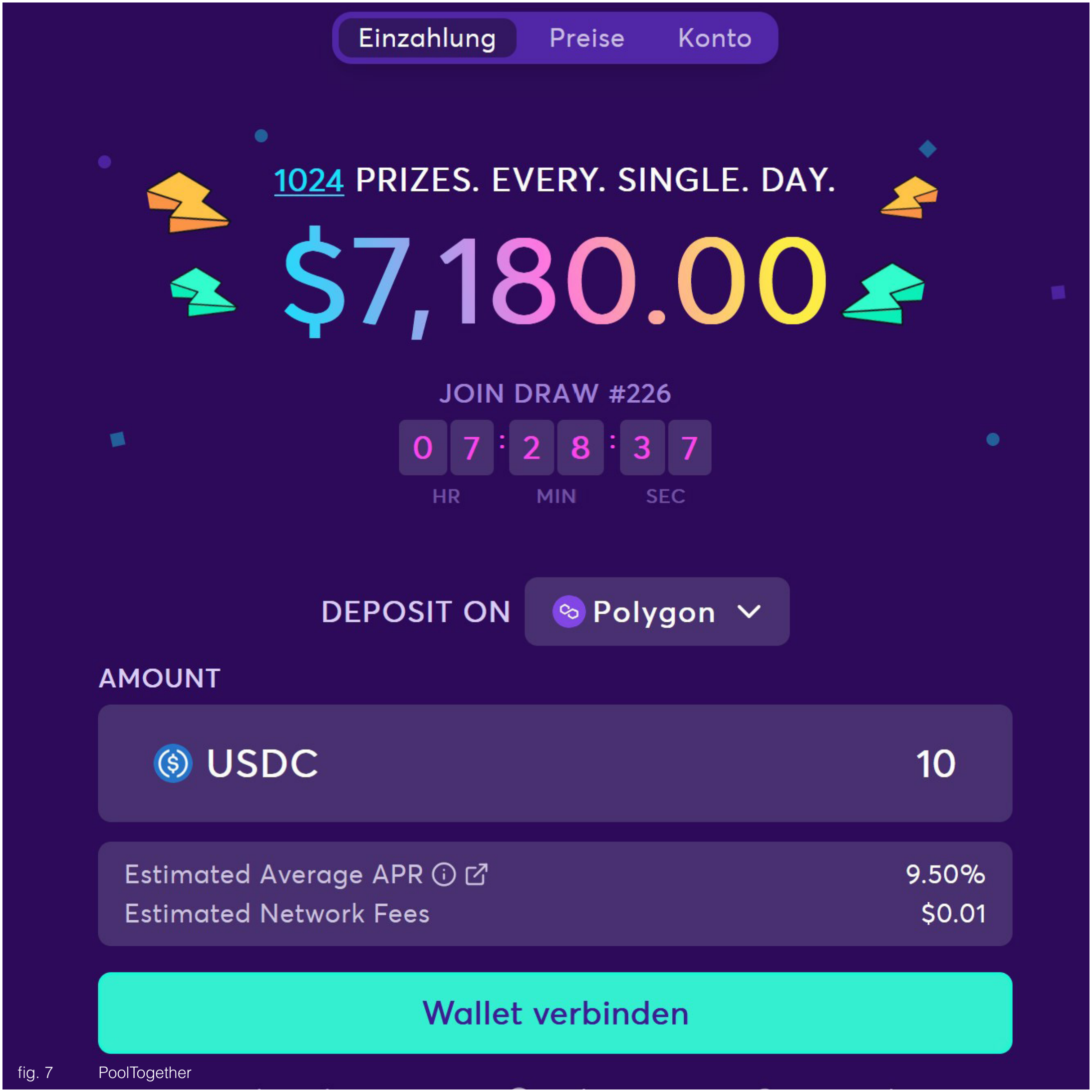


fig. 7 PoolTogether

If 100 people have received a drink through this contract before, we can assume that another will receive it as well. The contracts always have the same outputs with the same inputs. There is no need for anyone else to intervene and hand over the beverage. You sign the contract with the machine and it behaves according to the rules of the contract if you abide by them. This distinguishes smart contracts from contracts as we know them.

Smart contracts can also be used to conduct polls. Users of our ecosystem could send 1 TONI to a certain address that represents a specific drink they would like to be served by the vending machine. A smart contract would then send the TONI back to the sender's address after the voting period. In this case, the token would be used as governance.

Other use cases could be that the machine orders drinks on its own, if the inventory gets low. Since it cannot replenish its inventory itself, there would be a smart contract that opens the vending machine when someone scans its wallet address. This would allow the vending machine to identify the person and reward them with tokens for replenishing its inventory. Other possibilities include, for instance, that the drinks are cheaper for some people, or rather addresses, because they belong to the interaction design program, for example.

It should not be ignored that there is a possibility that a higher authority, for example the university, has an objection to this ecosystem that we have built. As we need a process to convert CHF into TONI and another process to dispense a beverage, it makes sense to develop an application that can be both displayed and operated on the touchscreen. If we now run this application only on a small computer built into the machine, we run the risk

Getting a drink with no TONI yet

TONI Example of use

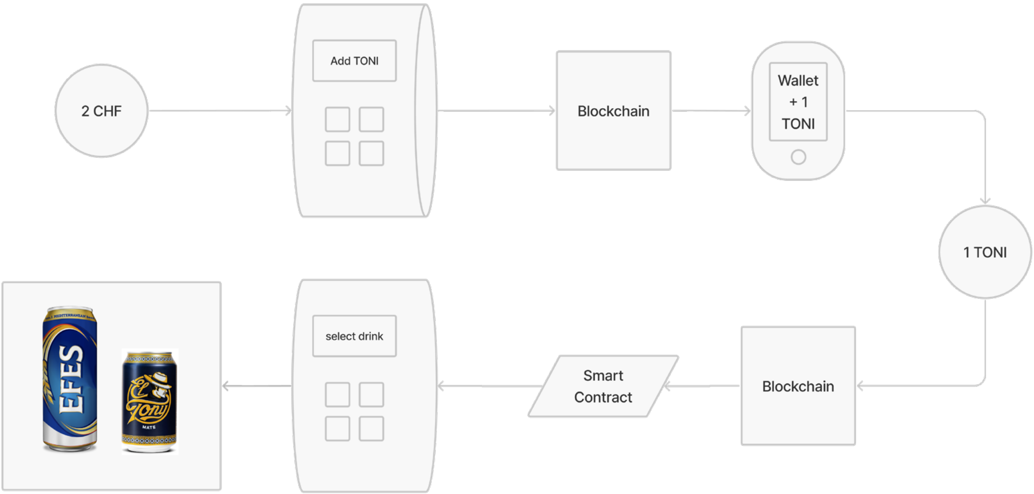


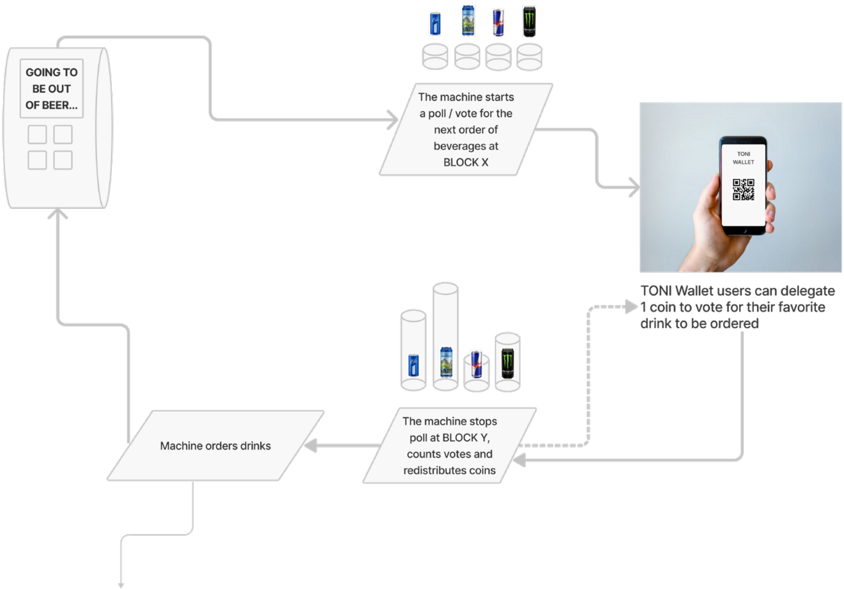
fig. 8 example of use TONI for getting a drink with no TONI yet *of this computer being blocked from network access or that it could be confiscated. In any case, the network issue could be circumvented with a separate mobile Internet access. To make it pointless to confiscate the computer, it makes sense to host an application on the decentralised peer-to-peer network, to create a co-called DApp.*

Decentralised Applications

Our era in Web 2.0 is experiencing the problems of centralised platforms. Richard Serra, a video artist, said in 1973 “if something is free, you’re the product”. Social media platforms, blogging platforms and similar platforms offer the possibility to share content created by individuals. However, as this content is created and stored on the platforms’ servers, it does not belong to the individuals who created it. But not only the content, also the personal data, the usage analysis of the product, and so on, have a commercial value for the platform operators, so that a free product can be offered. The Cambridge Analytica data scandal from 2018 showed us the danger of having our data concentrated in the hands of a few companies. This scandal led many people to delete their Facebook accounts and made people more aware of the importance of privacy. One of the ideas behind Ethereum or similar blockchains is the decentralisation of applications. Decentralised applications offer the same functionalities as well-known centralised applications such as Instagram or Netflix. A DApp may look no different to a user than a centralised application. The difference between an app on Web 2.0 and Web 3.0 is that there is no centralised database that stores the application state, and there’s no centralised web server where the backend logic resides. Web 1.0 is composable because most of the code is open-source and publicly viewable. The fact that the code is open-source

Voting for drinks

TONI Example of use



Ordering supply

Smart Contract Example

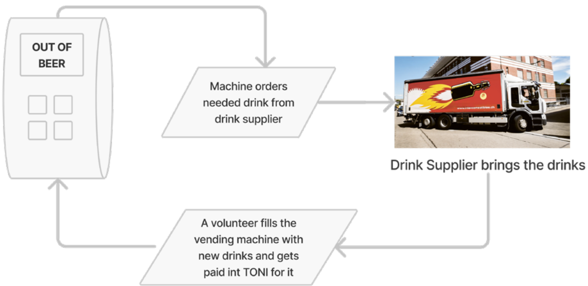


fig. 9 example of use TONI for voting for drinks to order and enabling restock means that it does not belong to anyone, and that anyone who wants to, can build on it without having to reinvent the wheel. On the basis of smart contracts, the functionalities of the DApp are defined, which makes their use trustless, because smart contracts will always behave the same way. The frontend can be written with any known language that can pass commands to the backend. The advantages of DApps is that they are resistant to censorship and control by third parties, such as governments. They are virtually impossible to shut down thanks to the peer-to-peer network. Furthermore, the anonymous login through a wallet means that you don't have to reveal any of your personal data if you do not want to. Transactions are recorded immutable and encrypted in the blockchain preventing transactions or data from being forged. Cryptographic encryption ensures that only those entities can access data intended or approved for it.

Even though we clearly differentiate our token from currencies, it still has a transactional value. For us, the token has a stable value of CHF 2. If we now imagine that someone is paying for a colleague's pizza at lunch, this person could easily send the amount owed to the colleague's address as 5 TONI, thanks to our ecosystem. In this way, financial transactions that would otherwise be made through intermediaries, by means of bank transfers, can be easily carried out using our decentral peer-to-peer network secured by the blockchain. Web 3.0 also offers the possibility of taking advantage of more complex financial products. These offers are summarised under the term Decentralised Finance (DeFi).

Decentralised Finance | DeFi

Decentralised Finance is a collection of services normally provided by banks. A global alternative to the current financial system. Currently, it is possible to lend assets to earn interest, borrow assets, trade assets directly, create a crypto-savings account to earn interest, buy insurance, and even buy derivatives. Simply put, Bitcoin is the first simple application of DeFi, as Bitcoin allows a value to be owned and transferred without any third parties involved, such as banks. Again, Ethereum is at the forefront with its network. Smart contracts make it possible to offer services that do not require intermediaries. DeFi builds strongly on the ideology that anyone and everyone should have access to a bank account. Over 2.5 billion people lack access to the global financial system. (Tapscott and Tapscott, 2016) These people are therefore excluded from the global financial market. DeFi wants to address this deficiency since "[...] no talent or resource is too small to monetize on the blockchain." (Tapscott & Tapscott, 2016)

ETH Build – Functional Prototype

On ethereum.org they put a lot of effort into offering people interested in development and people with an affinity for technology the opportunity to educate themselves. Among other things, they offer a platform for explorative research of different components of blockchain under the link https://sandbox.eth.build/. On eth.build one can create prototype-like constructs, but with which one can also send and receive real transactions in the different test as well as live networks. To validate our concept, we recreated the vending machine prototype in a simplified way on eth.build.

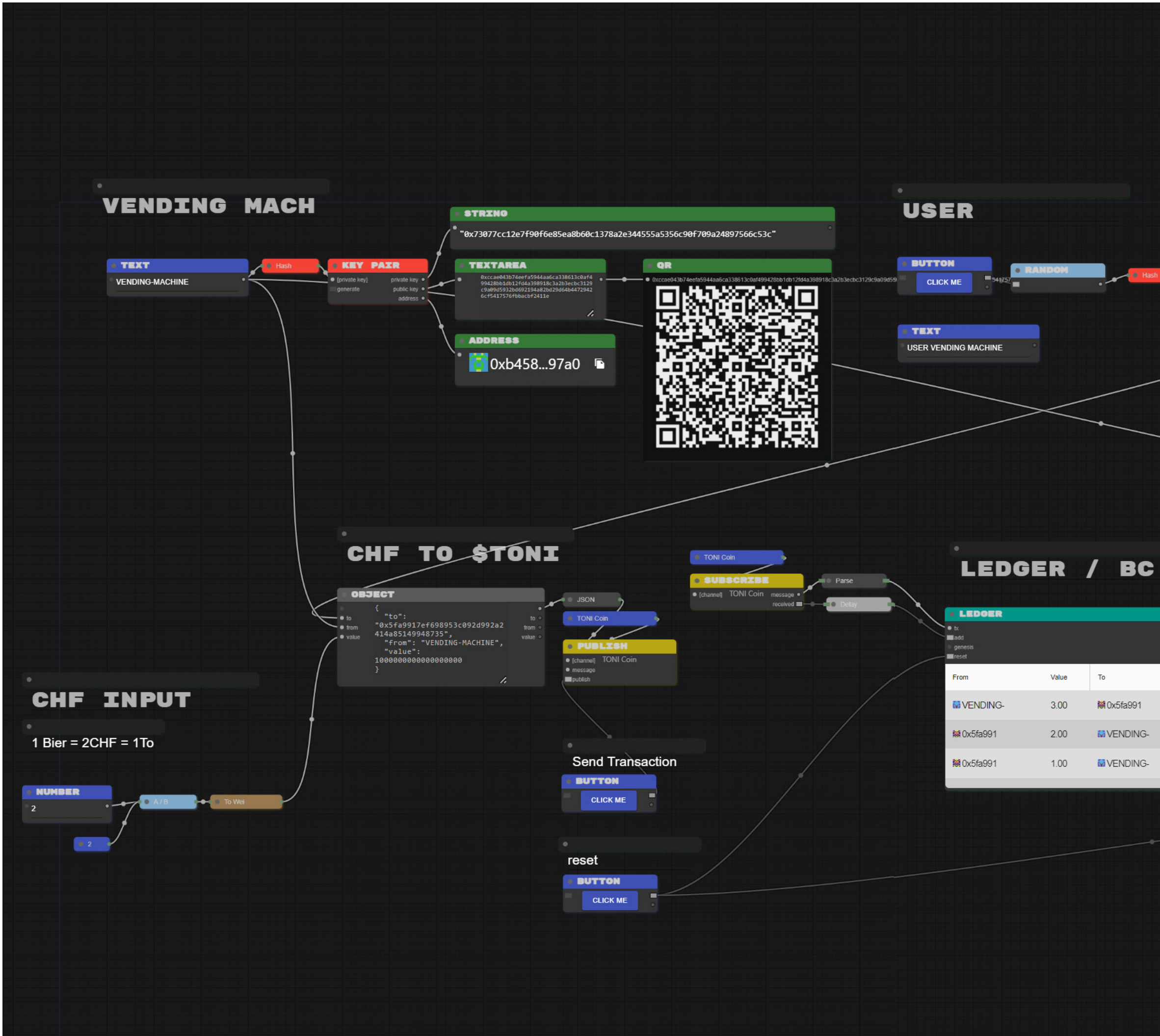
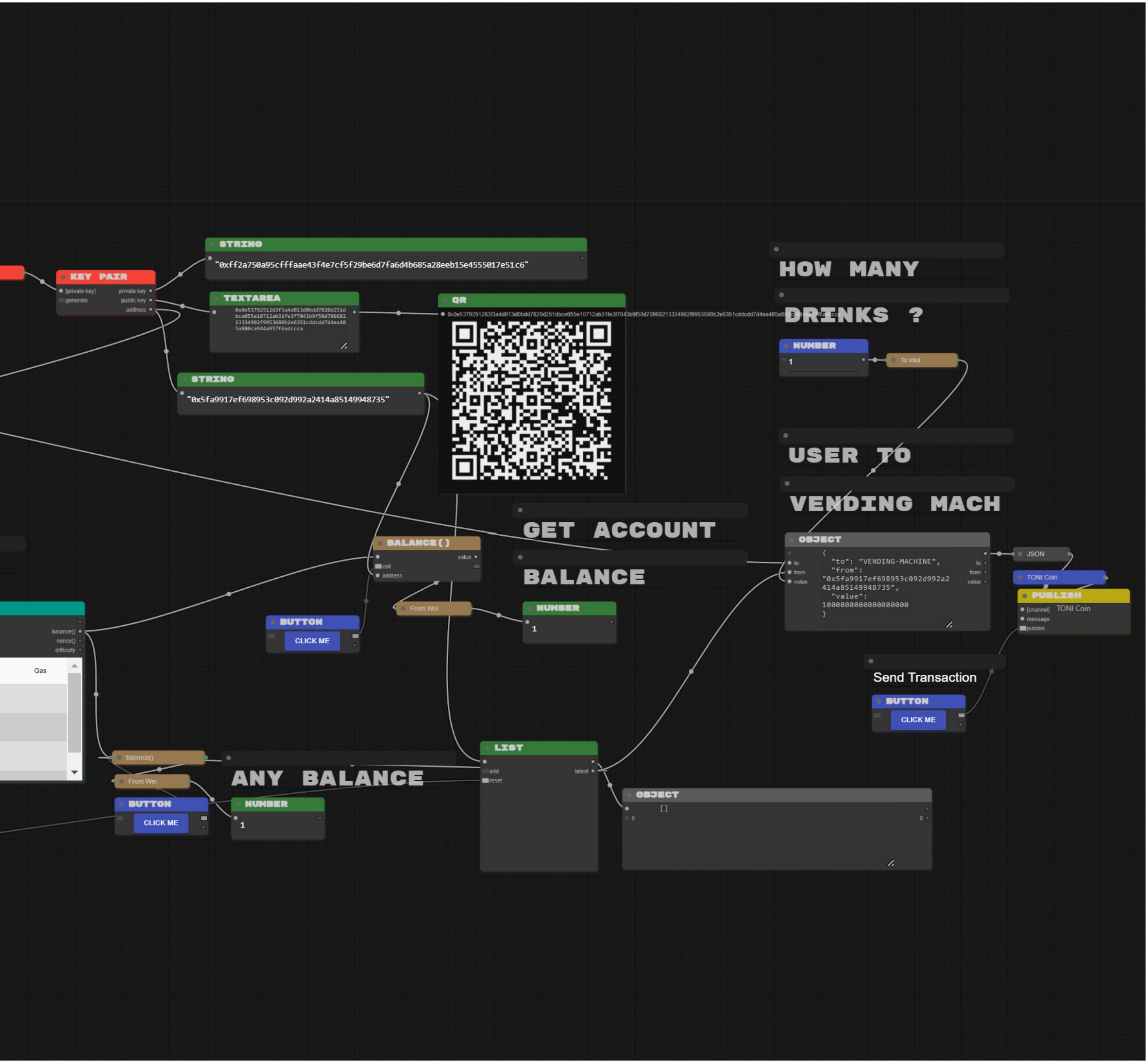


fig. 10 eth.build Prototype



KEY PAIR
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BUTTON
CLICK ME
NUMBER
LIST
OBJECT

The eth.build prototype was a challenge in itself, because we first had to learn how to operate the platform. But once you get the hang of it, you can build and test technical concepts very quickly. The platform is also very suitable for providing interested parties with a step-by-step explanation of exactly what is happening behind the scenes. This visualisation, as confusing as it may seem at first glance, helped to explain exactly what happens during a transaction to people who are not familiar with the technology. Sometimes simplification doesn‘t always seem to be the best solution to explain something in an understandable way.

Findings Vending Machine Prototype

The vending machine prototype allowed us to explore and better understand certain key technologies as well as theoretical aspects behind Web 3.0. By putting Web 3.0 in the context of a real-world application, it enabled us to see more clearly which components are used in which way and for what reason. What was originally a very abstract concept gradually became more tangible for us.

There are many aspects of Web 3.0 which have not been discussed in the past chapter. However, we consider this to be a simplified introduction. Exploring this prototype showed us that Web 3.0 is a construct of different technologies and ideologies. The main building block of these technologies is the blockchain whose strongest attribute is trustlessness. Therefore transactions do not require a third party to mediate or validate them. Users can transact directly with each other, without the need for a middleman like a bank, but for example also Uber or Airbnb.

Regarding a leverage point in which we can put our experience to use, we identified for one, the possibility of a redesign and rebranding of the wallet, which is currently rather incomprehensible for non-experts and pruned to the execution of monetary aspects of Web 3.0. Secondly, we identified a general need to break down this complex construct and make it more tangible. These Findings informed our research questions.

2.2 Research Question & Hypothesis

In this thesis we will explore ways of making web 3.0 understandable for unfamiliar potential users. For this purpose, we have formulated the following research questions according to which we proceed:

How might we create an experience that makes the use of blockchain technologies more understandable and tangible?

How might we leverage existing user knowledge to facilitate their introduction to and engagement in the subject matter?

Our hypothesis is that many potential users are put off by the bad publicity caused by bad actors in Web 3.0. Thus, the complexity of the technology is compounded by a lack of trust in it which discourages potential users.

2.3 Motivation

Our motivation is a simple one. We want to know more and understand which direction the Web will take in order to be able to take part in the design of our digital future. We are active in this field for quite some time, but have only indulged in the monetary aspects of this new Web. Following recent developments in the space, we both separately started to investigate the capabilities of these so highly praised and at the same to so strongly opposed technologies. If history has taught us anything, it is that opposed things usually bring tremendous change when adopted broadly. This space is moving at such a speed, that one has to continuously and constantly stay up to date. It motivates us to be at the forefront of something new for a change. As Ramon Marc, an Interaction Design Alumni from ZHdK, currently working in the field of Web 3.0 contacted Interaction Design at ZHdK, with the proposal of wanting to support Designers willing to indulge in this topic, our decision was as good as made. The field is huge and the demand for good UI/UX design even greater. Even if we can be categorised as digital natives, we see ourselves as digital immigrants (Prensky, 2001) in the Web 3.0 world, we take inspiration from Don Norman’s statement:

> “Modern technology can be complex, but complexity by itself is neither good nor bad: it is confusion that is bad. Forget the complaints against complexity; instead, complain about confusion.”
> (Norman, 2016)

It is obvious that Web 3.0 is a complex construct. We can verify this from personal experience. But we want to confront the complexity and seek out where it starts getting confusing.

2.4 Methodology

We used mostly people-involved methodologies, which were essential for finding a design solution for our intention. The methods we used were not predetermined; instead, we have tried new methods to answer the questions we approached. Our process has been a valuable learning experience for everyone involved.

Interviews

We have decided to make interviews in order to get the perspectives of people who are or were already engaged in the field of Web and/or Blockchain. The interviews were conducted with people who have been part of the evolution of the internet and blockchain-based Web 3.0. The most valuable insights we have gained from our participants were the critical aspects of the current state of Web 3.0 technologies.

Participatory Talks

The aim of participatory talks were to determine the sentiment, attitude, and general knowledge level of people unfamiliar with the topic. The participatory talks were about cryptocurrencies, how to buy them, and the different uses for them. The participants had varying levels of background knowledge on the topic, which led to some interesting discussions.
We have found that the participatory talks were very beneficial in helping people understand the topic of cryptocurrencies, Web 3.0 applications, and power consumption. It was also helpful in sparking interest in the topic and getting people engaged in the discussion.

Conversations

At every possible opportunity, we talked to people around us about blockchain and the development of Web 3.0. These conversations - out of pure interest - turned out to be one of the most effective methods we used. The outcomes have strongly influenced our problem definition and design solution.

User Observations

Observation of users helped us to learn a lot about how users interact with technology and what their needs are by observing them in their natural environment. This helps us identify problems they may have with existing technology so we can address them in future designs. Plus, observing users creates a shared understanding, which leads to more effective communication and collaboration.

Prototypes

Our project explores various aspects of blockchain technology in more detail through prototyping and experimentation. The findings of these experiments and prototypes led us to more specific examinations and prototypes. The prototypes became more meaningful and valuable when we tested them with the audience in order to get feedback for our design idea.

Bodystorming

To understand how our ideas can be represented in various ways, bodystorming became a powerful tool for ideation, allowing ideas to be developed and tested quickly and in a physical way.

Hacking

Hacking things helps us figure out how they work and make them work better or in a different way than usual. In trying to figure out how to experience the Web 3.0 in a tangible way, hacking a vending machine in our Atelier helped us to think further.

3 Concept

This chapter first examines the professional experiences and personal opinions of two people regarding the web and blockchain technology. Then, we leave the bubble and analyse the outcomes of the presentation on Web 3.0 and Blockchain technology heard by six people without any experience with it, different in age and profession. After thinking about the difficulties of getting started with Web 3.0 platforms and to understand what questions unknown users ask, we observed people creating a crypto wallet. We will then discuss the prototypes for our design project. Based on our methodological findings, we will discuss our perspective and present the final concept in detail.

3.1 Field Research

The main part of our work so far consisted of the examination of new technologies as well as related terminologies and their explanation as an incorporation into a treatise of the history of the web. This work could be done fairly easily by conducting desk research and the exploration of existing codes and applications. However, we have realised that due to our age, our lack of experience and our recent entry into Web 3.0, we do not have an authentic connection to the concepts and processes we are exploring as well as writing about. Therefore, to broaden our field research we have been looking for interview partners who could provide us with their personal experiences and enable us to put our knowledge into an authentic context.

Interviews

We have decided to interview people who are or were already engaged in the field of Web and/or Blockchain to get their perspectives. The purposes of the interviews were to explore professional experiences with the emergence and evolution of the web. Our first interviewee is someone who has been professionally involved in e-commerce for 30 years. The interviewee is special because of their long-term involvement in e-commerce and their personal evolution of the web.

Our second interviewee was a person who interacts with Web 3.0 on a daily basis. The goal of this interview was to gain insight into the life of someone who actively uses various services of Web 3.0, and to learn about their opinions on the current state of Web 3.0 technology. We used a conversational method to gain insight into their experiences of the two interviewees.

Evolution of the Web

Age:

65

Background:

After their training as detailed economists, they became acquainted with the newly emerging World Wide Web and its possibilities for customer acquisition through their work for a global enterprise. They created the first website of this company in Europe. Out of their own interest, they continued their education in this field and founded their own company, which developed and maintained web pages. They later applied this knowledge into the development of e-commerce platforms for a large Swiss company in the position of a project manager. Aiming to explore more personal experiences with the emergence and evolution of the web, we conducted an interview with a person professionally involved in e-commerce for 30 years. Rather than asking specific questions, we only gave one assignment in this interview, which was: “Tell us about your life with the Internet from the first interaction until today.” Leading us into a fascinating six-hour journey through stories and anecdotes related to a specific technology or web-related job. Working in the car rental industry in 1986, he encountered computers as tools to manage bookings with an Excel-like tool but not yet with the internet. For him, the whole history of the Internet began in 1996 with the commercialization of the Web. Stating that there were some ambiguities at the beginning about the new emerging terminology of the Internet. Remembering that there was quite a lot of confusion about the differentiation of the two network types of Intranets and Internet, because the Intranet was more commonly used at the time. Fortunate enough to have an acquaintance hosting server for said Internet, on which he hosted their first email accounts, he began to gradually immerse himself in the rapidly emerging area and learned to code. Adopting the mindset of forward-thinking companies, he quickly set about bringing the American-based company he worked for, which already offered a website for the U.S., online in Europe. He initially started with a pure HTML 1 website that referred to offers through hyperlinks. Quickly adding the possibility of making reservations by filling out a simple form that sent an email to employees of the car rental company, who in turn copied the data by hand into a database. Changes in prices had to be entered manually for each vehicle class every Monday. Regarding this time, he specifically remembered the emergence of the company Swissquote, of which they were one of the first customers. Swissquote made it possible for them to obtain daily stock market data by email as a CSV file. A true revolution for that time, in which only banks had access to this raw data. Spurred on by the financial opportunities they saw in this data, its analysis through self-written code and the emergence of Internet companies, he began writing his own analysis tools. He described the next few years leading up to the bursting of the dot-com bubble as euphoric, a feeling of being at the forefront of the emerging new world. Ultimately, this meant that they and their workmates were occupied with stock market data in the mornings and in the afternoons, he dealt with the daily business. At the same time, database technologies have become more and more sophisticated. Acknowledging that there were communication problems between the marketing department and the IT department, he founded their own company. He pointed out that there was and still is, a culture of IT representatives expressing themselves in such a way that the marketing department does not understand what exactly they are trying to say. Remembering that, when someone from the IT department says what they have done, they usually do not say what effect their actions have on the other users of the infrastructure. A discrepancy that led and still leads to a lot of disagreements and mistrust. Highlighting that there is a communication bias from technical staff towards other personnel, which is as relevant today as it was back then. He sees the transition to Web 2.0 as when he was able to “[...] enter something into a database and that data is displayed on the website.” In this interview we also discussed many technical terms, the explanation of which would exceed the limits of this paper as well. Mentioning in passing that no one was using Photoshop because it cost 12’000 CHF, ending with specifically noting that the whole development of web technology “[...] allowed the smallest entity to participate in commerce without middlemen and without the cost of unnecessary intermediaries.” A statement strongly reminiscent of the promises of Web 3.0.

Findings

The interviewee discussed his experience with the internet from 1996 onwards, when the commercialization of the web began. He described the early days of the internet as being confusing, with a lot of new terminology emerging and how he believes that there is a communication bias from technical staff towards other personnel in the business. The emerging new terminology is confusing and reminds us of the current state of blockchain and Web 3.0 technology in our daily lives. The reason for the communication bias between technical and non-technical people could be this confusion of terminologies and the non-knowledge of working principles of the technologies.

Extreme user

Age:

38

Background:

They work in the field of cyber security and came across the topic on the basis of a physical representation of cryptocurrencies, a Bitcoin ATM. They have been passionately involved with it ever since. We interviewed an individual who actively uses various services of Web 3.0. He started his journey into Web 3.0 in 2016, when he became curious about Bitcoin vending machines. He has experienced a lot of the transformation of this fast-moving field firsthand. The individual works in the field of Cyber Security, and was already familiar with cryptography, which made it easier for him to get started. However, he explained that it required a lot of effort to understand and contextualise the basic concepts of different cryptocurrencies, processes, and mechanisms. He had to do a lot of research on his own, utilising resources on the internet and accumulating knowledge through books, before he felt he had a basic overview that allowed him to interact consciously and be aware of what is happening behind the scenes. In his opinion, the entry into Web 3.0 depends strongly on the understanding of concepts and their interconnections. He sees a prevailing bias in the fact that these technologies, which are supposed to benefit all of humanity, can only be used by people with a pronounced "IT affinity". Furthermore, as a cyber security expert, he is rather critical of the concept of Mobile First in Web 3.0. He argues that many different functionalities come together on the smartphone, and we interact with all kinds of shady links, applications, and files through our mobile devices. The risk of being compromised is increased in this context. Forced to use certain tools to access the services he desires; he complains about the lack of functionality of tools such as the known wallet called MetaMask that he has to use in order to interact on the Ethereum network. "MetaMask is shit". This sentiment towards this tool stems mainly from the fact that in his experience, the tool is not reliable, not versatile enough and leaves a lot of room for improvement of the intuitiveness of use. Transactions are not always properly executed, and they desire certain functionalities, such as automation of workflows that are not yet integrated. He is critical of the promise of the complete decentralisation of Web 3.0 services because he realised that dAPPs, in one way or another, always need to be able to interact with a Blockchain to make modifications or display a current state. Realising that a mobile device or browser is not capable of hosting a blockchain and that one must rely on centralised services to enable interactions with blockchains nodes, the construct of decentrality quickly falls apart. He states that so-called remote procedure calls (RPC) as of now, are processed by very few providers and the outputs of these requests are simply trusted even though these providers could alter them. So, if I was to request my account balance using the MetaMask wallet, the RPC processing service Infura could tell me that my balance is 10 even though my actual balance on the Blockchain is 100. No matter how decentralised a network is, if all requests and responses must pass through a single centralised entity that is able to alter them, the whole decentralised infrastructure is useless.

Findings

The individual has been using various services of Web 3.0 since 2016 and is familiar with the basics of cryptocurrencies, processes, and mechanisms. He mentioned that the people who are not familiar with IT concepts have a hard time getting started. There is a prevailing bias in the fact that these technologies can only be used by people with a pronounced “IT affinity”. One of the reasons for that could be that the entry into Web 3.0 depends strongly on the understanding of concepts and their interconnections. MetaMask as one of the entry points to interact with Web 3.0 is, from his perspective, not reliable, not versatile enough and leaves a lot of room for improvement of the intuitiveness of use.

Participatory Talks

While talking to other people about our thesis, it became apparent that there is a lot of interest in what Web 3.0 and in particular blockchain is. So we promised two people to organise an evening where we introduce them to the topic in the format of a presentation accompanied by dinner and wine. For the preparation, we asked them to specify what exactly they were interested in knowing more about.

The questions were:

> What are Cryptocurrencies and how do they work?
>
> How can I buy Cryptocurrencies?
>
> Why is it dangerous?

During the two-week preparation period, word of our event spread and our circle of participants grew to six people. Four more People with more different interests.

> How does this cryptography work?
>
> Why does the price of Bitcoin keep rising?
>
> It uses a lot of electricity right, why is that? And to be clear I don’t support it!

What is Blockchain?

What is mining? Can I do that too?

Is there a possibility to make it more environmentally friendly?

In addition to addressing these questions, our presentation also aimed to gauge the sentiment, attitudes, and general knowledge of people unfamiliar with Web 3.0 and blockchain Technology. The participants consisted of four women and two men, ranging in age from 24 to 65 years old. Their fields of activity were in different areas, including a commercial employee, management assistant, social pedagogue, CEO, and workshop manager. The presentation included accessible explanations of how cryptocurrencies work, examples and explanations of Web 3.0 applications, explanations for the topic of power consumption, blockchain and many other aspects. We asked the participants where their biggest interests lied at the beginning of the presentation. All six participants wanted to know how to buy cryptocurrencies initially. Therefore, we started with this prepared section of the presentation, where we pointed out the difference between centralised and decentralised exchanges, described different currencies and their functionalities, as well as discussed access through wallets or accounts. As simple as it sounds, it was not. There were many preliminary questions to be answered and gaps in understanding or incorrect concepts had to be addressed. In particular, several questions on general financial terms had to be clarified. Beginning at FIAT currency and ending with compound interest. As crypto currencies appear to be very similar to conventional currencies at first sight, many questions arose about comparisons with conventional providers of financial services such as banks. “Do I have to think of it like a bank?” was a recurring statement. This encounter being overshadowed by a recent ransomware attack on a Swiss car dealer which was forced to pay the ransom in Bitcoin, made the constantly reappearing issue of security a pressing topic in our discussions again. Being used to the fact that monetary activities are subject to numerous regulations, this too was an area of intense discourse, which was essentially also tied to the question of accountability of cryptocurrencies. “Who’s controlling it and what do I do if something does not work?” The questions also revealed varying degrees of background knowledge of economic matters, which in turn excluded some of the participants in their discussions. Needless to say, we have not only prepared slides for the purpose of explaining different aspects of Cryptocurrencies, we also guided the participants through the process of creating an account on one of the biggest and in our eyes one of the most secure centralised exchanges called Binance. To avoid them having to invest their own money right from the start and to allow them to immediately experience some of the functionalities of the Binance APP, we prepared vouchers with a value of 20 CHF each, which they could redeem in their account and play around with. After four hours of this mix of workshop, discussion, presentation and user-testing, four of the six participants had installed the app and three of them had verified their account. All of these three participants had made at least one transaction with the gifted amount. We offered further support by creating a group chat for questions concerning the topic. Furthermore, we provided personal support in the weeks following the meeting if this was desired. In general, though, they were rather overwhelmed with the functionalities of the Binance Exchange App even though it provides a light mode for users with limited needs and some low level tutorials to get started.

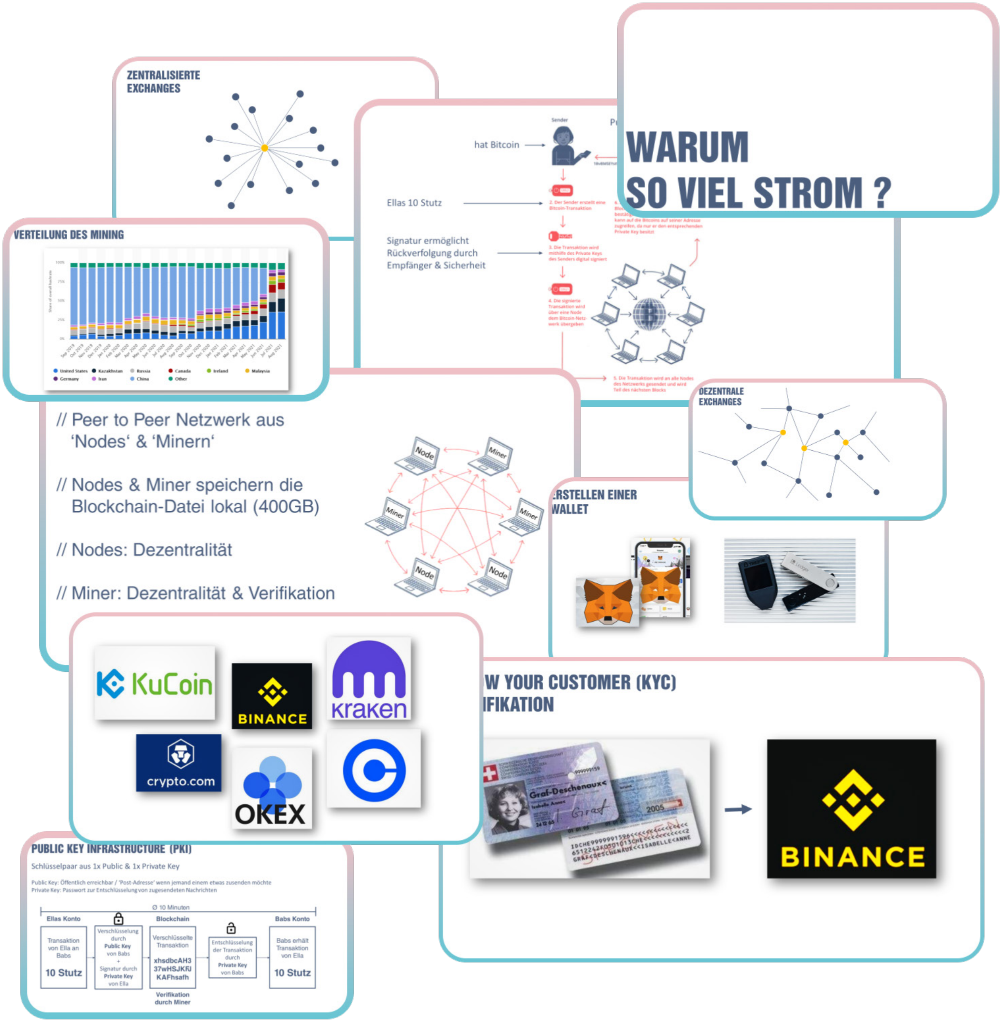


fig. 11 selection of slides of the presentation

Findings

Many participants had difficulty creating an account, which indicates that creating an account is more difficult than in Web 2.0. The topics we presented raised interest and many questions. There was a lot of interest in the topic of electricity consumption. People had questions about comparisons with conventional financial service providers. They were also concerned about security and regulation. Our experiment with the Binance app showed that people can‘t get into Web 3.0 and interact there because they lack the knowledge and there is a lot of ambiguity in their minds that can‘t be easily clarified due to complicated and incomprehensible resources for non-IT people. In addition, we have learned that the lack of trust in the technology is not primarily due to bad publicity, but rather to plain confusion.

fig. 12 insight into the presentation

User Observations

The aim of making the Web 3.0 space understandable for all people has led us to discuss the onboarding process. Onboarding to Web 3.0 platforms or protocols typically starts with connecting a wallet. Technically, this means that the person proves ownership of an account by signing part of the data with a private key.

We wanted to find out what the difficulties are in creating a wallet, what questions unfamiliar users ask, and what the general process is for creating an account. We observed three people by installing the MetaMask browser extension.

MetaMask is a Web 3.0 crypto wallet in a browser extension format or in app format for mobile usage. It is the primary way used for the Ethereum ecosystem to interact with smart contracts. 17,000 Web 3.0 domains – mostly decentralised finance applications - are integrated with MetaMask for interactions. Since it's so broad, the entry point of a new Web 3.0 user is typically downloading the MetaMask extension to start interacting with the Web 3.0 world.
Three people were tested on how they install MetaMask on their computer, respectively what steps they follow, and what they think when installing. Two people were tested with the computer we provided. In this case the installation was done on a virtual machine because there are many malicious copies of this plugin in circulation, and we did not want to expose the personal devices of the test subjects to any danger. We have opened the website https://metamask.io/ before the test and invited two participants to sit in front of the computer. We have seen that people do not deal with a browser or computer unfamiliar to them as they are used to, so we decided to do the test once

fig. 13 insight into user observation

with the personal computer of the test person with consent.

All participants scrolled through the home page of MetaMask, trying to find what to do. None of them clicked “Download” immediately, because they were unsure if that was what they needed to do. The first test person downloaded the extension after 20 seconds. The second person visited the FAQ and found the answer they were looking for. They felt insecure on the Add-on page of Firefox, because MetaMask Plugin was marked as unchecked, which made them unsure about downloading the extension. Nevertheless, they downloaded the extension. The third person we tested with his personal computer was concerned about the permissions the plug-in required and took a minute to consider and discuss with us whether he should download it. After that, he downloaded it. Two people created the password to access the wallet using a password manager. The third person shared that he usually does not use a password manager, but he would like to start using one. MetaMask showed a video with the title “Your MetaMask Secret Recovery Phrase” before generating the secret recovery phrase. The main idea of this video is to explain what a Secret Recovery Phrase is, what can happen if third parties have access to it, how it should be protected, and what it is for. The difference between traditional websites with a central database and MetaMask is explained by the example that traditional websites have central databases that control and recover accounts, while in MetaMask all the power belongs to the owner of a master key. The video recommended writing down the master key, hiding it somewhere, keeping it in a safe deposit box or using a secure password manager. The message was “whoever holds the key, controls the accounts.” All participants voluntarily watched the video to the end. Afterwards, they wrote the master key in their notebook or on a piece of paper. The third person wrote the master key in a notebook and angled his laptop so we could not see his key.

Findings

Users have different needs when it comes to creating a password. Some like to write it down physically and hide it so that only they can recognize it, others rely entirely on the password manager. Storing the master key also raises the question of how to deal with other passwords and shows the convenience of centralised platforms with their password reset mechanisms. The installation of MetaMask took between 6 to 12 Minutes. After setting up the wallet, one attendee asked us what the fastest way was to get cryptocurrencies into the wallet. Crypto wallets are primarily designed for cryptocurrencies and not for other Web 3.0 functions. Some changes need to be made to the user interface to convince people that it can also be used as a login.

Prototypes
Building an own Blockchain

After theorising about it we wanted to know if it was actually possible for us lay people to connect the vending machine from 1994 to the blockchain in order to introduce people to the process of creating a wallet and using it to make transactions. The vending machine would use a stablecoin like TONI to provide people with drinks that are valued at two Swiss francs. The machine would be connected to a blockchain that does not deduct any fees for transactions, as usually thes casel, making it more convenient for people to use.

To use the vending machine, people would first create an Ethereum-based wallet, exchange the Swiss franc for the token of the vending machine, and use the token to make the transaction or buy a drink from the vending machine. This idea aimed to introduce people to a wallet creation process and get them to create a wallet or take the first step into the Web 3.0 world. The public blockchains like Ethereum usually require a gas token. Gas refers to the fee or price required to successfully complete a transaction or execute a contract on the Ethereum blockchain platform. However, the term is often used to refer to transaction fees in the Web 3.0 world. In the Ethereum blockchain, gas is paid for with ETH. The price for it is unstable. The drinks that the vending machine supplies are valued at two Swiss francs. The token that is used to buy the drinks should also have a stable value so that people do not make a loss or profit. For this, a stablecoin is needed. Stable coins are cryptocurrencies that try to link their market value to an external reference. Stable coins can be pegged to a currency like the Swiss franc or to the price of a commodity like gold.

Since the transactions in the public blockchains - in this case we take Ethereum - are possible with a gas token, the vending machine user in our case has to convert their cash to ETH in addition to the token of the vending machine, which is stable in value against the Swiss franc, in order to be able to carry out a transaction at all. To avoid this, there is the option of building a blockchain yourself that does not have a gas price.
We decided to build a blockchain based on ConsenSys Quorum. It is an open-source protocol layer that enables Ethereum for private or public production blockchain applications. As an enterprise Ethereum Client, we choose GoQuorum. An Enterprise Ethereum Client is a supplement to Main Ethereum Client with extra features.

We choose the cloud based virtual machine with following technical properties for installing our blockchain.

```
Ubuntu Server 20.04 LTS
8 GB RAM
4 Intel CPUs
160 GB NVMe SSDs
5 TB transfer
Location Frankfurt, Hosted by DigitalOcean
```

GoQuorum requires following installations in the server:

```
Node.js
Docker and Docker-compose
Truffle
Curl command line
```

The Ethereum client requires a minimum number of four participants which keep the peer to peer network running and confirm transactions through the consensus mechanism. We set up four of these so-called nodes on our own server to validate the blocks and verify the transactions. We installed the web block explorer to display the blocks in a web application.
To monitor what is happening on the chain, how many coins are circulating, how money accounts are interacting with our chain, we installed BlockScout to see this in a web application. We configured 1000 TONI in the chain for testing purposes. We created an independent Ethereum account in MetaMask as an owner account and registered it in the chain. The first transaction with Baran's Ethereum account and from our private blockchain was successful. The transaction could be performed and in less than 30 seconds the tokens were on Baran's Ethereum wallet.

Findings

We have seen that it's possible to connect a vending machine from 1994 to a blockchain in order to introduce people to the process of creating a wallet and using it to make transactions. The vending machine would use a stablecoin like TONI to provide people with drinks that are valued at two Swiss francs. The machine would be connected to a blockchain that does not deduct any fees for transactions, as usually the case, making it more convenient for people to use. To use the vending machine, people would first create an Ethereum-based wallet, exchange the Swiss franc for the token of the vending machine, and use the token to make the transaction or buy a drink from the vending machine. This idea aimed to introduce people to a wallet creation process and get them to create a wallet or take the first step into the Web 3.0 world.

Interconnections of the Webs

The intention with this prototype was to explore how interested people are in learning about different technologies in their connection to different versions of the web. For this purpose, we used a paper prototype that addressed the concepts of Protocol & Plattform, Static & Dynamic, Decentralised & Centralised, Ownership, and Forms of Access to the Web. The Interface in principle consists of three circles, the smallest referred to as Web 1.0, the middle one as Web 2.0 and the outer one as Web 3.0, terms were inserted into the respective version using smaller circles and connected using lines. For more detailed explanations that went beyond the visual and visualisation, we used QR codes whose content could be read directly in the camera application. The characteristics of the web changed in phases: the first web was decentralised, the second centralised, and Web 3.0 is a mixture of centralised and decentralised applications. The protocols were the main core of the first web, but in the second web, the platforms became the priority. In the third web, both characteristics are seen, but the protocols are again the main core. Web 1.0 was read-only, and the content belonged to the producer. In the second web, the content belonged to the people or companies that profited from it. In Web 3.0, the ownership changes again, so that people own content created by them. This explanation shows us the same characteristics of the web, the changes in the different phases, and the differences in the meantime.

The visualisation is intended to make these connections easier to understand. We highlighted interdependencies by connecting circles. This prototype should enable an exploratory examination of terms and concepts and resulting states of the Web today. It should be noted that we see this prototype as a snapshot of an interactive installation on a screen or beamer. This prototype has been tested with three different people.

Findings

This prototype showed us that the interest in developments over the different time periods in this manner does not seem to be particularly interesting. Even though this is a low fidelity paper prototype, it would have been useful to use colour for differentiation and a larger font size for better readability. The use of QR codes to access additional information when needed was perceived as helpful and amusing, especially because the code did not have to be scanned but could be read directly. In a further step, we want to make the various topics and terms an interactive experience with colours by means of digital click dummy prototype.

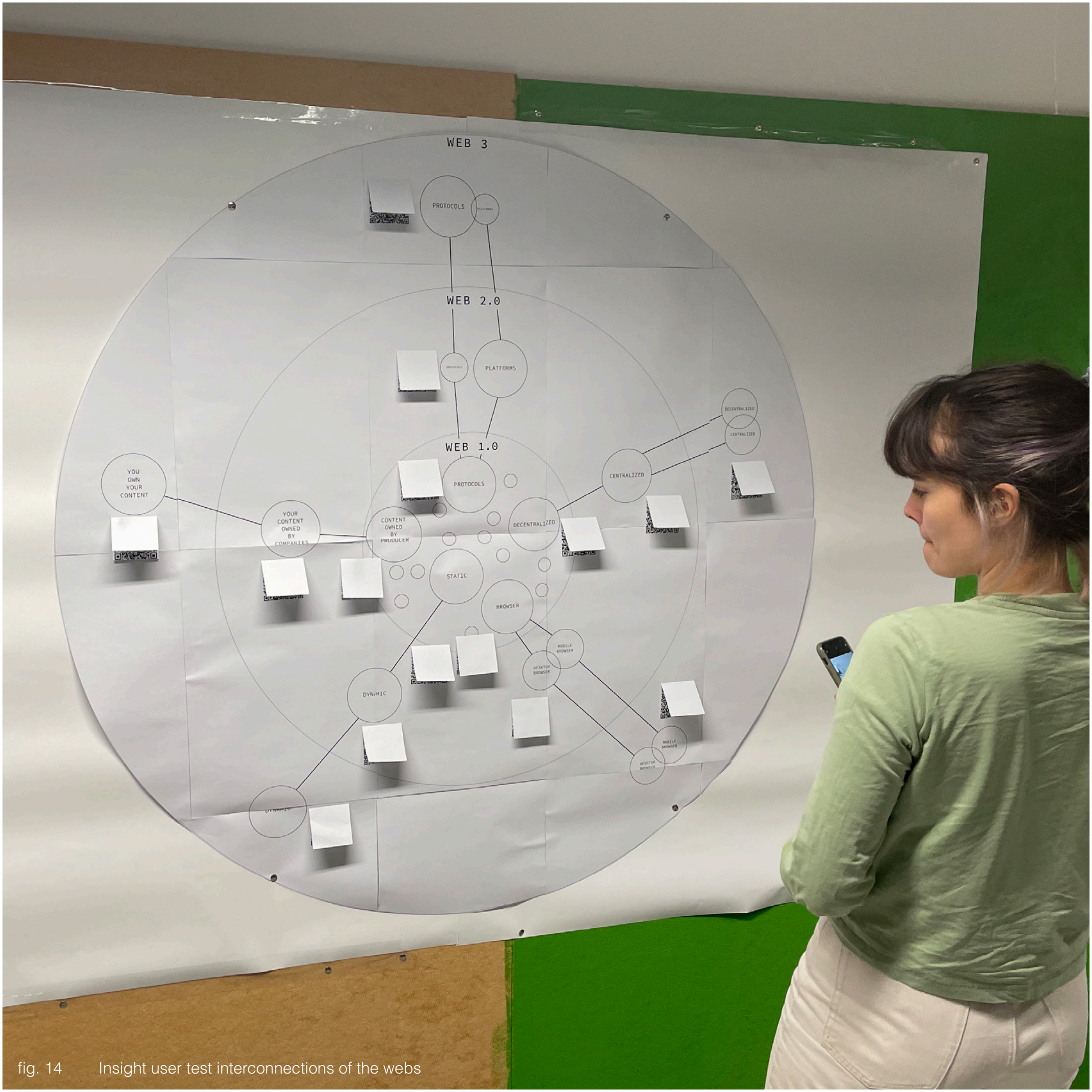


fig. 14 Insight user test interconnections of the webs

fig. 15 Insight user test interconnections of the webs

fig. 16 prototype interconnections of the webs

What is which Web?

In order to understand the features, concepts, and terms of the web, you need to have some prior knowledge. The history of the web from 1.0 to Web 3.0 has both differences and similarities. It is important for us to understand the idea of the Web and its evolution, so it can be valuable to look at the past and compare it to the present.
Our second prototype has the goal to interactively visualise Web terms and concepts from all phases, in order to make differences and commons visible. We wanted to arouse users' curiosity and make them want to know more, so we created simple explanations that are displayed when you hover over a certain term. We have described the following web phases with relevant concepts, terms, platforms, and technologies:

Web 1.0: Read only, HTTP, central server, decentral, HTML, Protocol based

Web 2.0: HTTPS, central server, functionality, Platform based, WhatApp, sharing content, HTML, Amazon, iPhone

Web 3.0: Wallet, IPFS, sharing content, HTTPS, HTML, Protocol based, functionality, iPhone, Crypto, trust, owning data, decentral, community-governed

This prototype was created in Figma. We tested it with two people and both were curious and first went to the words with the mouse, read different terms. Then they first pressed Web 1.0, saw the relevant terms and went through these terms. After that, it was a matter of them comparing the differences and similarities of the different versions of the web. They also went through

Web 2.0 and Web 3.0. They both wanted the three different phases to have three different colours to create an overall picture at first glance. One person wanted the other words to fade out when reading the explanation of a term to keep it cleaner on the screen. Both understood the concepts, but for them there were still too many technical terms included that could be explained in a simplified way with examples from everyday life.

Findings

We see that the visualisation of connections helps comprehension and that conveying a digital idea in an analog way requires a lot of imagination. Even if it is a low fidelity prototype, it would be beneficial to add some colour. The integration of animations as well as images would also be advantageous in the next step. Leaving certain things open, not explaining exactly what is happening, is unsettling for some but also encourages people to examine the prototype more closely. We realised that instead of clarifying the technical terms and their meanings, a non-technical, human explanation is needed to make communication and understanding easier. The topic of Web 3.0 is versatile and there are many subtopics that could be addressed. However, one topic that keeps coming up is blockchain. Everyone has heard of it, but no one really seems to know what it is. For some it's just too complex, for others it's a waste of time because to them it appears to be all about cryptocurrencies, while others don't dare admit that they don't know how it works, so they outright lie about it. The topic of blockchain is indeed a complex one and many tech savvy people are interested in learning more about it, but the interest of the rest of the population seems to be very limited as a result of this perceived complexity. We believe strongly that this lack of knowledge must be resolved. “According to experts, apart from disrupting financial services, blockchain could end up transforming a number of important industries, from healthcare to politics, whereas it has the potential to create new foundations for economic and social systems.” (Politou et al., 2021) There are many use cases for blockchain technology beyond cryptocurrencies, and it is important to understand how it works in order to make informed decisions about its use. Therefore we will focus on creating digital literacy about the topic of blockchain and its associated technologies.

WEB 1.0 WEB 2.0 **WEB3**

READ ONLY	WALLET	SHARE CONTENT	PLATFORM BASED
HTTP/S	IPFS	HTML	WHATSAPP
CENTRAL SERVER	PROTOCOL BASED	FUNCTIONALITY	AMAZON
IPHONE	CRYPTO	DECENTRAL	COMMUNITY-GOVERNED
TRUST	OWNING DATA		

The InterPlanetary File System is a protocol and peer-to-peer network for storing and sharing data in a distributed file system.

fig. 17 screen prototype what is which Web?

Gripping Blockchain Prototypes

Due to its digital nature, blockchain is essentially non-physical. Of course it incorporates physical components like servers, network cables and so on, but the basic operations are only visible in a user interface or in code. We have therefore addressed the question of what would happen if the blockchain and its functionalities were brought into physical space. Through bodystorming and the utilisation of artefacts, we started to reflect on what our work might look like in the physical space and what impact the physical form might have.

Bodystorming Blockchain

A tangible representation of blockchain can help people to visualise and understand the concept of blockchain. We used bodystorming to create an idea for the physical representation and interaction with blockchain because it is a powerful tool for ideation. It allows you to quickly generate and test ideas in a physical way. This is especially useful when working with new technologies, like blockchain, because it helps to understand how the technology can be represented in many ways.
Our question to answer was how to make the fundamentals or core concepts of blockchain technology understandable in a tangible way. The technology itself is a chain of blocks, and for tangible representation it is a powerful element to experientially convey the main idea that the information is distributed but cannot be changed. We came up with a scenario where the basic terms of the blockchain are placed on a shelf on the wall, and at the same time there are small blocks on a table that can be filled with these terms. The function of each term is different. What can we do to fill the blocks with the individual


fig. 18 bodystorming blockchain

Fill your own Block

The most common type of transaction on blockchain is cryptocurrency transaction. However, blockchain can also be used for other types of transactions such as sending messages, signing smart contracts or owning Non-Fungible-Tokens (NFT's).
The purpose of this prototype is to gain a better understanding of the properties of a blockchain and the different types of transactions that can be performed with it. Additionally, this prototype will help us see how the different blocks in a blockchain are linked together. For this as a second prototype we built a table with four sections.

This prototype is an extended version of the first one, i.e., the blockchain tower is also present in this prototype. Each section has a scanner for scanning the wallet, and a frame where you can put blocks on it. The blocks are equipped with three lights - red, yellow, and green - and once they are placed on the frame of a section and programmed, they light up yellow.
When the programming is done and the block is ready to be mined, i.e. pushed into the blockchain tower, they light up green. The table is projected from the top. The different sections, the frames and instructions for their use would be visualised with this method.
Wallet: In order to interact with the blockchain at all, a wallet is needed. The wallet section has a button with a receipt printer. A Wallet is created here and printed by receipt printer with a QR code when you press the button. To be able to see the wallet content, a scanner and a screen is also intended for this area.

Transaction (Cryptocurrency): The interaction in this section is filling the block with a cryptocurrency transaction. When a block is placed to the frame,

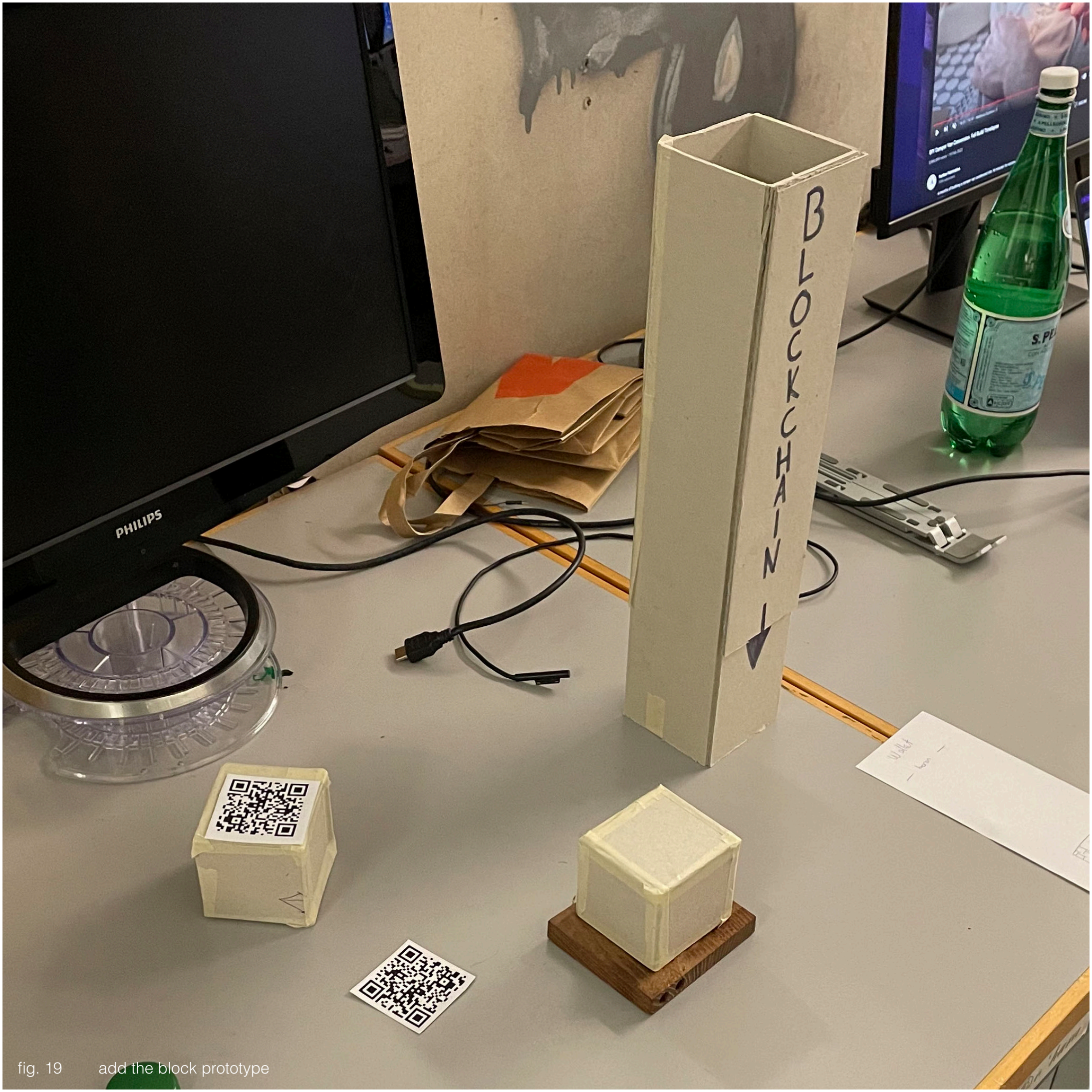


fig. 19 add the block prototype

should the wallet be scanned. Then the available tokens in the wallet are able to be transferred to another wallet, which will also be scanned by the scanner.

NFT (Non-Fungible Token): The NFT section is equipped additionally with a webcam. The ownership of a physical artefact can be added as NFT to Blockchain. After scanning the wallet, a webcam can be used to take a picture of the artefact, which can then be recorded in the blockchain as an NFT and ownership of the artefact can be assigned to the corresponding wallet.

Message: In this section, a message can be sent to a recipient via the blockchain using a keyboard.

fig. 20 fill your own block prototype

Findings

This concept would allow people to practise various blockchain interactions, such as performing transactions, minting NFT, sending a message, minting a block, creating a wallet, and checking the properties of their own wallet. Understanding the immutability of the blockchain can be built by visualising the entire blockchain, which has been and will always be created from the blocks minted by the table. A transaction is not about sending data, but about adding information to a chain. The blockchain tower is a well-functioning idea for this purpose. Since NFT is understood in the mainstream as a digital artwork, proving ownership of a physical object by minting a block would explain NFTs main idea that it is not just about digital artwork. But there are many other aspects of blockchain that would not be present here, since the concept is limited to four main sections. Our goal is to create a comprehensive understanding of the blockchain concept, and this prototype has shown us that showing the most important basics will lead people to ask new questions, but these basic questions cannot be answered by the experience provided in this prototype.

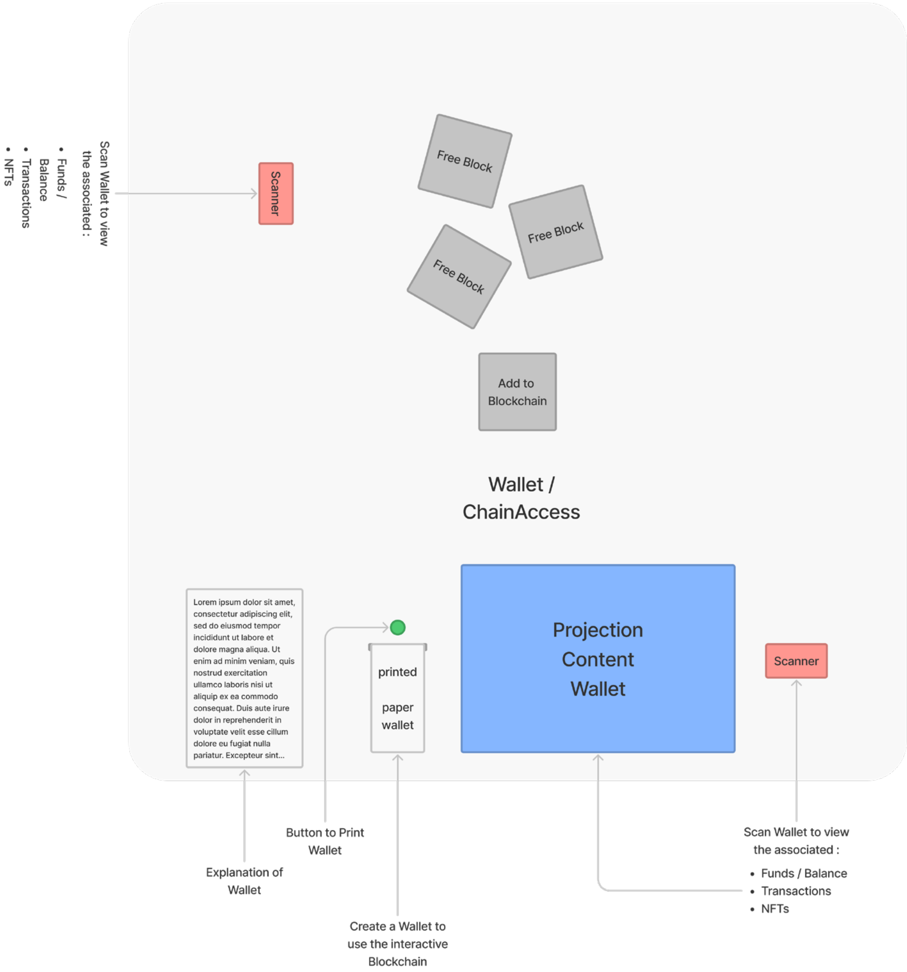


fig. 21 fill your own block prototype

3.2 Our Angle

The findings of our research lead us to the conclusion that there is a need to establish digital literacy. We have observed that it is rather difficult to comprehend technical processes and their effects by simply reading or hearing about them. Technical and digital knowledge is usually difficult to grasp because it cannot be easily observed or it depends on preliminary knowledge. We therefore consider that applying our skills as interaction designers towards the creation of an interactive piece, with the goal of making processes tangible and experienceable, holds enormous potential for creating lasting digital literacy. To narrow our scope we will concentrate on the technology of blockchain, as we consider this topic to be very beneficial in gaining an understanding of the bigger picture of Web 3.0. We will use Blockchain and not Web 3.0 as the core idea, because it is a finding from our process that more people already have an understanding of Blockchain than of Web 3.0. Using blockchain as a starting point, will enable us to explain all the associated technologies from the ground up, instead of working from top down, which would be the case regarding Web 3.0.

Digital Literacy

Digital literacy is a very broad term. Generally being defined as the “[…] ability to navigate, evaluate, and communicate information online or in a digital format.“ (Unknown, 2022). We therefore consider it necessary to define it in a more concrete and project oriented way in order to be able to focus on a specific aspect as well as to be able to evaluate the effectiveness of our work. We will focus on the ability to evaluate with the goal of supporting the ability to navigate. Thereby strengthening “[…] the act of moving around a website or computer screen, or between websites or screens.” (Unknown, 2022). The ability to evaluate forms the basis for the ability to navigate in a given environment by creating awareness and knowledge of the surrounding terrain. Safe and purposeful navigation depends heavily on the ability to evaluate.

3.3 Concept

We found in our field research that the new terminology of new technologies is confusing for people who are not in the field of information technologies. The confusion leads to a prevailing bias that the new technologies can only be used by people with an IT affinity. Our research question posed at the beginning, “How can we create an experience that makes the use of Web 3.0 technologies more understandable and tangible?” brings us to the point that it is necessary to create an understanding of the main technology behind Web 3.0, i.e. Blockchain.

Our prototypes and observations have shown us that the visualisation of interconnections helps comprehension. We have seen in the participatory talks, in conversations and in interviews, that the emerging technologies like Blockchain raise many questions that need to be answered in a non-technical way to resolve the lack of knowledge. Instead of clarifying the technical terms and their meaning, there is a need for a non-technical, human explanation to facilitate communication and understanding for a broad group of people.

Blockchain is a complicated technology, and there is a lot of information available on it. However, it is difficult to tell what is true and what is not, or to find beginner-level information among all the material that is out there. Our concept helps people new to blockchain learn the basics, its applications, and things to consider, so they can develop a comprehensive understanding of the functions and capabilities of blockchain. Our concept is an interactive table that explores and teaches about blockchain and its components. We have decided to represent each different component of blockchain in a human-friendly way by representing each component with frequently asked

fig. 22 Block concept rendering

question; Why does bitcoin consume so much electricity? The literature, resp. answers are written by us in an instructive and easy language that may be accessible to a wide population. By visualising interconnections between topics, we are aiming to create comprehension. We consider this work to be most effective in an exhibition context.

fig. 23 Block concept rendering

3.4 Target Group

Digital literacy is as broad a term as the users of the digital are a broad target group. Our goal of improving digital literacy requires that we meet users where they are at and are mindful not to overwhelm them straight away. The reality of the depth of knowledge regarding the web, computers, and technology in general being so strikingly inconsistent, leads us to situate our target group in the age range between 12 to 70 years of any gender or sexual orientation. We embrace the fact that we will find everything from the inexperienced first-time user of the web to the skilled developer in our target group. We acknowledge that this represents a very broad spectrum. Keeping in mind that we can not reach every individual with our design, nevertheless working on trying to address as many individuals in this range as possible.

3.5 Related Projects
no1s1 by ETH Zürich & Dezentrum

no1s1 is a house that is managed by a blockchain-based smart contract. In this way, no1s1 can decide itself about its use and maintain itself autonomously. They conceptualise a decentralised autonomous space (DAS) as a decentralised autonomous organisation (DAO) connected to a physical location. DAOs use a combination of decentralised ledger technology (DLT) and the Internet of Things (IoT) to create self-managed coordination mechanisms through smart contracts. The solar-powered small cabin works autonomously, and anyone can rent it online for a certain period. For the usage of no1s1, is a Web 3.0 wallet - MetaMask in most cases – needed. Users make a request for a meditation duration of 1-60 minutes. A price in Ether will be charged for the corresponding duration. Once the transaction or smart contract is completed, a QR code will be created to enter the cabin. In this way, many people can coordinate for a specific purpose without the need for hierarchical structures and human mediation. People can organise themselves within it and change the rules in the contracts according to democratic principles - the structure therefore does not need a human owner. People ask how a house can function without an owner. We find that no1s1 provides the basis for giving people an understanding of decentralised applications. This created process allows people to think about how it works, in a tangible way.

fig. 24 no1s1

A-Z of AI by Oxford Internet Institute & Google

The Oxford Internet Institute, in collaboration with Google, has launched a portal explaining how AI is created, its fundamentals, and its ethics, with the goal of helping nonprofessionals understand what AI is in the truest sense of the word. The A-Z of AI includes over 26 topics, including the use of AI in climate science, ethics, machine learning, human-in-the-loop, generative adversarial networks, and AI bias. Communicating the features of AI to non-technical people with a simple form makes the technology more accessible to many people. The interest to start with something can die very quickly if only complex forms of information are available. For us, this way of communicating the technology is interesting for our project. However, we put value on hands-on, i.e. that an interactive exercise possibility would be an extension of the idea.

Making sense of artificial intelligence

This A-Z guide offers a series of simple, bite-sized explainers to help anyone understand what AI is, how it works and how it's changing the world around us.

fig. 25 A-Z of AI

Material-Archiv by Gewerbemuseum Winterthur

The Material-Archive of the Gewerbemuseum Winterthur is a space for exploring different materials in an interactive and playful approach. Visitors can touch numerous material samples at will, compare them or match them with the detailed information in the database of over 1000 material samples. The information is presented in varying depth and complexity to ensure that the entire audience, from children to professionals, can expand their knowledge at their personal level. Illustrations, video and audio explanations as well as experiments contribute to a pleasant learning experience. The materials, arranged thematically in easily accessible shelves, can be physically touched and explored. If more information about the material is required, it can be placed on a surface next to a computer screen. The material is recognised using an NFC chip and the corresponding entry in the database is retrieved. The information from the database is available in different degrees of depth to include a wide range of different users.

This related work is particularly inspiring to us because of its inclusivity and the fact that we believe that this space enables real explorative learning on an individual level. Technology is used to provide users with seamless interactions that allow them to focus on the material without getting distracted. Furthermore, this space solves the issue of how several individuals can be present at the same time and engage individually without hindering or disturbing each other.

fig. 26 Material-Archiv in Gewerbemuseum Winterthur

Nike Digital Retail by Experience – Demodern Digital Agency

For the Flagship store of Nike in Berlin, Demodern Digital Agency developed three different modules that take the shopping experience to another level. Of particular interest to us are the animations on the large touch surfaces and the connection of information when a product is placed on the screen. The possibility to compare two products makes the shopping experience more exciting for two people and enables the use of the interface by several people at the same time. We will keep in mind the possibility of creating interpersonal interaction through the action on the screen, when two or more different people are currently using the interface.

fig. 27 Nike Digital Retail

Situating our Work

With these and many other related works, we explored a wide range of interactive possibilities to make complex issues more understandable by making them more tangible both physically and digitally. Turns out that there exists no interactive way to explore a blockchain and its components the way we have intended to do it. Frankly, there is nothing that would even come close to this approach. We find that, for example, no1on1 creates an experience that makes one reflect on the possibilities of using blockchain. However, their website does not specify how to connect or use a wallet, for example. It is simply assumed that one knows what it is and how to use it. In contrast AtoZ of AI fascinates because it makes a complex topic understandable through appealing visualisations and little snippets of information. It is kept very basic from the content perspective, but it helps one get one‘s head in the game. To adopt this kind of content approach in the form of easily digestible small bits of information would certainly benefit our concept. The Material Archive in the Gewerbemuseum Winterthur offers hands-on experience with the materials, which makes it unique and extremely engaging. The ability for people to explore different interests individually at the same time is something that we would like to incorporate into our work as well. What we see as a disadvantage is that the way of interaction does not allow comparison among materials. The relationships of the materials are displayed in the physical space, but not in the digital space.Contrasting this, the interconnections of the different topics should become visible in our experience. Is it to show that it is technically possible, or is it to show the technical possibilities?
We have observed that digital realities such as AI, for example, are often made experienceable in a digital way. However, in the case of more complex issues such as no1s1, one likes to fall back on a physical artefact because it is supposed to facilitate understanding. With our work, we want to fill a gap

of knowledge that people seem to be eager to fill, but don‘t quite know how. Our project will allow users to experience an abundance of interconnected information about blockchain interactively by using physical and digital elements, which has never been seen in this form before.

4 Project Development

The following chapter discusses the different investigations made using prototypes, experiments and user-testing, which led to the final bachelor thesis project. Starting with exploring ways to make blockchain more tangible in the physical by bodystorming and prototyping a process in which users can fill physical blocks themselves as well as add them to a blockchain, many small experiments were conducted in order to find an approach that is coherent with the subject matter. The findings of these experiments and prototypes ultimately led to more specific examinations and prototypes in the field of infrared touch interfaces, marker tracking and rear projection. In turn, the use of these technologies requires the design of an attractive user interface, fabrication of tokens with a proper affordance and the creation of comprehensible user-oriented content. The following experiments and prototypes address a wide spectrum of explored aspects. The findings from the experiments and prototypes will give us the end result to build our final product. Next, we will list the technical development of the product, from the interface to construction in detail.

4.1 Bodystorming Interaction Surfaces Spaces

Asking ourselves about how big our table needs to be in order to place the tokens and interact with it by touch led us to try out different sizes of surfaces. We drew the surfaces with painters tape and paper. Painters tape is a powerful tool that allows us to see and test our ideas. It‘s easy to use, stick and remove, and a good connector for cardboard. We found that a large height of a surface makes it difficult to reach that point, either with an artefact or by hand for touch interactions.

fig. 28 bodystroming screen sizes

Single IR Diode Touch Detection

Projection from the top has several disadvantages. One of them is that the projected surface will be hindered with the body movements. The tracking of objects, as well as fingers for touch interactions is also troublesome. Considering needs such as multi-touch interaction or real-time tracking of artefacts, we found through our experiments that Plexiglas projected from the bottom can be used for this purpose. As the first prototype for the technical construction of the table, we used 30x20cm PLEXIGLAS LED 0E012XL as the surface. It ensures us the maximum transmission of the light. The two edges were each illuminated with 6's array of IR Led Transmit diodes 1,25v (15v in total). When the finger comes into contact with the plexiglass, the LED diodes emit infrared light that is reflected off the finger and captured by an infrared camera. The camera then tracks the movement of the finger and sends the information to a computer, which is used to control the table. This allows fingers to be tracked, and multitouch interactions can also take place. Giving different IDs for different objects, we decided to use fiducial markers. Fiducial markers are small objects placed near a subject being imaged by a camera or other imaging device. They appear in the image as small, bright dots and can be used to track the subject's movement or position. In order to recognize the finger and fiducial marker movements, we tried the TUIO framework out. TUIO is a protocol that allows for interactive multi-touch applications to be developed. It is used to track the movement of objects on a surface with a camera. TUIO analyses the data that comes from Infrared camera and sends the location of detected fingers and objects via UDP- and OSC protocol. We used the reacTIVision vision engine with processing client to display movements and positions of fingers and objects to which a fiducial marker was attached, seen by the camera through Plexiglass.

Findings

Plexiglass Led 0E012XL has excellent light transmission. This allows for infrared light on the whole surface. When you press on the plexiglass with your finger, the pressure is seen white by infrared camera. However, the IR diodes were not strong enough, that’s why we were supposed to press strongly to see the press of fingers in the infrator camera. We have found that Plexiglass Led 0E012XL can be used as a surface for the touchtable we build. Infrared LEDs must be more powerful. Rather than projecting from the top, projecting from the bottom allows us to have better visual projection. However it needs a film on the plexiglass so that the projection stays on the surface and does not project up to the ceiling.

IR LED Strip Touch Detection

Building on the previous experience with single infrared Diodes, a further iteration of the touch detection was realised using a 5 metre 12 volt infrared LED strip. The LED stripe illuminates the edge lit Plexiglas panel much more evenly, which allows for stronger contrast and ultimately better touch detection.

Findings

This version demonstrated clearly that the RealSense camera only recognizes touch in the centre of its field of view. At the edges of the image, the infrared reflection was barely visible. After extensive investigation, this can be attributed to the attached infrared filter that was added to the camera for a different project. For this reason, we tested the Raspberry IR-CUT Camera Module, which is intended for night vision and has a viewing angle of 160 degrees, enough field of view to cover the whole intended area of 150cm on 150cm. With the camera module, the infrared reflection could be detected consistently over the entire panel.

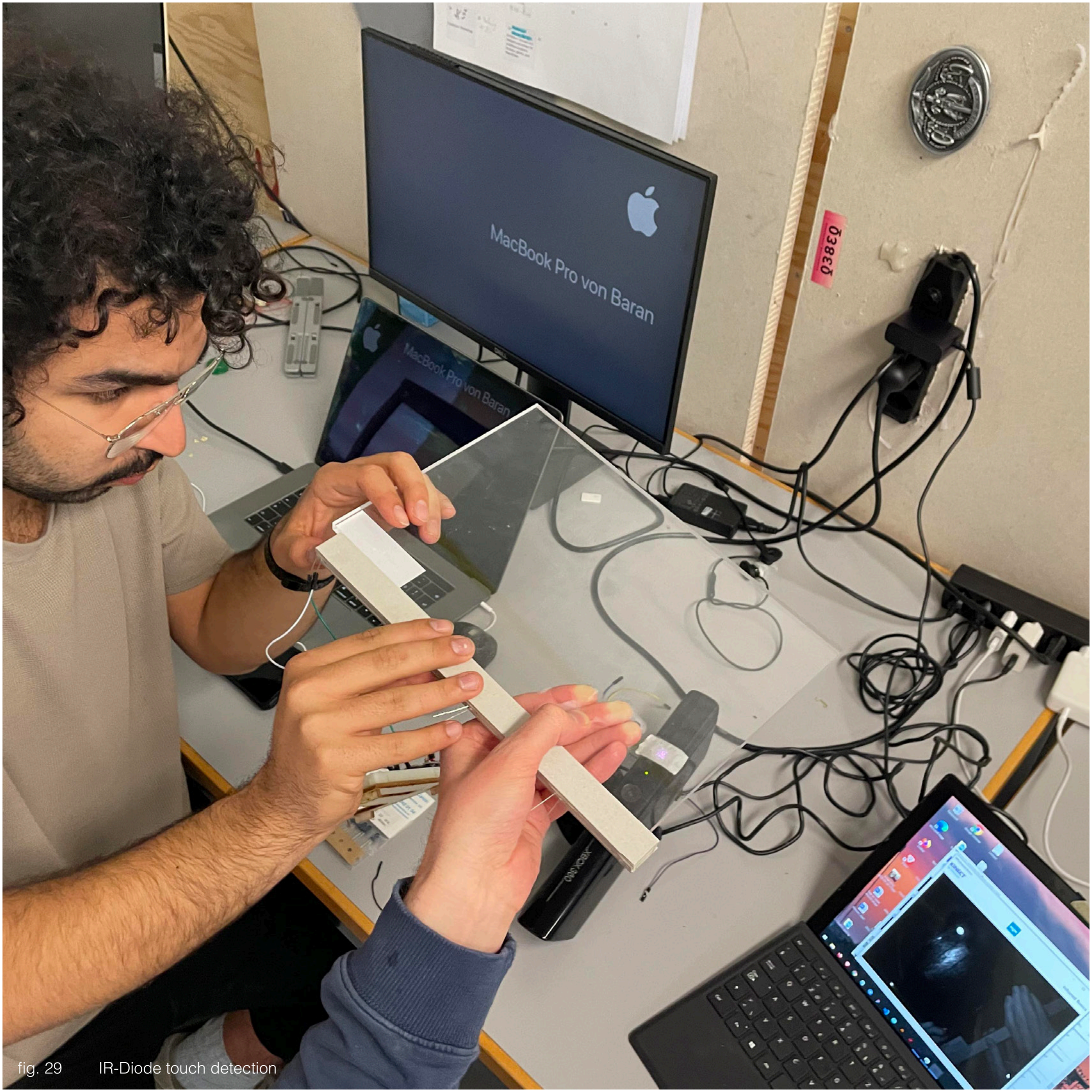


fig. 29 IR-Diode touch detection

reacTIVision and TUIO

We have looked into existing image processing infrastructures in order to track the fingers and fiducial symbols. reacTIVision is a computer vision framework for the fiducial marker and multi-touch finger tracking that was first released in 2005. The framework runs with a protocol called TUIO. This protocol is responsible for encoding the state of fiducial symbols and multi-touch interactions from the interactive table. We have tested the reacTIVision 1.5.1 (release 2016) with the TUIO11 Processing client. While reacTIVision was connected with the infrared camera, TUIO11 Processing client was waiting for the multi-touch and fiducial marker inputs to visualise it on the Processing sketch. When the program detects an input via camera, it processes what kind of input it is, recognizes the coordinations, and sends the information via UDP port to the TUIO client. The TUIO client, in our case Processing, visualises that input with available coordinations.

Findings

The fiducial symbols have unique IDs which enable us to identify the tokens and their positions. In order to do that, we link the fiducial symbols for each token's bottom side, and a camera captures them at the bottom of the surface. reacTIVison can process the real-time video image and identify the ID of the tokens and their positions in x,y,z. In our tests, the identification and the position recognition worked without any problem. reacTIVison could communicate this information with TUIO, which enabled it to see the token's visualisation in Processing sketch in real-time. But in our surface setup with Plexiglas and Infrared LED Strip, the touch detection was not working as we expected, especially when we stretched a rear projection film on Plexiglas. Although the touch inputs were due to the projection film being weaker, they were still visible in the camera. But reacTIVison couldn't process them as touch input. That's why we have decided to work with other computer vision engines for more sensible and advanced recognition of inputs.

Rear Projection Material Tests

To prevent obscuring the projected image with arms and hands, which negatively impacts the user experience, we explored different materials that allow for rear projection. A rear projection would allow the display of information and animations at any time, even in the case of touch interactions and manipulations of the tokens. Using an endlighten Plexiglass plane with 8 millimetre strength as a base for the screen, allows for different projection materials to be applied directly to the plane. Considering that the Camera still needs to be able to detect infrared reflections as touch inputs, the material either needs to allow infrared light to pass through it or be transparent enough to still allow detections. Furthermore, the material needs to be transparent enough to allow the recognition of tracking markers. Not many materials meet these requirements.

Beginning with two adhesive projection films meant specifically for real projections, one being fully transparent and one being semi-transparent but mirrored on one side, the results were rather sobering. The transparent film Rückprojektionsfolie Transparent, giving a marginally better image than the bare acrylic plane is not suitable as the colours are quite flat and the contrast is poor. Furthermore, the projection is further directed to the ceiling and looking directly at the table surface may cause the beamer to blind the user. The semi-transparent and mirrored film Rückprojektionsfolie in Chrom/ Anthrazit, allows for stronger contrasts and more vibrant colours. However, the material is constructed in such a way that only light from the projector can be transmitted through the film and no infrared light can be reflected back to the camera, which likewise hinders the detection of markers.

Recognizing that material applied directly to the acrylic plate impedes the flow of infrared light and that non-adherent materials merely resting on the plate are more readily available in Switzerland, we tested three different fabrics. The 3600 Lasergewebe, a laser fabric, being close to 90% transparent, giving stronger contrasts and colours than the transparent film and allowing for infrared reflection as well as marker detection. However, this high level of transparency also leads to glare and the projection being relayed to the ceiling. Another material is a White PVC rear-projection fabric found in the spare materials section of the Interaction Design Studio.This material has the best image quality of all the materials tested so far. Even if the material itself is very thick, infrared reflections can be faintly detected and markers, if backlit, as well.

Findings

The fabric that best meets our needs is a compromise between the laser and PVC material. The 1510 Galicot, white 100 percent cotton fabric provides adequate contrast and colour intensity, allowing infrared as well as marker tracking reliably without the need of backlighting the markers. One drawback, however, is that the fabric is rather coarse, which makes the image appear more grainy. This material will be used for further iterations, not least because it is the cheapest at 14 CHF per square metre.

fig. 30 projection film test

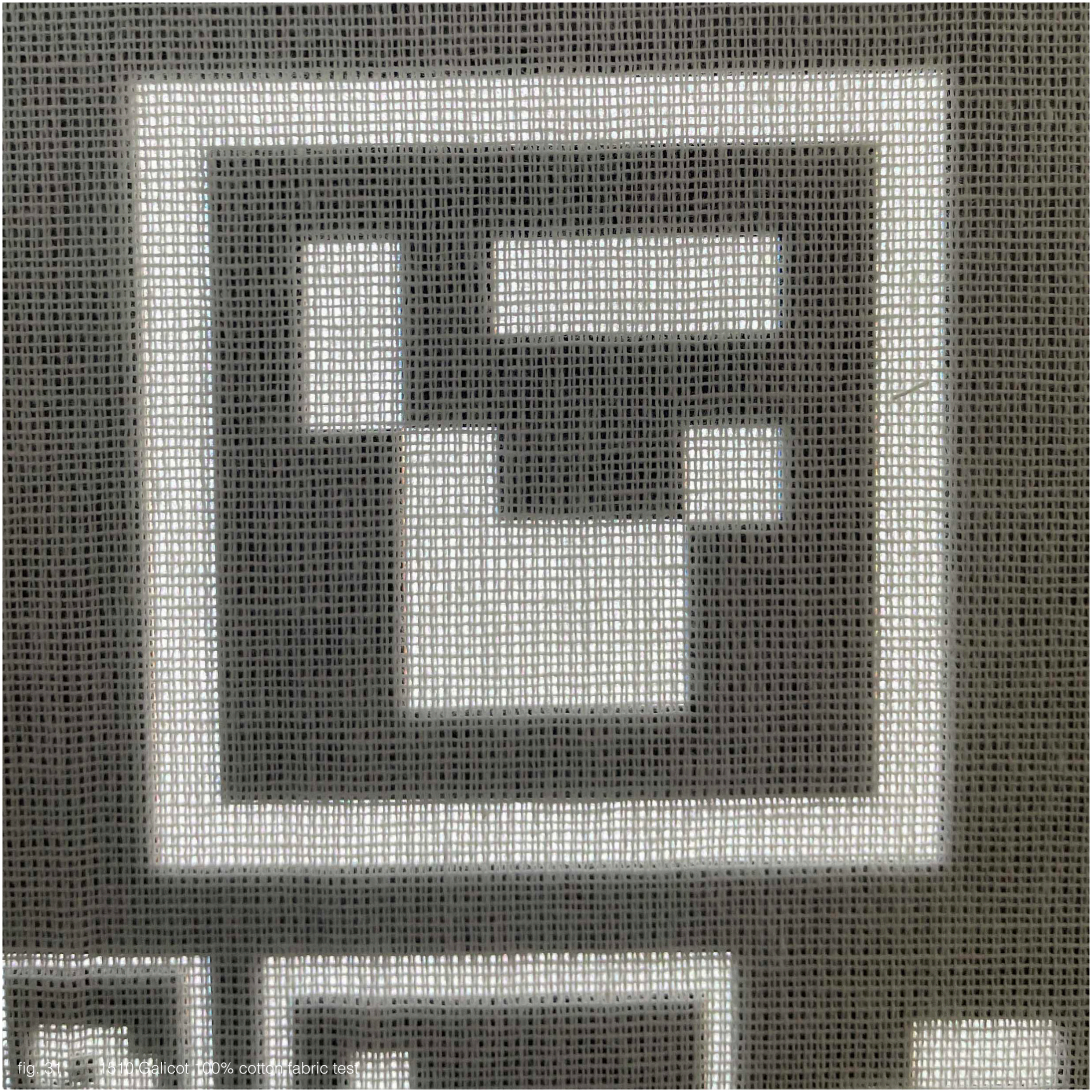


fig. 31 1510 Galicot 100% cotton fabric test

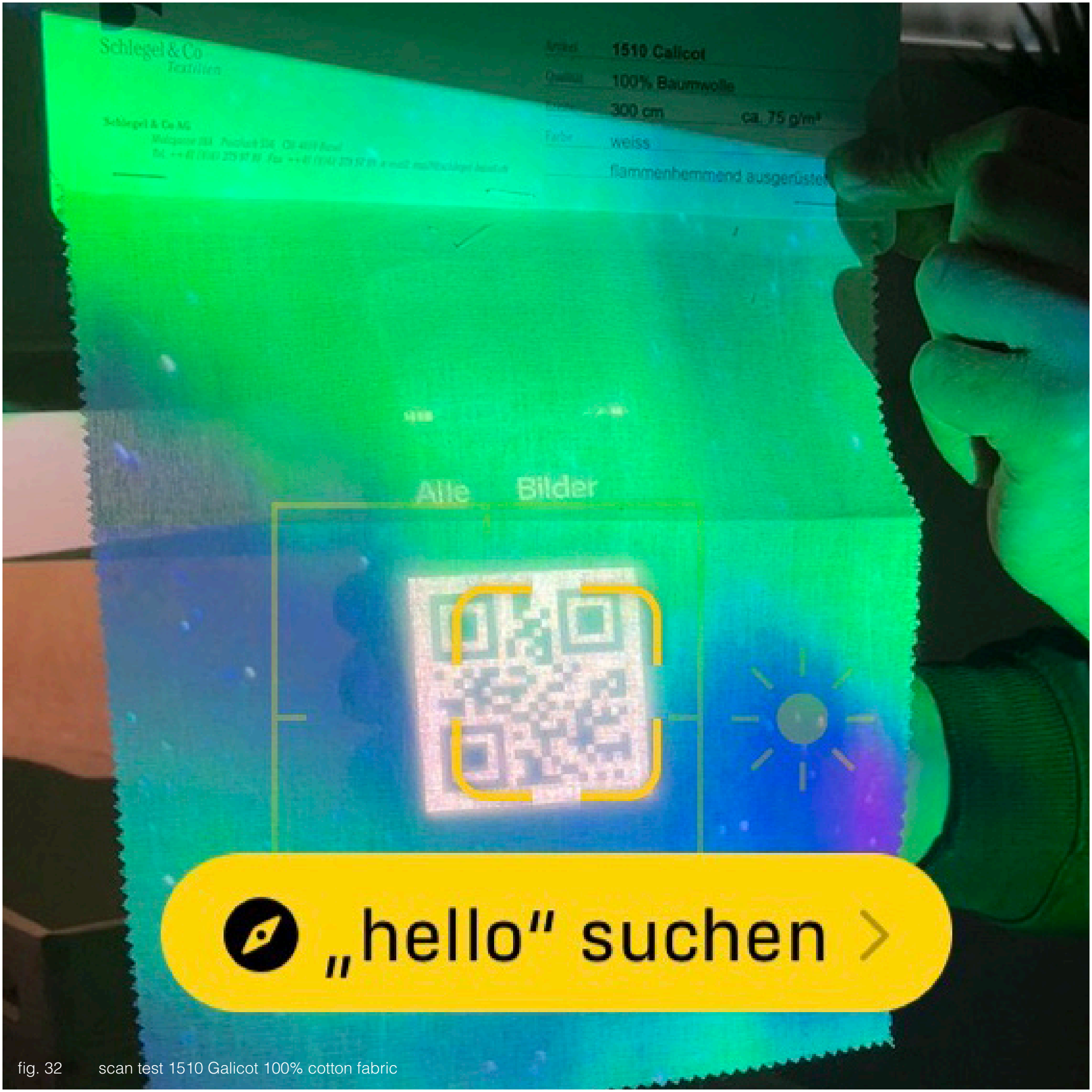


fig. 32 scan test 1510 Galicot 100% cotton fabric

OpenCV – Blob Detection

The Open Source Computer Vision Library (OpenCV) is an open source computer vision and machine learning software library. The library works on multiple platforms supporting many different programming languages. It is free to use under the open-source BSD licence. It offers many different functions for real-time computer vision, including one for so-called blob detection. Blob detection is used to define a circular shape within an image. In our case, a finger touching the surface and thus reflecting the infrared light can be recognized as a circle or oval. This represents a touch input, the coordinates of which can be determined and processed or mapped . Using Python 3 and the cv2.SimpleBlobDetector_create(params) function with adjusted parameters , in combination with preprocessing of the image material, OpenCV was able to detect clear blobs even under poor conditions.

Findings

OpenCV surprised us with its excellent blob detection, despite the fact that the contrast of the blobs was very poor. Not only the good detection but also the simple and clear handling of the library, which runs without problems on different platforms, supports our decision to continue working with OpenCV. OpenCV is more versatile than ReacTIVIsion and gives us more freedom to tailor the detection to our needs. Not to mention that reacTIVIsion has some struggles with compatibility issues as a result of its age. OpenCV is up-to-date and more reliable.

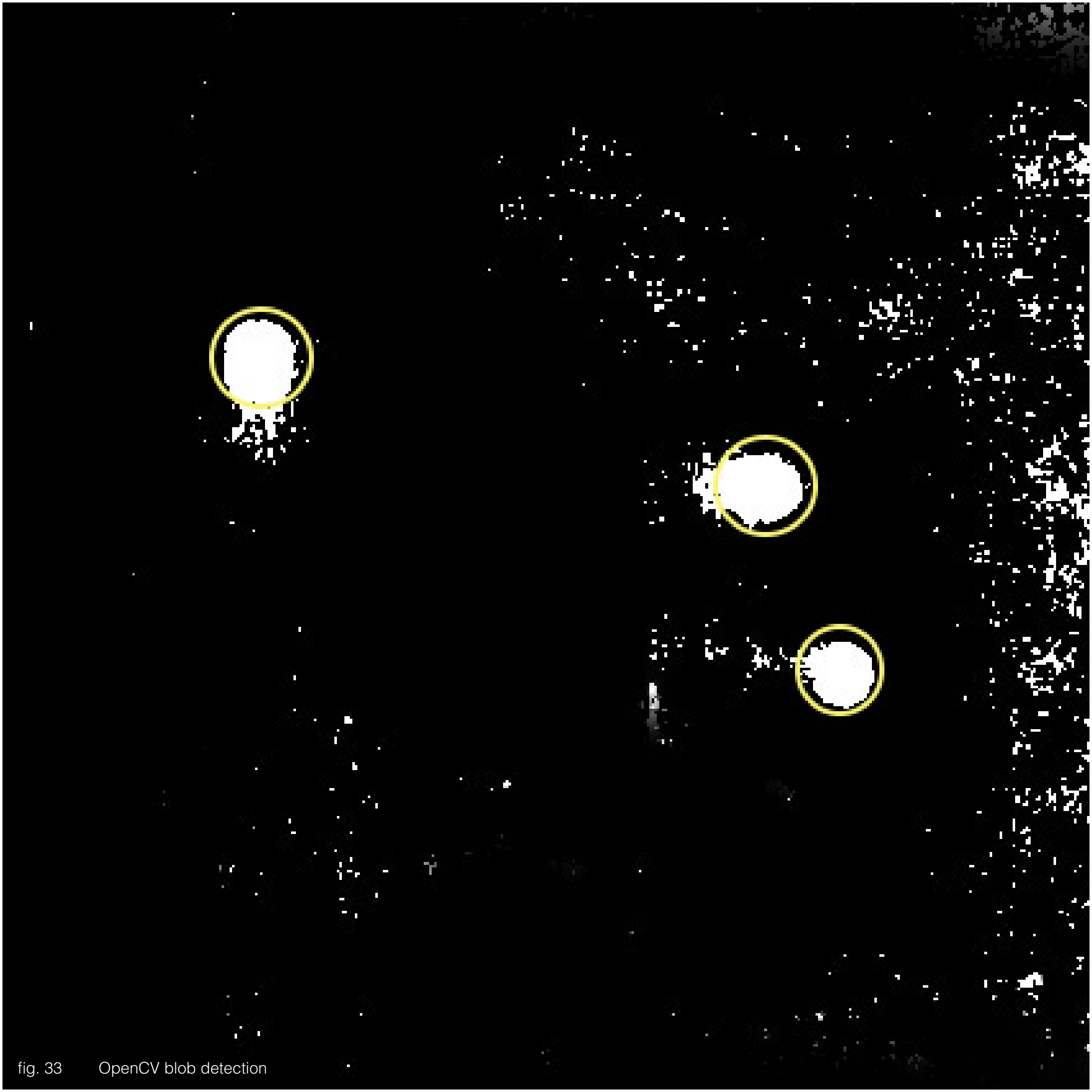


fig. 33 OpenCV blob detection

OpenCV – Aruco Marker Detection

By switching to OpenCV we also have to substitute the fiducial markers. For our first test, we chose Aruco markers as they allow us to create a custom dictionary with which the detected marker or markers from the image are matched. Unlike other fiducial markers, this approach of using a static dictionary allows the marker to keep its ID even if it is not identified. In the case of other markers, a different ID is assigned with each new detection, which is not in our interest. OpenCV allows the detection of a large number of Aruco markers at the same time without a lot of computational effort. This might make it possible to run our installation on a microcomputer such as a Raspberry Pi. The function: markerCorners, markerIds, rejectedCandidates = cv2.aruco.detectMarkers(frame, dictionary, parameters=parameters) among other things such as the ID outputs the four corner points of the marker, from which we can determine the exact position of the marker in the detected frame. Based on this localization, we can display the interface accordingly.

Findings

Our test runs, starting with a non-pre-processed image followed by processed images for better detection similar to blob detection, have confirmed that the markers are more than up to our standards. At great distances from the camera, the markers were still detected very well and even with intentional blurring of the marker using a thick piece of paper and PVC foil, it could still be detected. These results strengthen our decision to use Aruco markers for token recognition.

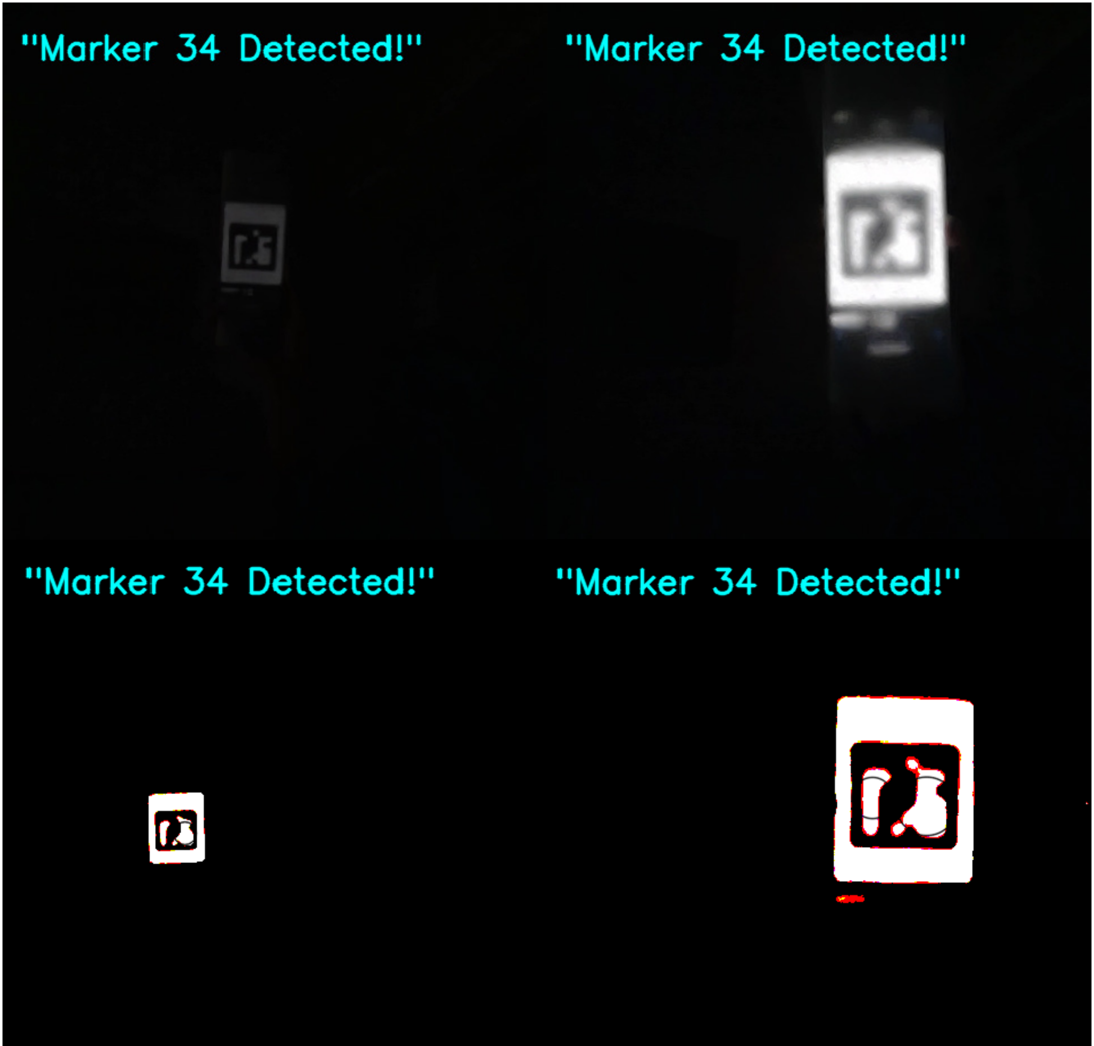


fig. 34 different size & material tests for Aruco Markers

4.3 Token Connections Prototypes

With the need to clarify which subtopics the tokens should address, how they should be connected and which information should complement them, we prepared the tokens and used a glass sheet as a base and a whiteboard marker to iterate over and test different ideas.

Connecting Tokens

Investigating whether the selection of subtopics which the tokens should symbolise is conclusive, sixteen prototypical tokens with the name of preselected subtopic and a matching symbol were engraved into an MDF board and cut out using a laser cutter. In a first step the tokens were distributed on a glass sheet in accordance to their interdependencies. A whiteboard marker was used to visualise these interdependencies by connecting them with a line. Furthermore, token-specific UI element concepts were sketched out and their requirements regarding screen space were explored.

fig. 35 tokens for connection prototype

Findings

We observed that even though the subtopics are all interdependent with at least one other subtopic, there is a need for subtopics that help group the tokens. All the connections among the tokens make the UI cluttered. We either need to work with different opacities or define less connections adding subtopics that allow for a more structured, tidier interface. Considering the amount of components that will be displayed if all tokens are on the table at once, one should be able to minimise any text boxes in order to be able to focus only on the connections for example. Even though the tokens were only low fidelity prototypes, they exemplified the need for tokens that provide a stronger affordance for grabbing them and making people understand that they can manipulate them. In a further iteration, the flat tokens will therefore be replaced by three-dimensional acrylic cubes. Content wise, the tokens lacked some subtopics that are necessary to support our narrative, therefore we need to add some more tokens, and specify others. The Prototype reinforced the decision to build the table in a size of 150 cm by 150 cm. As the UI elements surrounding the tokens will take up a fair amount of space, not to mention token specific elements such as four nodes for the blockchain token, 150cm will provide enough room to accommodate all tokens and their UI components.

fig. 36 reflecting on connections of tokens

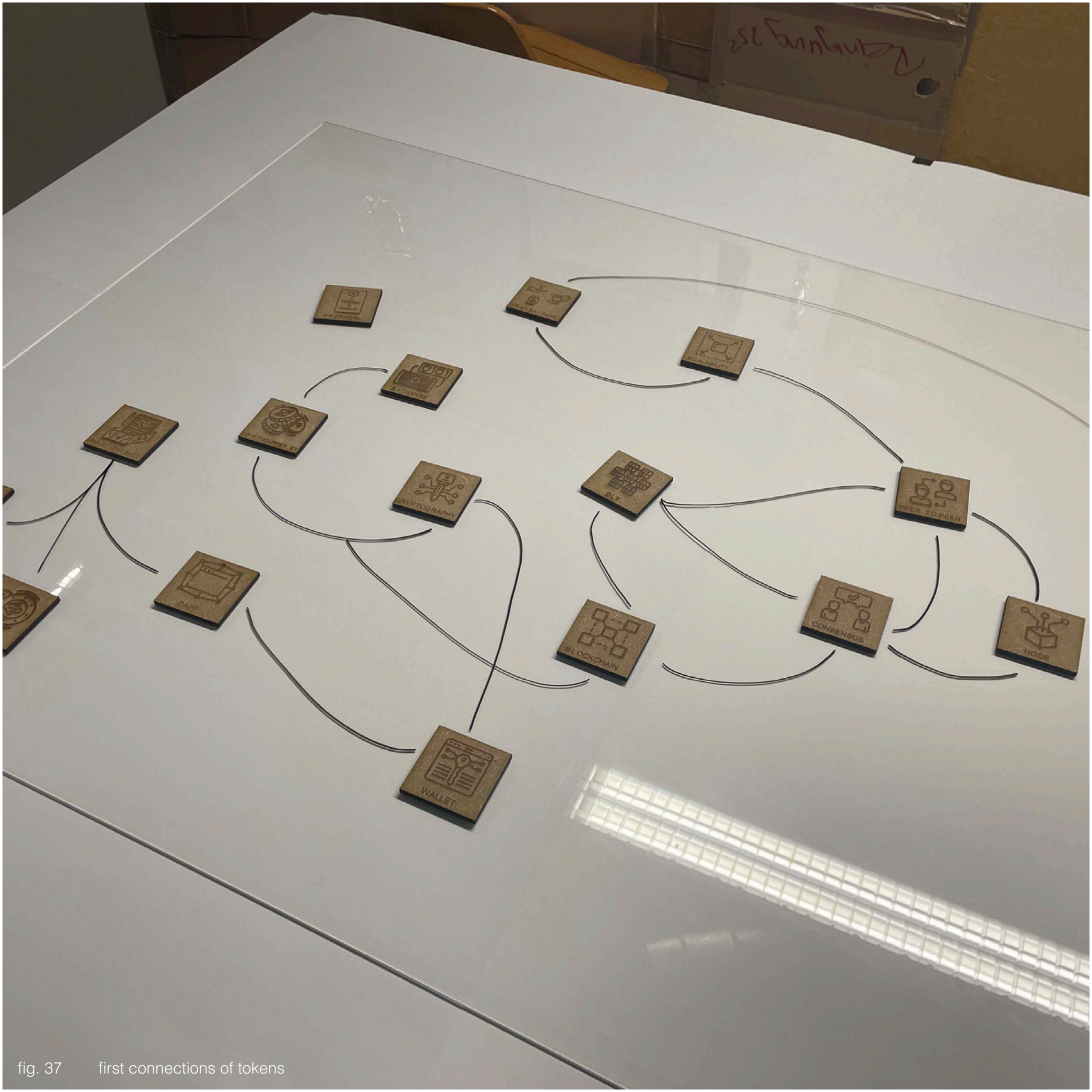


fig. 37 first connections of tokens

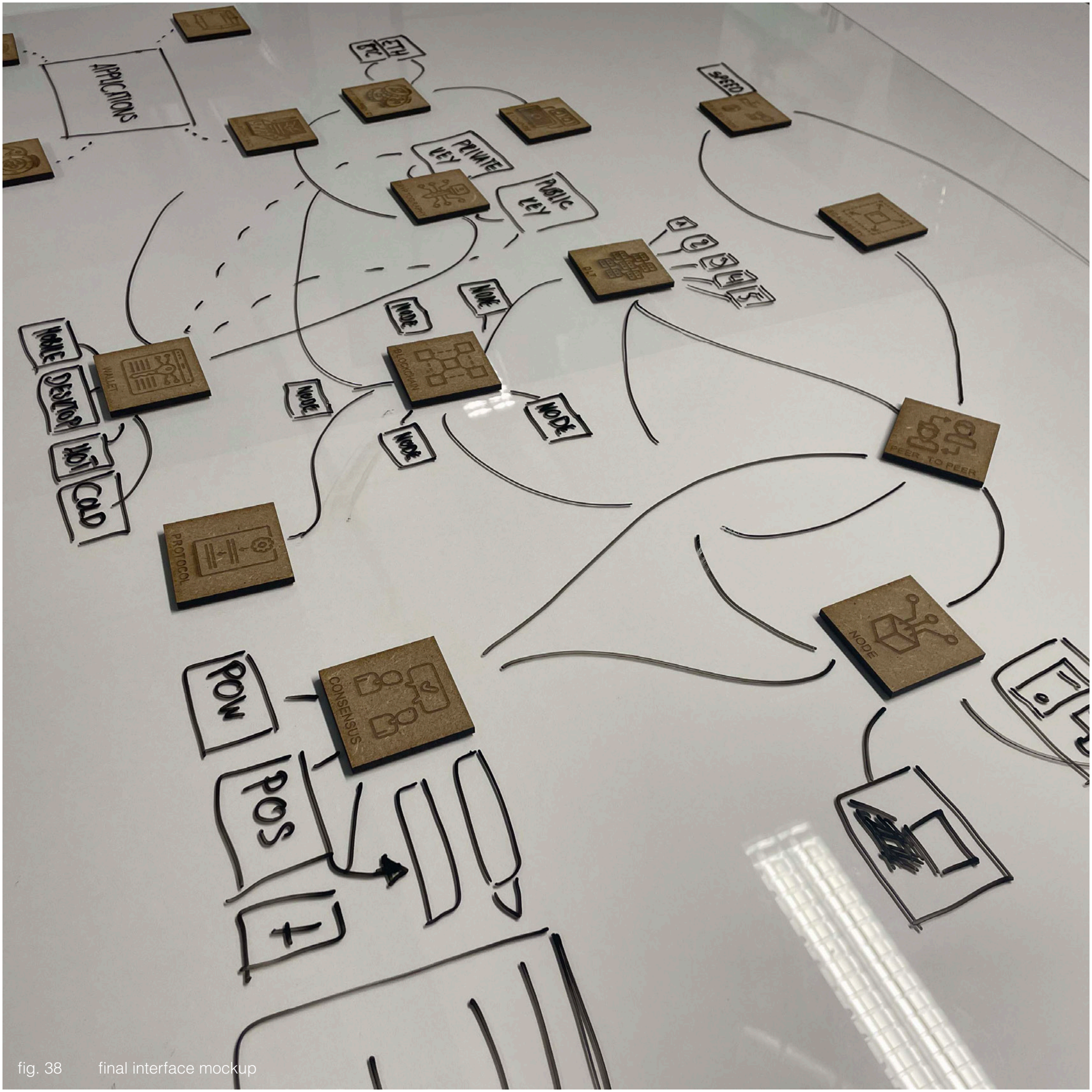


fig. 38 final interface mockup

Gummitwist Blockchain

Inspired by the Chinese jump rope or in Switzerland also known as Gummitwist, which is a simple closed rubber band that can be used for a variety of different games in which people need to stand either within or outside of the stretched rubber band, the focus changed to tangible connections. Further investigating the potential of visible and tangible connections, this prototype consisted of tokens and their visualised connections through black rubber thread. The connections are thus given and they can be examined by shifting individual tokens. However they always bounce back to their original ordered form. When the tokens are deliberately clumped together, the result is a simple but interesting sorting game.

Findings

A predefined order, which the user can change without destroying it, provides the opportunity to focus more on the playful exploration of connections and subtopics. It must therefore be considered that a certain basic structure could already be given, and that the activation to use it is more likely to be caused by exciting interactions than by content or gamification. In terms of the interface, it would be intriguing to develop an engaging micro interaction that makes general use more playful.

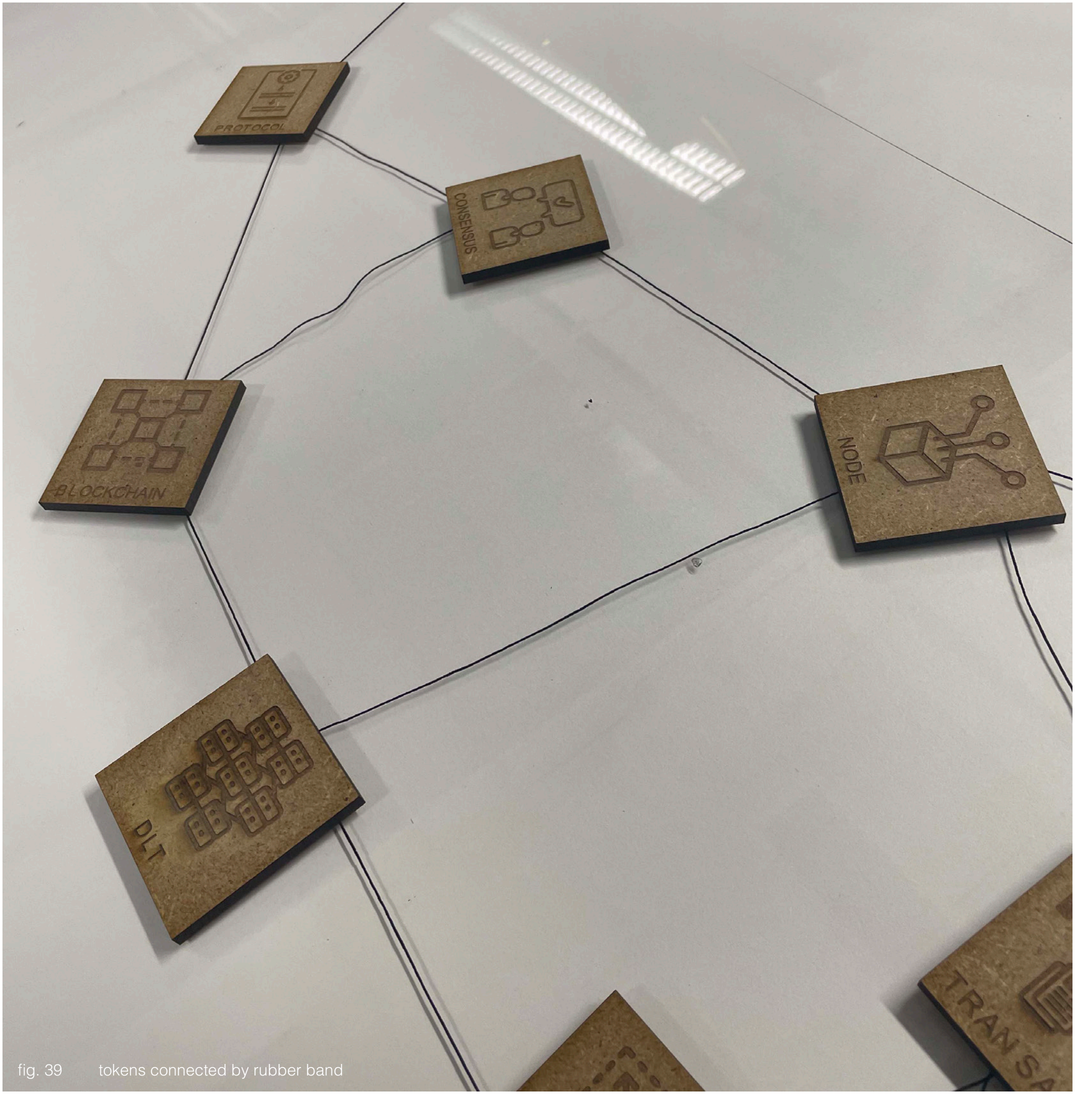


fig. 39 tokens connected by rubber band

Place the connected Tokens

Examining the usefulness and effects of predefined structures on the interface a test was conducted using the previous prototype. In this subsequent iteration, the rubber band connections were labelled and the positions of the tokens were indicated using whiteboard markers on glass, creating something resembling a street map. The tokens were removed from the glass and users were asked to place the crumpled up Tokens on the map orienting themselves at the connections, labels and implied places for tokens.

Findings

Labelling connections with single words provides more motivation for users to read and place tokens. If there is little information, users are more likely to be willing to take a guess and see if they are on the right track. The physical rubber connections allow the user to compare the connections to the ones on glass and see if their solution is correct. Adjusting the difficulty of a task by providing feedback for self-monitoring seems to be an approach that we should pursue in any gamification effort.

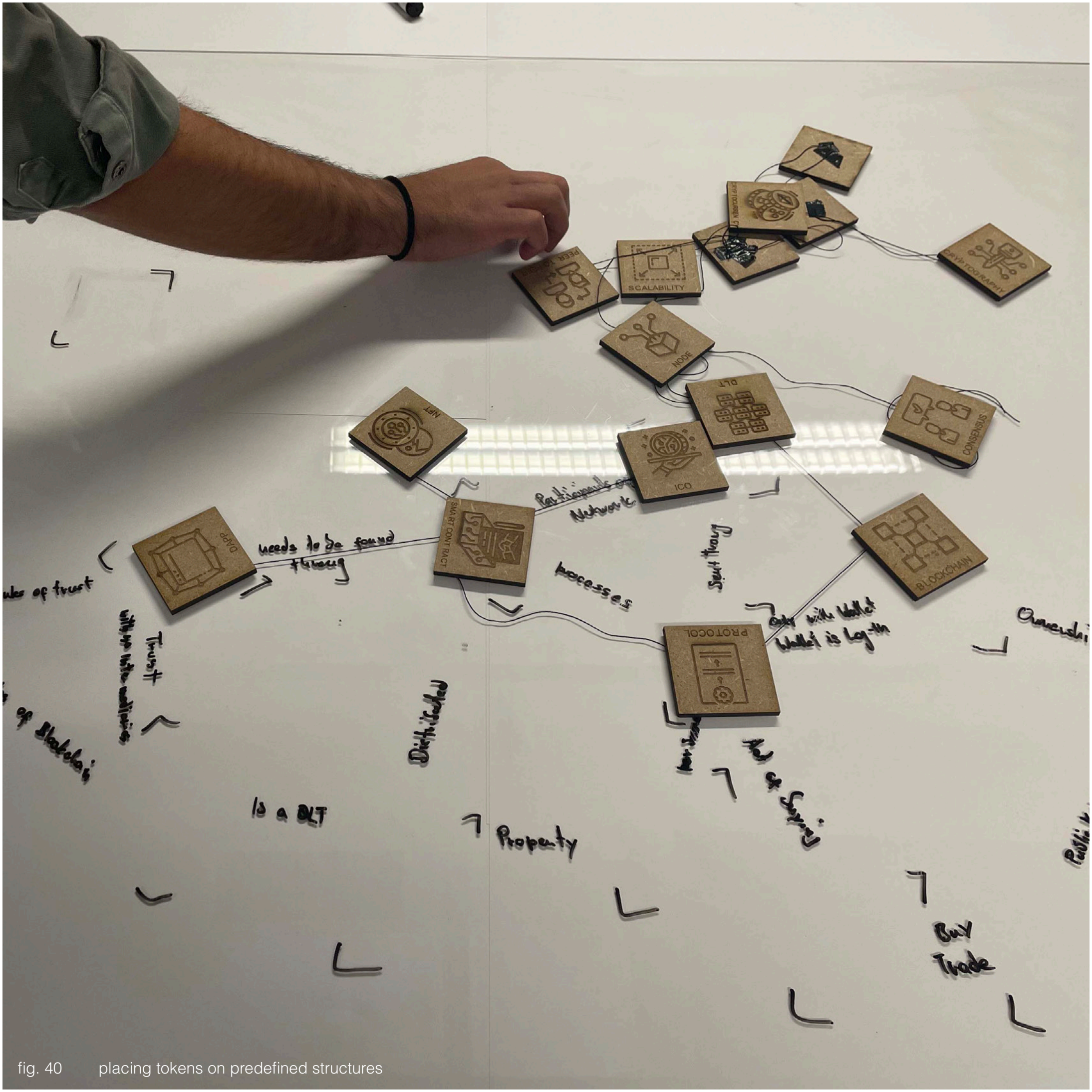


fig. 40 placing tokens on predefined structures

4.4 Fluent Interface Prototyping

Aiming to test the user experience of our analog, low fidelity prototype, we conducted a user test in a way we named fluent prototyping. As the interactive table will allow users to freely decide which token to place where at any time, the interface has to adapt to these unpredictable user inputs. The users were instructed to explore what happens if they place a token on the table and try to complete the unfolding task of adding more tokens. Additionally it was communicated that they are welcome to ask questions and make remarks during the usage and we would attempt to clarify them live through changes in the interface. Using our fluid prototyping we continuously adapted the interface to the user's input and attempted to clarify any questions or remarks that arose, by making changes through wiping away, adjusting or adding to the interface with white board markers. The tokens were supplemented with corresponding texts after being placed on the table. In order to encourage the user to place more tokens on the table, dotted lines and circles were used to indicate possible connections to other tokens not jet placed on the table.

Findings

It became clear that there is a need for an explanation or attractive animation that gets potential users to make an initial interaction. It needs an appealing onboarding. Furthermore, it is not obvious why additional tokens should be placed on the table. The dotted lines by themselves are not motivation enough for some users. Although this puzzle like placing of tokens, making people want to look for the right subtopic to connect, is something that should be further investigated. In this context, gamification must be considered as a possible motivation for completion. However, a time constraint or measurement is seen as more of a hindrance, since the goal of the project is to transfer knowledge and one should be able to proceed at one‘s own pace. Achieving points for properly placed tokens would be more appropriate in this context. The provided texts were perceived as too long and too complex. It was criticised that the texts are not interconnected and that it is difficult to figure out which tokens are connected by reading the texts only. In general there were not enough clues that would have enabled the placement of all the tokens by the users themselves. If the mode of operation of the table is going to be gamified, there definitely need to be clues and hints in the shape of messages, images and animations.

Regarding the tokens, they are too abstract in their current state. They are incomprehensible and the inexperienced users cannot do much with them on their own. Transforming the token to the three-dimensional allows the use of four additional faces. In a next iteration these faces of the token are to be used to point out questions or misunderstandings that exist regarding this token specific subtopic, by engraving them on the sides of the block.

In terms of space, it became obvious that one person alone can not use the table from one side only. The user needs to change the sides in order to place all the tokens with all their UI components visible on the table. In the current state, this circumstance is not considered negative. If the UI components point in the respective direction of the closest side of the table and are readable, the user can focus on a particular subset of the tokens. Furthermore, this circumstance may encourage collaboration in the case of multiple simultaneous users.

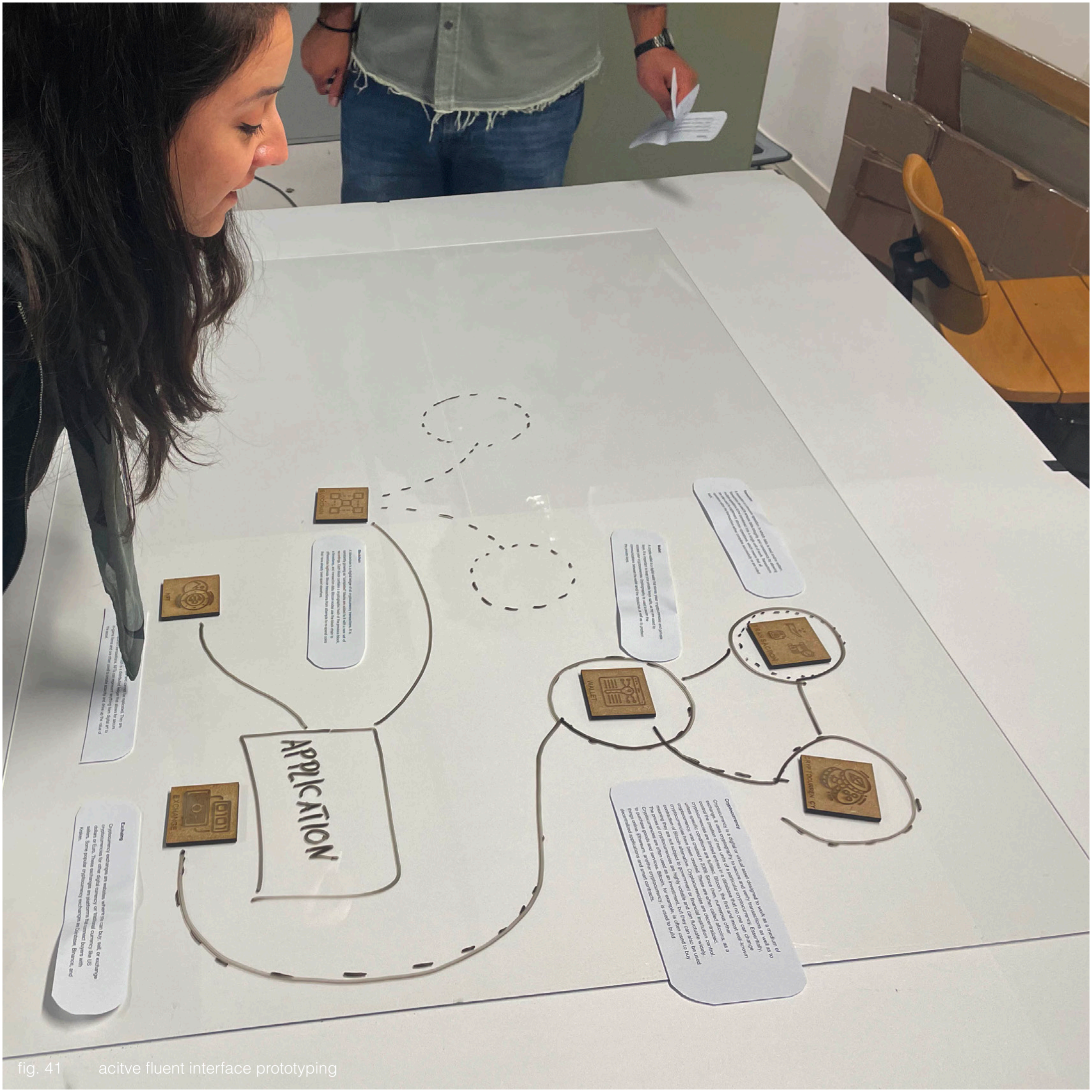


fig. 41 acitve fluent interface prototyping

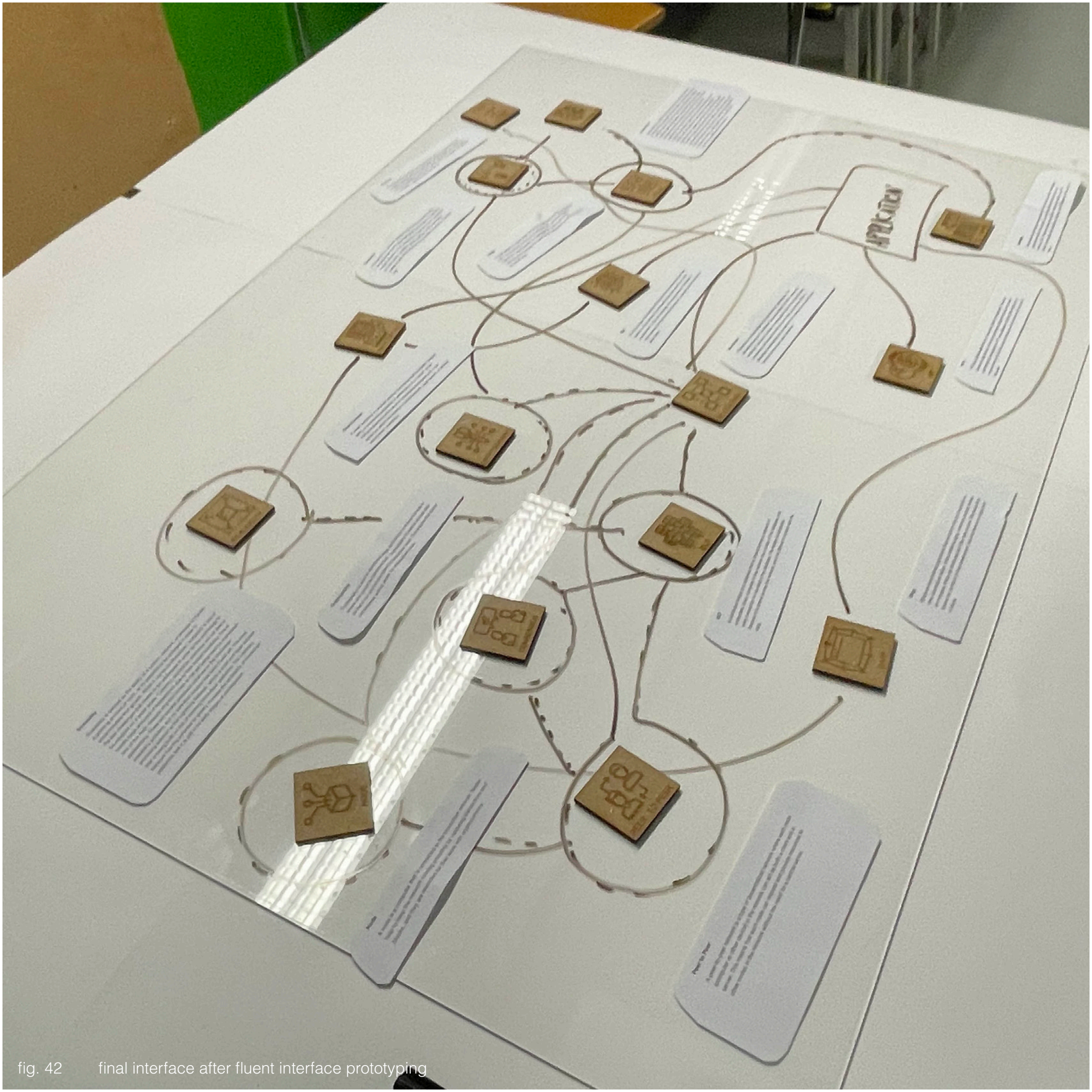


fig. 42 final interface after fluent interface prototyping

4.5 Interface Development
Blocks

Whenever a token is placed on the screen, the topics corresponding to that token will appear on the screen. These topics are represented by square content boxes that are 80mm in size, and they are located on each side of the token. The blocks corresponding to a particular token always appear at the same x and y position as that token. When a token is removed from the screen, the blocks disappear as well.
When one of these topics is selected, the block will expand from the bottom or top edge downwards or upwards (depending on its position). The topics can also be extended with pictures or other multimedia materials.

Connections

Almost every block that appears with a token is also connected to another token. An example would be, with the placement of Bitcoin token, the question of why Bitcoin consumes electricity appears. The question is answered in the block, however, for the deeper insight of it, there will be a connection to another corresponding token, in this case “Consensus”, visualised. The interconnections are drawn with a transparent arrow. As soon as the corresponding token is placed on the screen, the block connects to the corresponding block in Consensus, which is the extension of the topic.

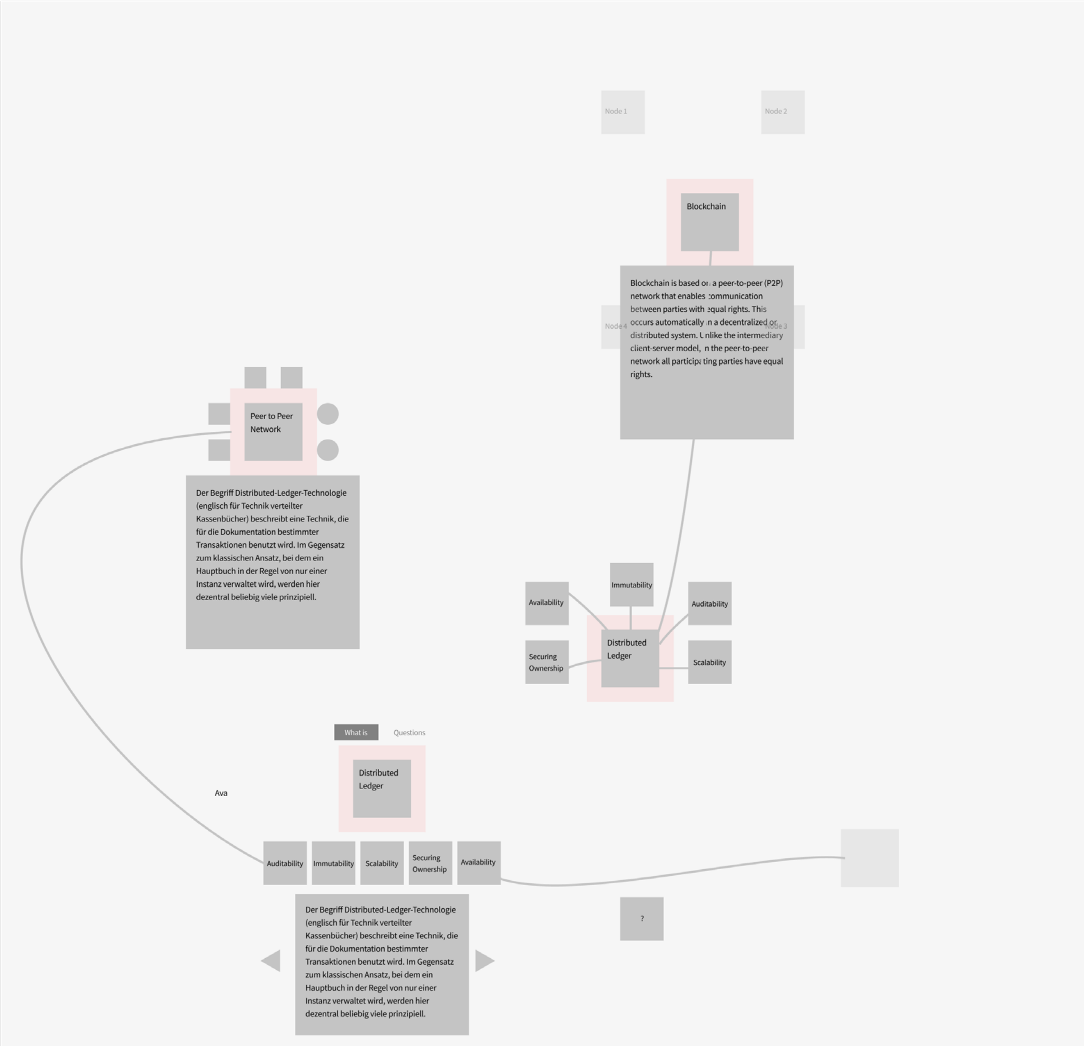


fig. 43 first mock-up and wireframe of interface

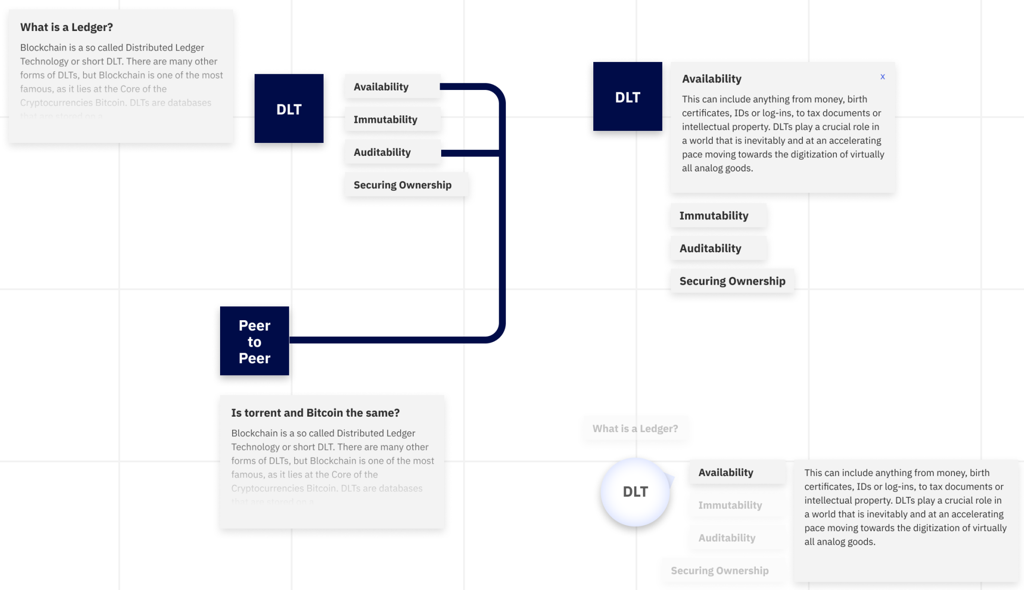
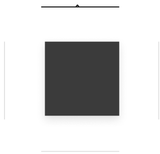


fig. 44 testing rounded connections and radio dials as interactions



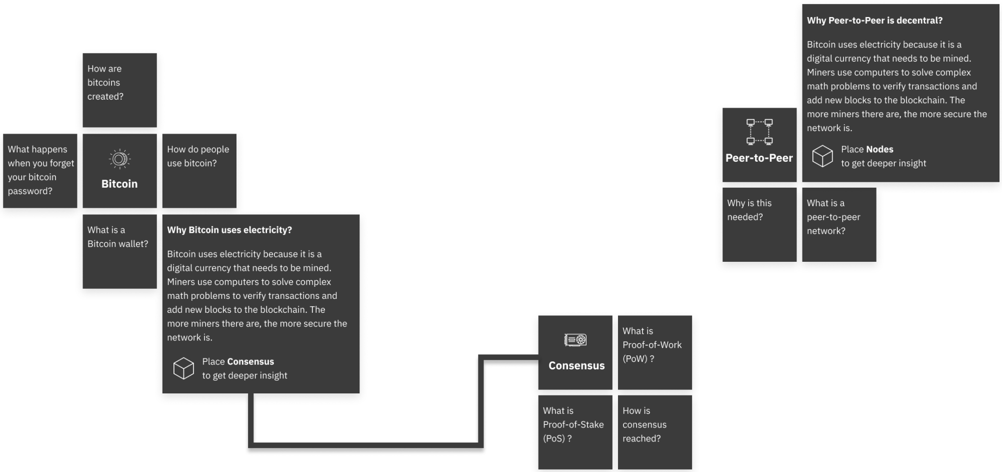


fig. 45 black and white iteration with square corners

Interactions

The interaction flow begins when the user places a token on the screen. The tokens represent the main components of the blockchain. They are represented by answering the frequently asked question on the respective topic. The table provides a strong reader-text interaction. Interaction with an educational text involves a series of cognitive operations such as expectation, combining information and formulating its interpretation. When several people interact with the table, they can perform similar activities with others. While one user reads the text privately, a group of people can interact with a single token as a group and discuss the topic.

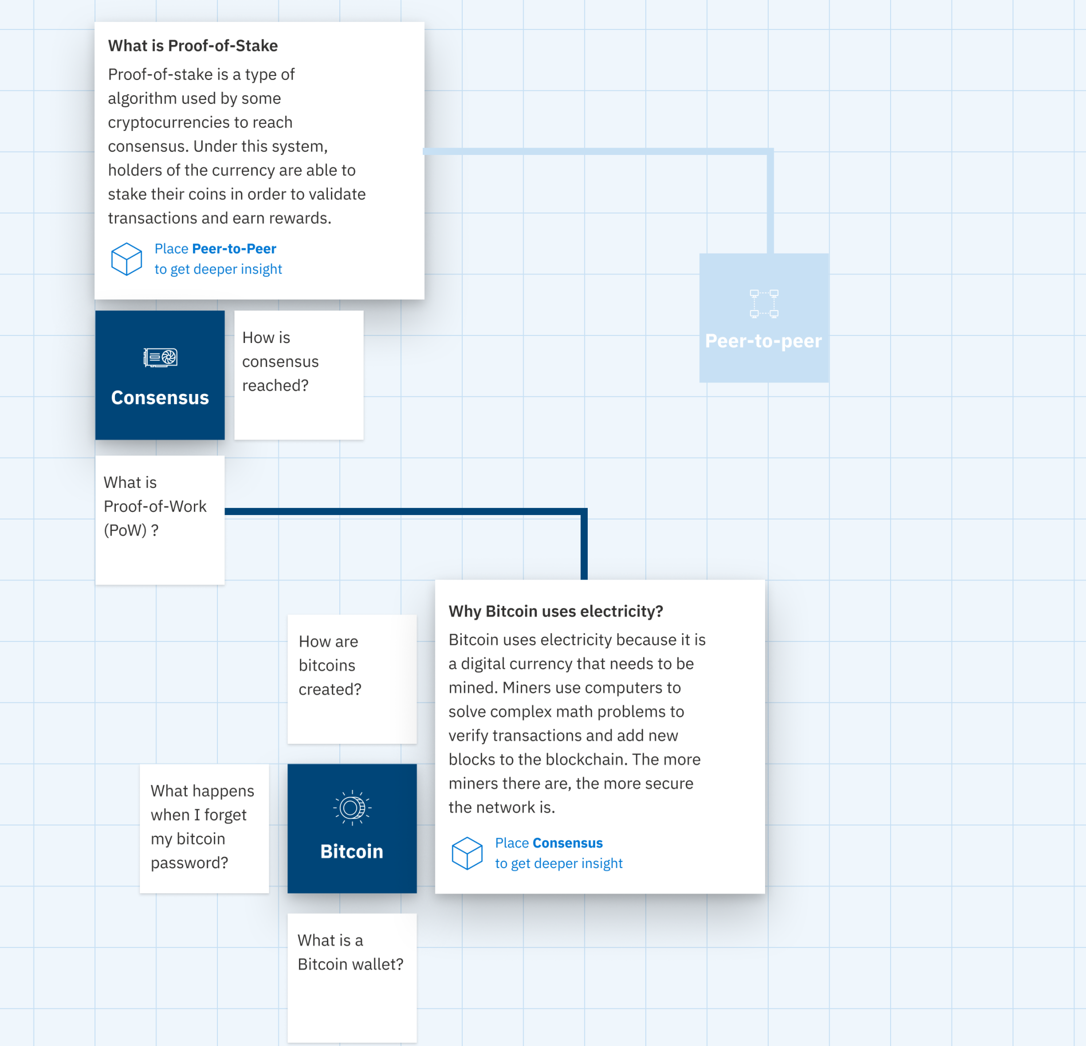


fig. 46 final interface of two token connected by a question

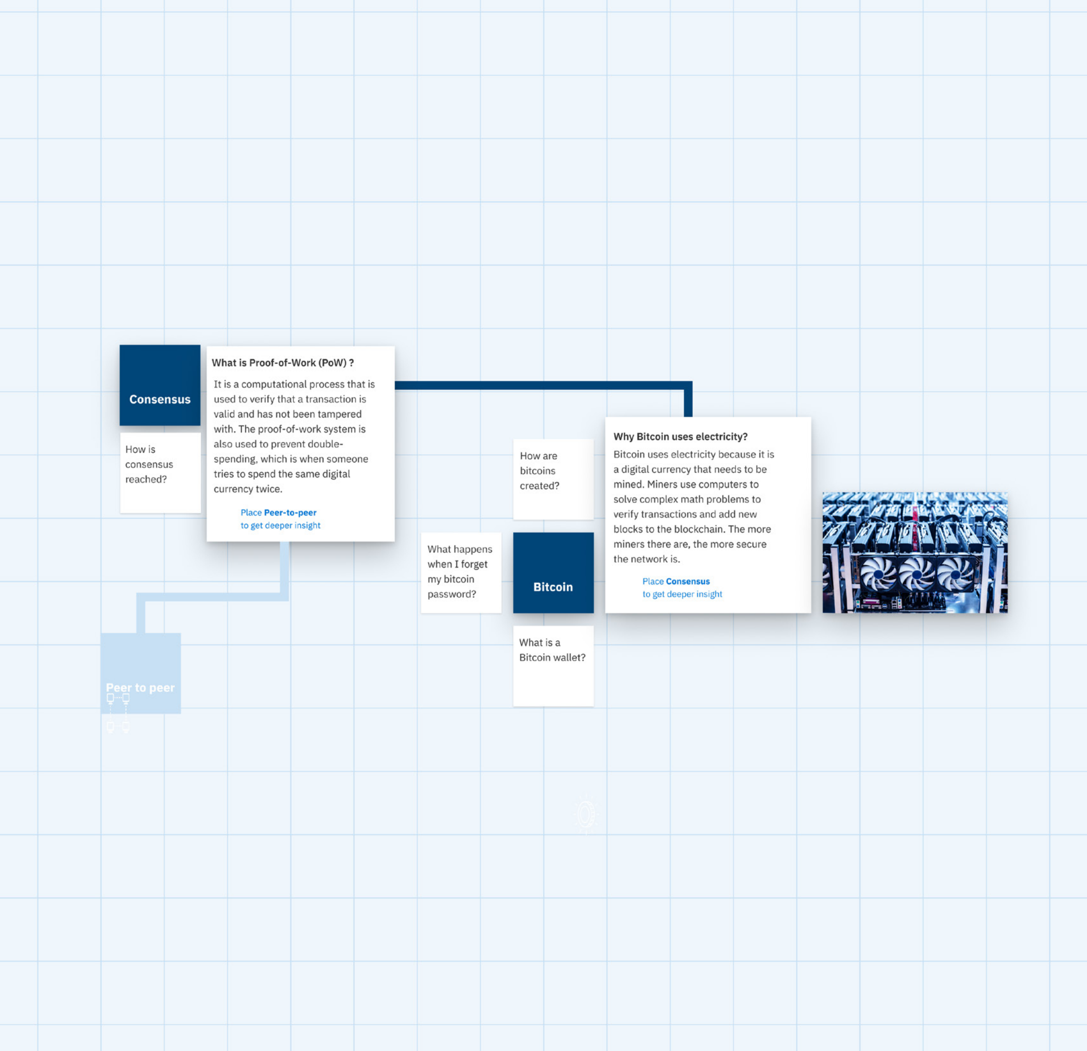


fig. 47 final interface with images and suggested next token

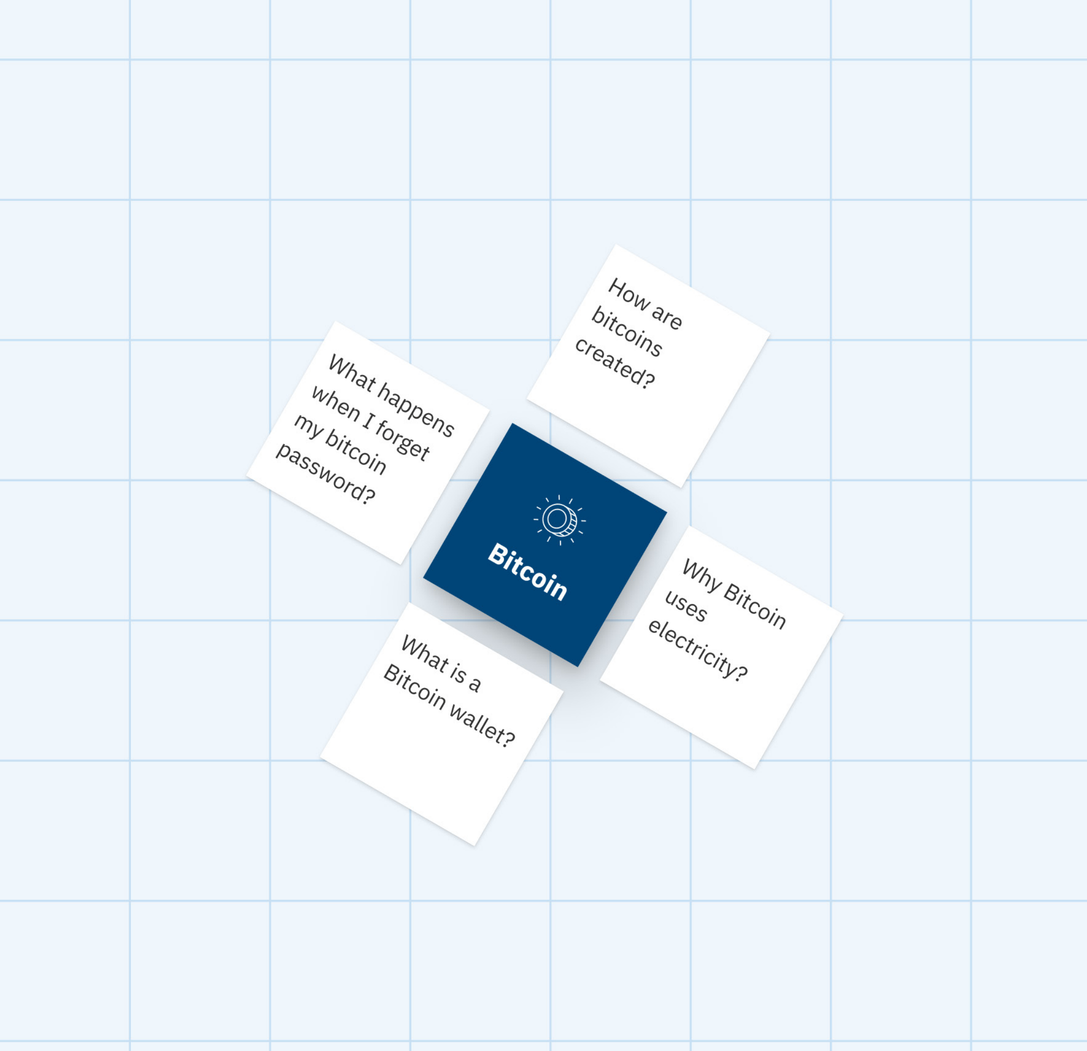


fig. 48 final interface rotating token

Content

The texts and questions are a kind of blueprint for building blockchain comprehension. The user recognises clues and connections in the text and combines them into different themes. We know that comprehension can vary depending on text and question type, and that readers' word recognition and background knowledge can account for these differences. For this reason, we have decided to keep the texts simple and clear by using familiar words and a structure that includes an introduction, explanation, and summary. For the questions and statements, we use quotes we've picked up in interviews and conversations about our topic.

Topics

We have reviewed 15 main topics and 50 subtopics in order to define topics to present. The reviewing process has enabled us to gather them into 24 main subjects, starting with Distributed Ledger Technology, the main technology behind Blockchain, until Non-Fungible-Tokens. Each component is represented by a physical token that can be placed on the interactive screen.

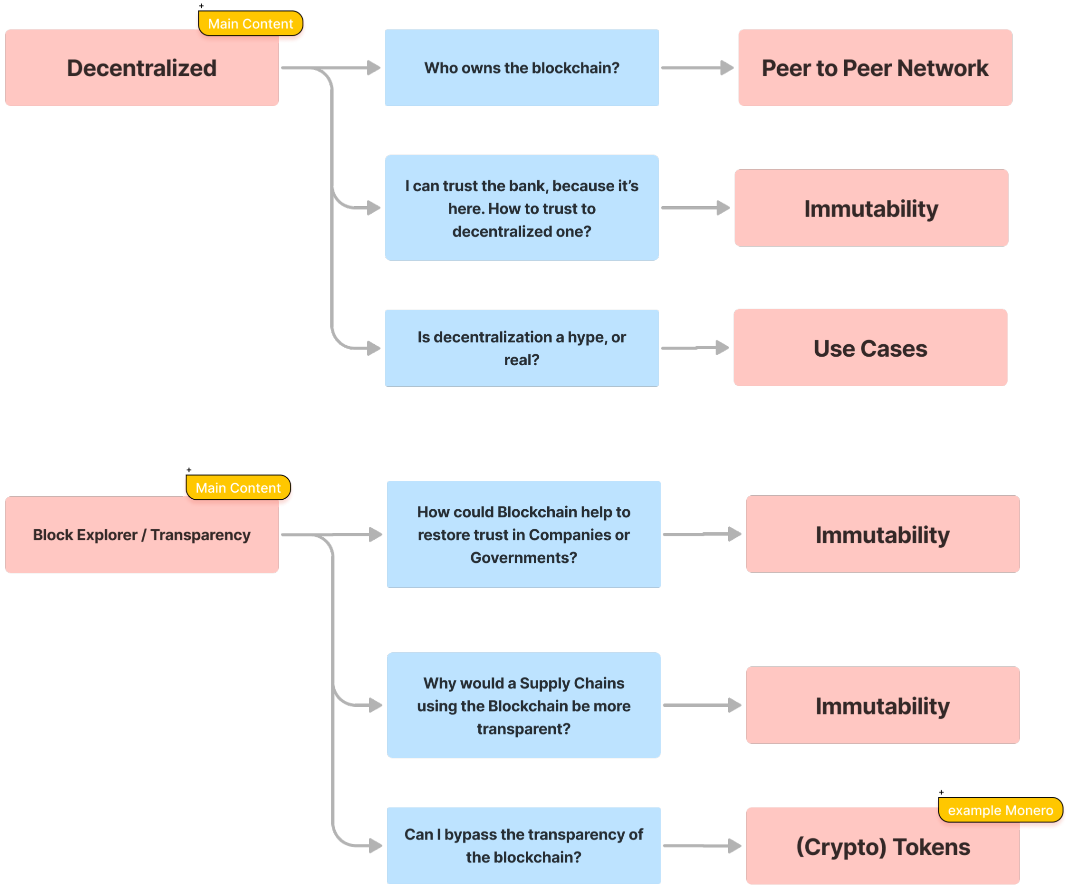


fig. 49 selection of the main themes and related questions and their following tokens

fig. 50 all 24 tokens and their planned content

Blockchain uses a lot of Electricity

First of all, not every blockchain consumes an extraordinary amount of power. In the case of Bitcoin, however, this is correct and there is a reason for that.

At the moment, the Bitcoin network consumes 125.1 TWh per year. That is more than twice as much electricity as the whole of Switzerland with 59.2 TWh per year. It should be noted that in the Asian region, for example, a quarter of the electricity needed to maintain the network is produced by coal. This understandably raises questions about the environmental sustainability of this technology. Globally, however, hydroelectric power is used as the major source of electricity for blockchains of various cryptocurrencies.

What is the reason? It's very simple. It's about binding the participants in the network, the miners, to a real, physical expense. This means that in order for a miner to have the opportunity to be rewarded for his work on the network, he must first spend money. In this case, the money is spent on electricity and the necessary hardware. It is a kind of game theory, because the miner should have such large expenses that it is more financially worthwhile for him to correctly participate in the network. This is because a miner can also make false transactions. However, these are usually discovered by other legitimate network participants and the miner is excluded from the network and remains on his electricity and material costs sit. It must cost so much, so so much electricity must be consumed, that it is simply not worth it for miners to cheat, but that they rather play along correctly.

fig. 51 selection of the content of a response in detailed form, not yet broken down

4.6 Block Development

Scaffold

For the first prototype, we decided to build a scaffold out of wooden slats. We also used metal L-pieces, so that if we had secured the Plexiglas sheet, we could easily remove it.

fig. 52 construction of the wooden scaffold

Panel & Lighting

We first had to trim the 2000mm x 1500mm panel to 1500mm x 1500mm using a vertical panel saw. We polished the plexiglass at the edge with a hand drill, a polishing attachment and acrylic polish. This procedure is important in order to achieve maximum fluoroscopy of the panel. 1500mm length illuminated from two sides is a distance that is just at the limit of what is possible with the PLEXIGLAS XT LED Farblos 0E012 XL.

fig. 53 positioning of the panel and placing of the PCV projection foil

Camera

As camera we use a Raspberry Pi Fisheye camera, which just about sees the whole surface of the table with its viewing angle of 160 degrees at a distance of 930 mm.

fig. 54 raspberry pie with ir-camera duct taped on top

Projection

As a conventional short throw projector cannot produce an image of 1500 mm height at a maximum distance of 900 mm from the table surface, we had to upgrade to an ultra short throw laser beamer. The Xiaomi Mi Laser 150 projector provides an image of 3000 mm by 1500 mm with a distance of 500 mm from the projection surface. Since the projector has a certain offset, we had to place the projector on the side of the table and not directly below it for first tests.

Realization

After some settings and adjustments, we realized that the 1920x1080 resolution of the projector was not sufficient to show the texts in the interface as we envisioned. The height of 1500 mm and the square shape of the screen make the area of the projected cube with a resolution of 960x1080 lack sharpness. The resolution would have been sufficient to show connections, but we are primarily concerned with the content. For this reason and the lack of budget for a 4K projector, we decided to focus on the content and the interaction of the tokens. In addition, time was limited, and the technical implementation of the functions would have taken more time than our actual objective, of providing digital literacy through content. For this purpose we simplified our concept.

fig. 55 conventional short throw projector test

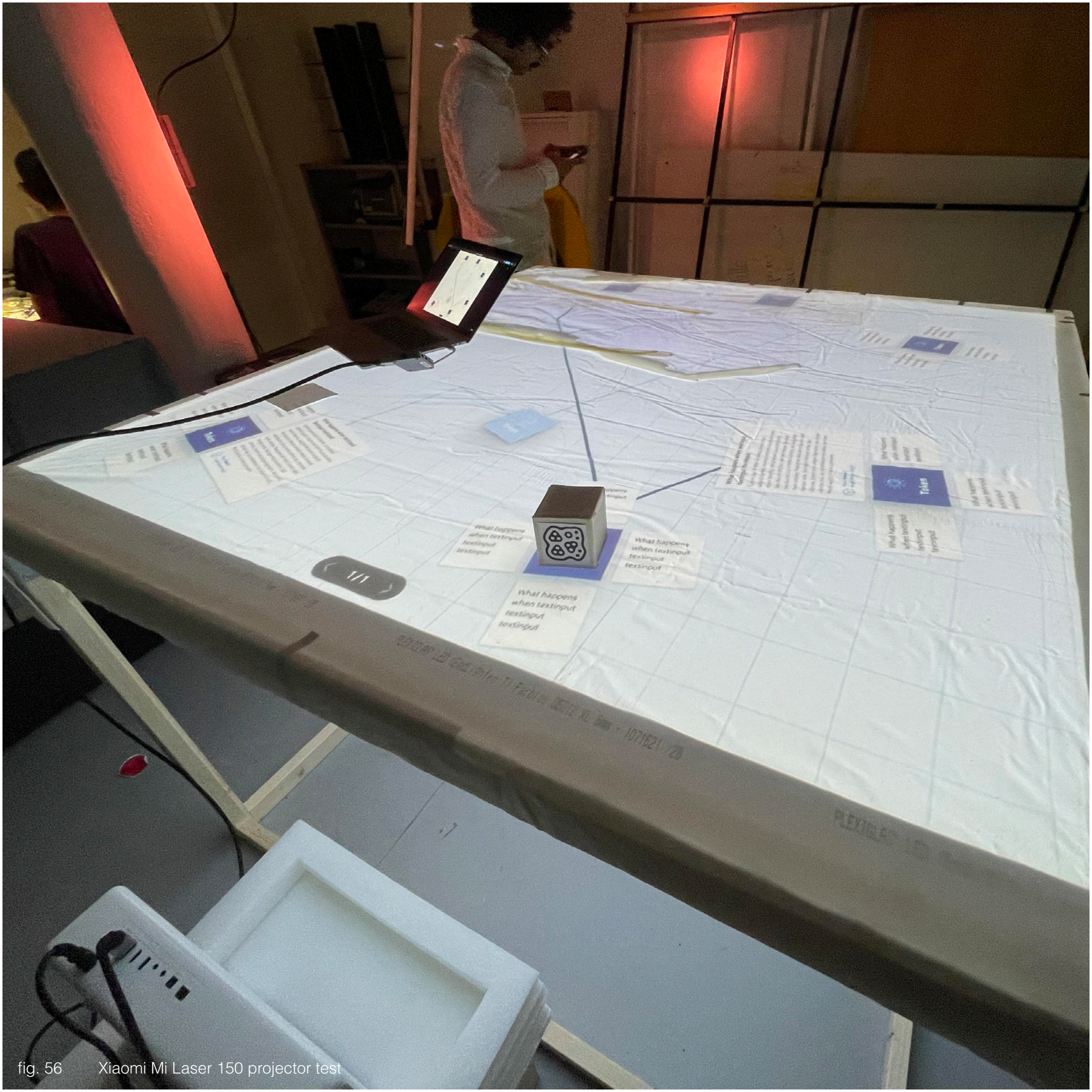


fig. 56 Xiaomi Mi Laser 150 projector test

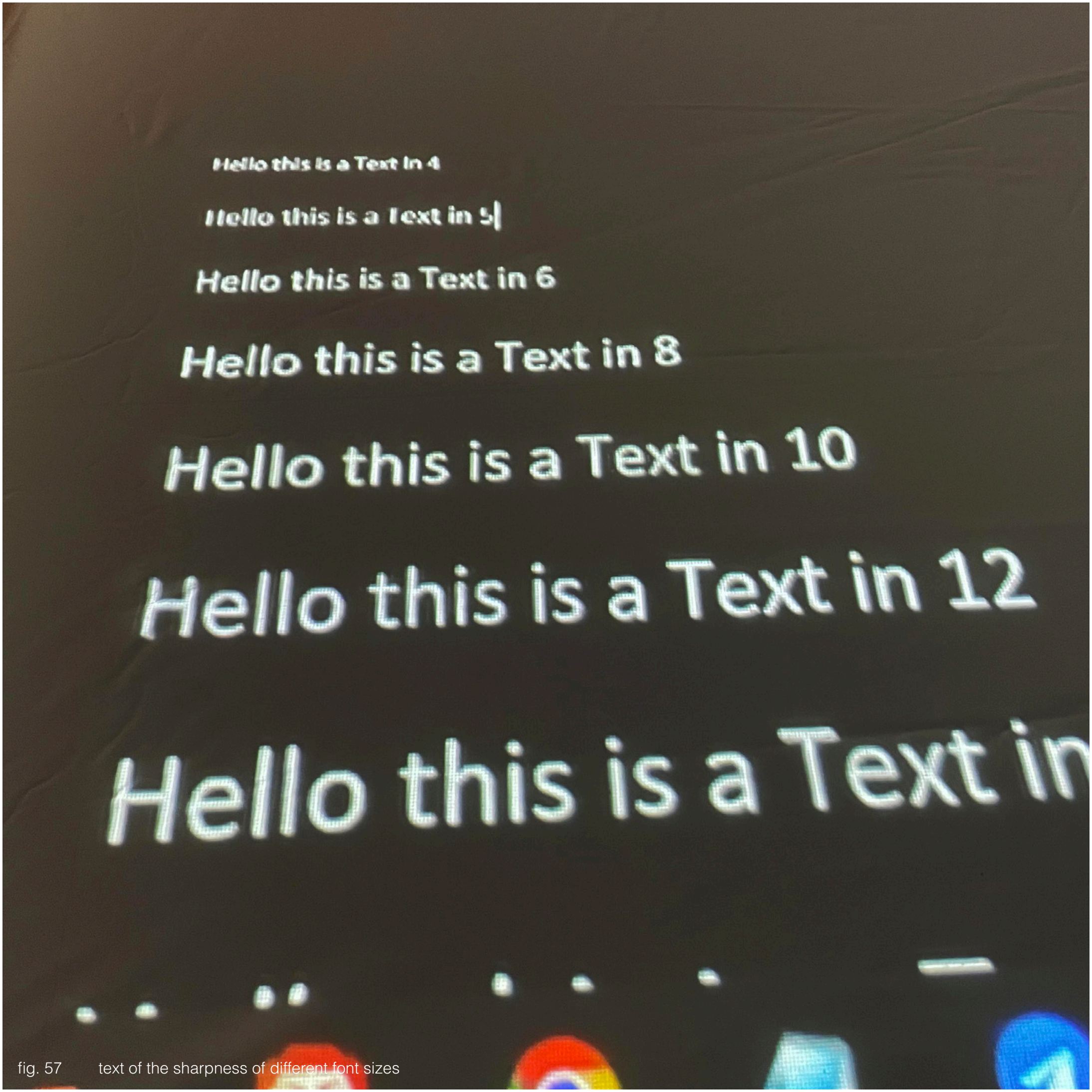


fig. 57 text of the sharpness of different font sizes

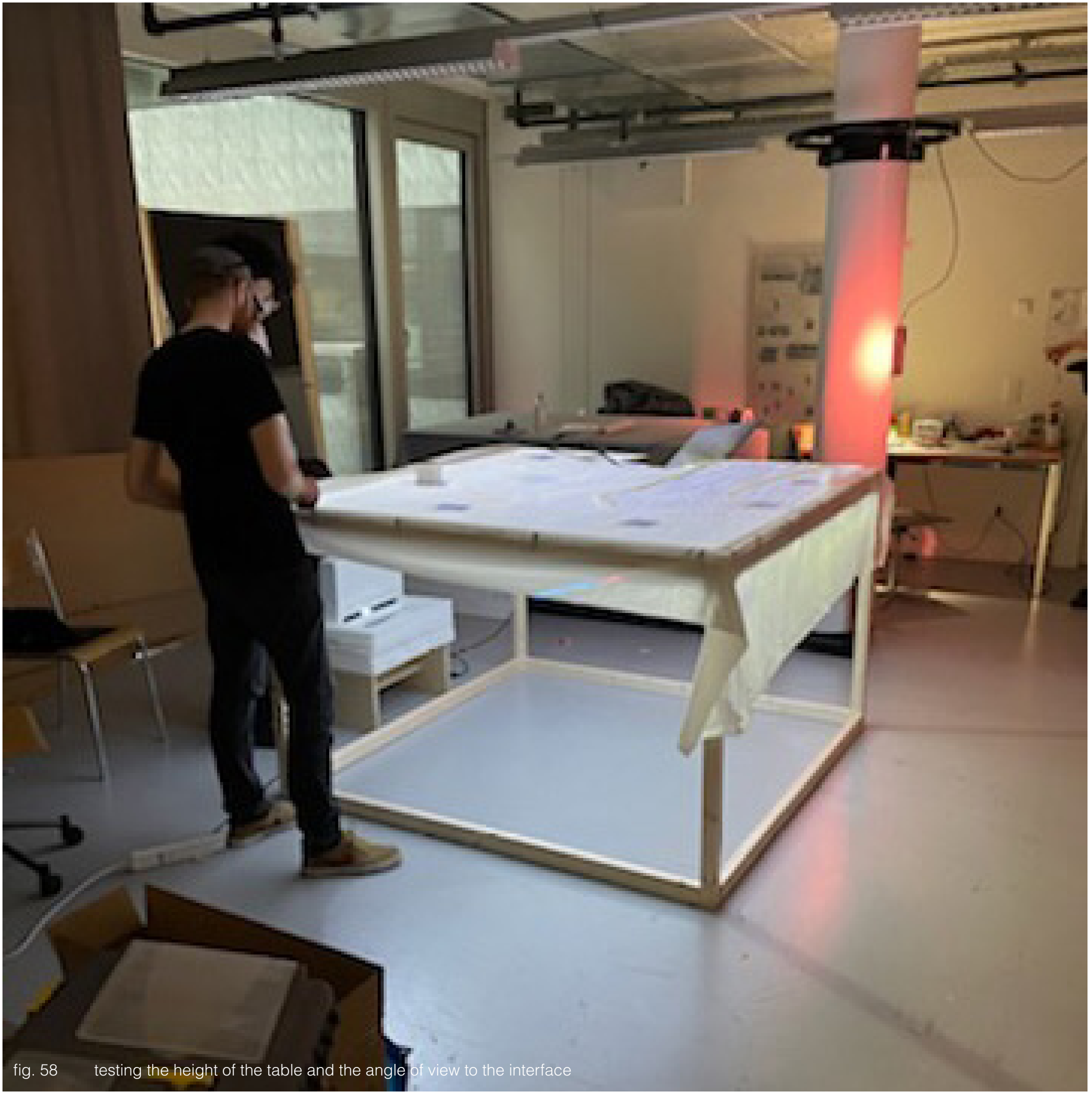


fig. 58 testing the height of the table and the angle of view to the interface

fig. 59 discussion about how to proceed

4.7 Concept Simplification

The insights from building the table led us to simplify our concept. The technical challenges should not prevent us from creating digital literacy. Therefore, instead of projecting the interface onto the table, we will project blocks onto the wall. We will continue to use the tokens as previously intended. The tokens can be placed on a smaller block instead of the large table surface and rotated. Depending on the angle, the questions or statements and our content will be displayed.

Each question or statement has a token that would make sense to work on next. The tokens are therefore placed on a large block between the two intended user stations, which can be operated individually. The respective block matching the side or the topic is made visible by lighting up in blue color by a LED.

For this iteration we do not use touch input. The interaction is simply done by placing and rotating the blocks and swapping them with the next block. Since we no longer have touch input, the Aruco recognition can now be done using conventional webcams.

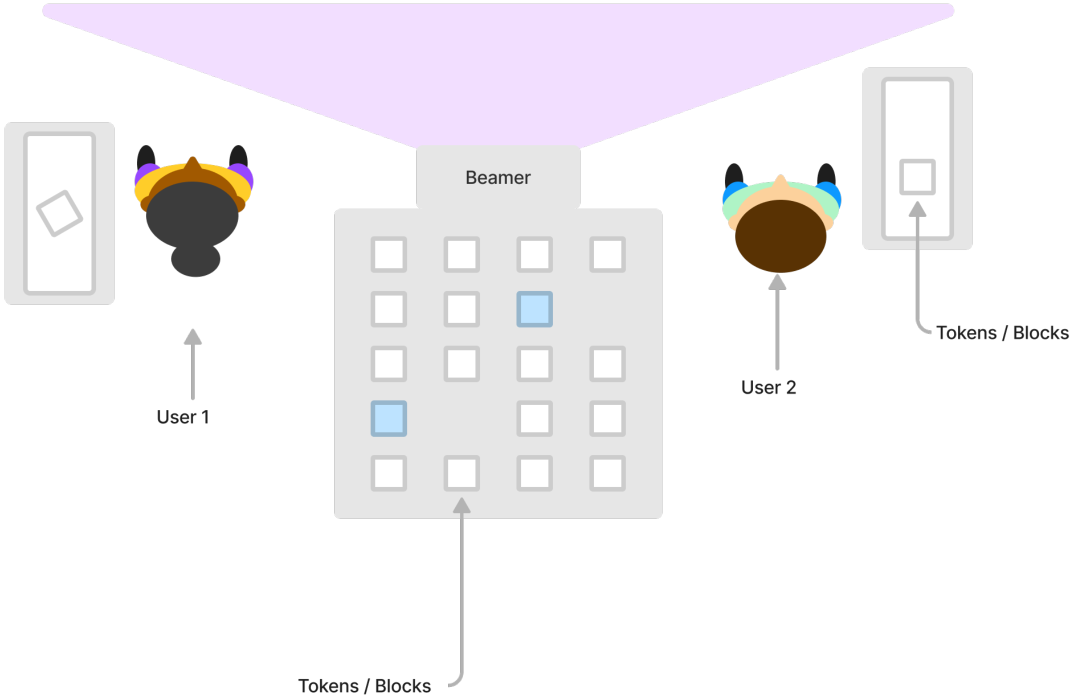


fig. 60 sketch of the simplified concept

fig. 61 preparation of the blocks for simplified installation concept

4.8 Tokens
Design

The tokens are made of sandblasted acrylic glass. They are in square form with the dimensions 60mm x 60mm. Three sides contain questions and statements about the corresponding topic. The main theme is written and represented by an icon at the top of the token as well as on one side. To keep track of the positions of the tokens and to identify which token it is, a unique ArUco marker is placed at the bottom of each of the tokens.

With the first iteration, we have experimented with the use of rounded edges, so that the block is more comfortable to hold. However, this rounding is a violation of our overall design, so the user will have to endure the somewhat unpleasant hard edge of the blocks created in the final iteration.

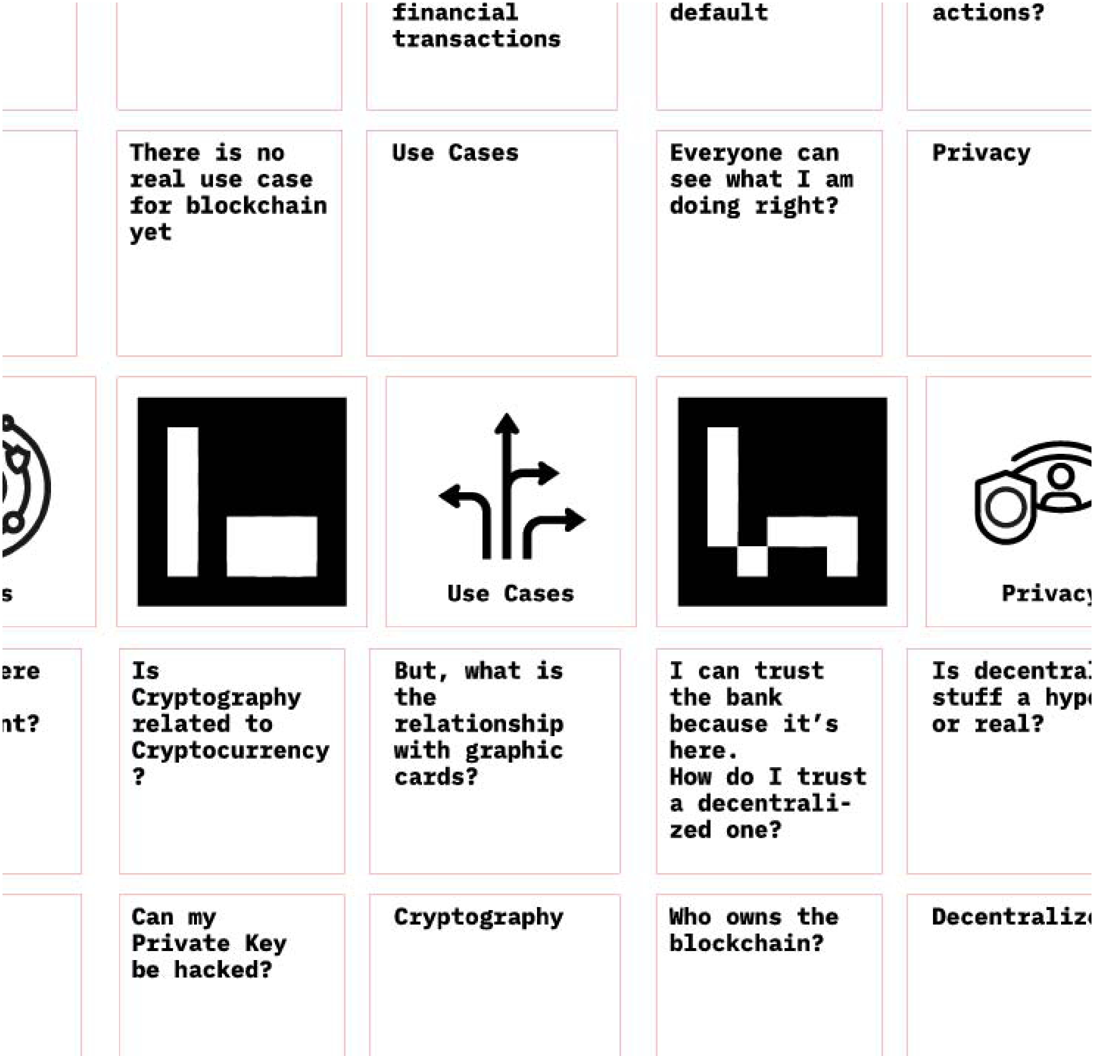


fig. 62 laser cutting template for tokens

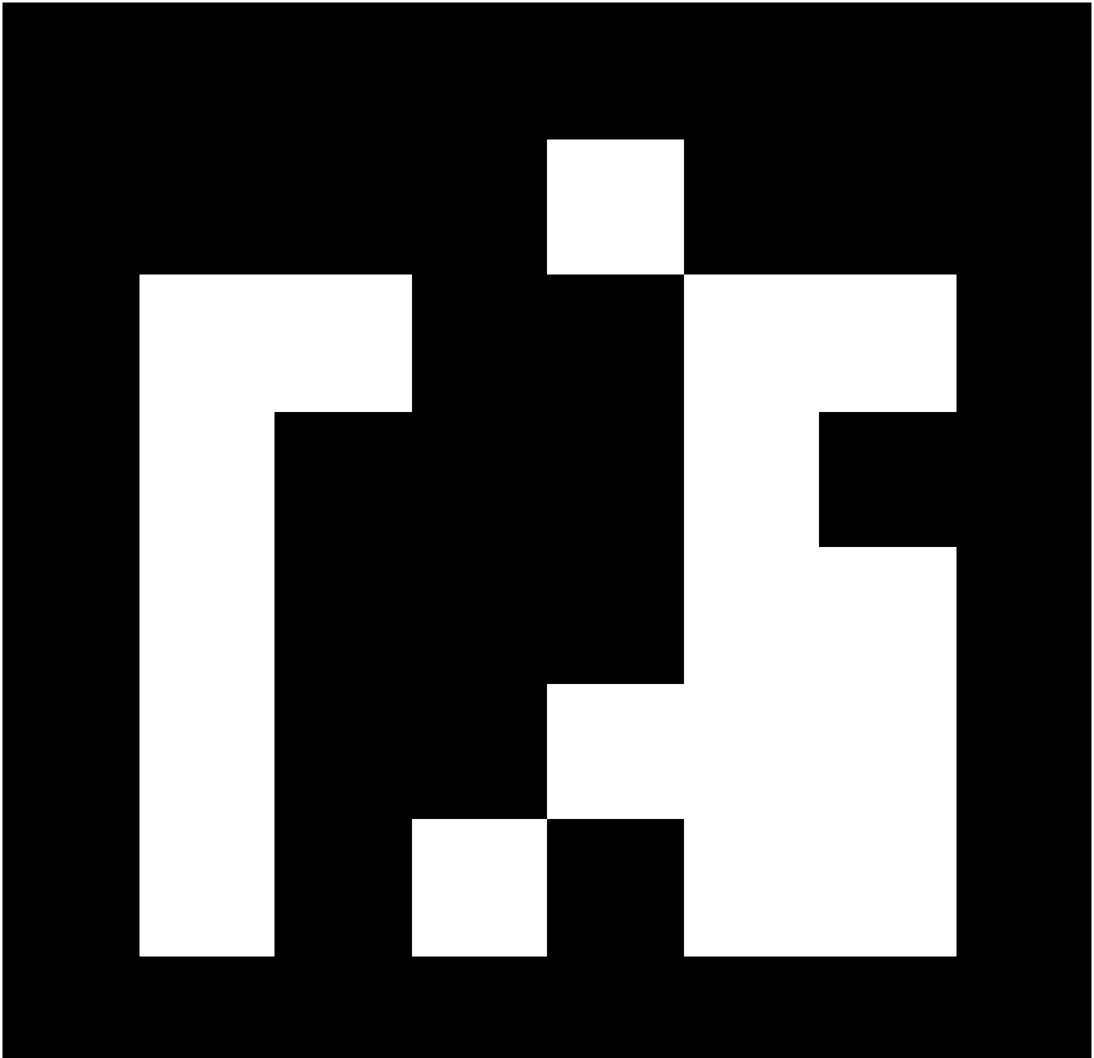


fig. 63 ArucoMarker

fig. 64 iterations of tokens with and without written theme on top

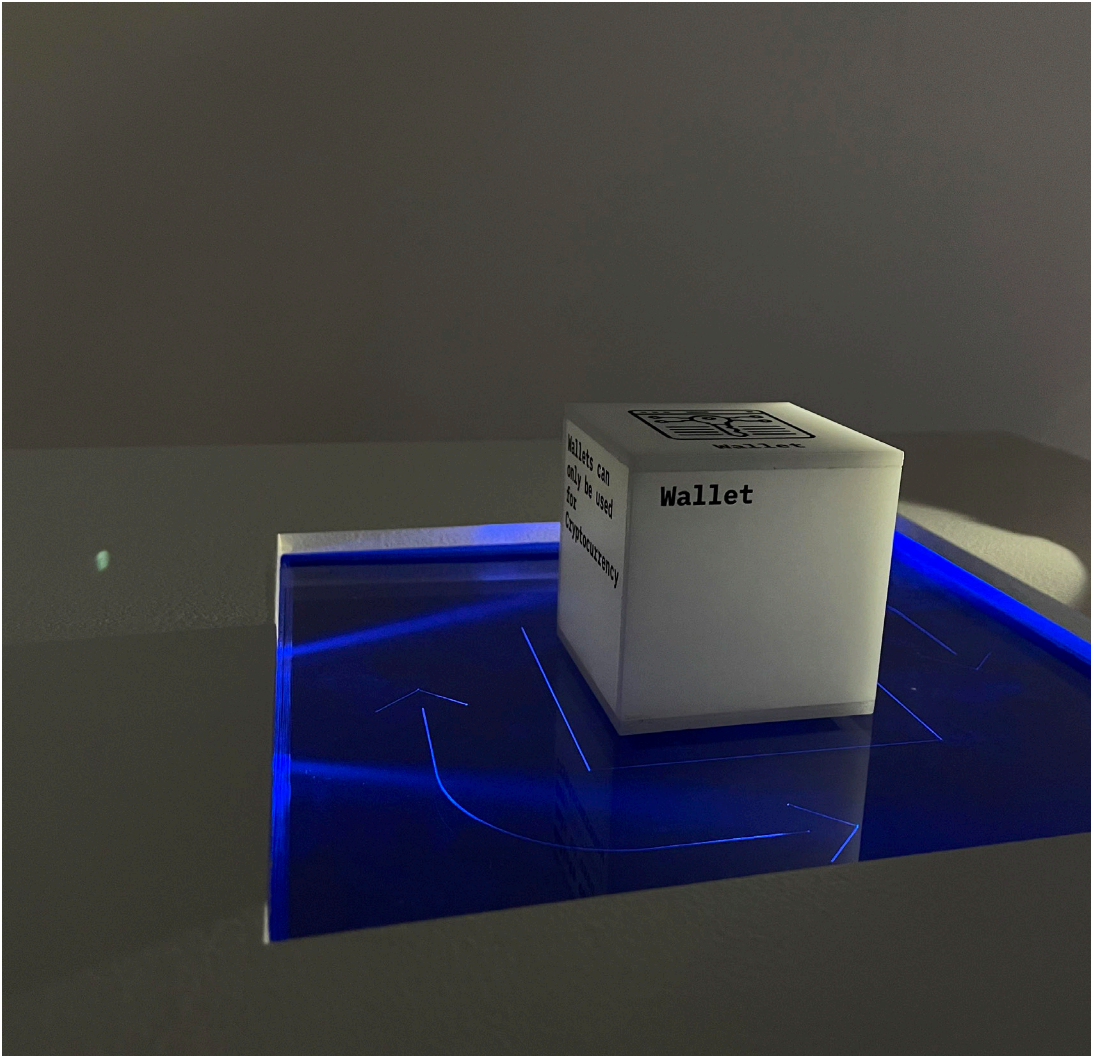


fig. 65 testing the illumination of the engraved panel for the placement of the token

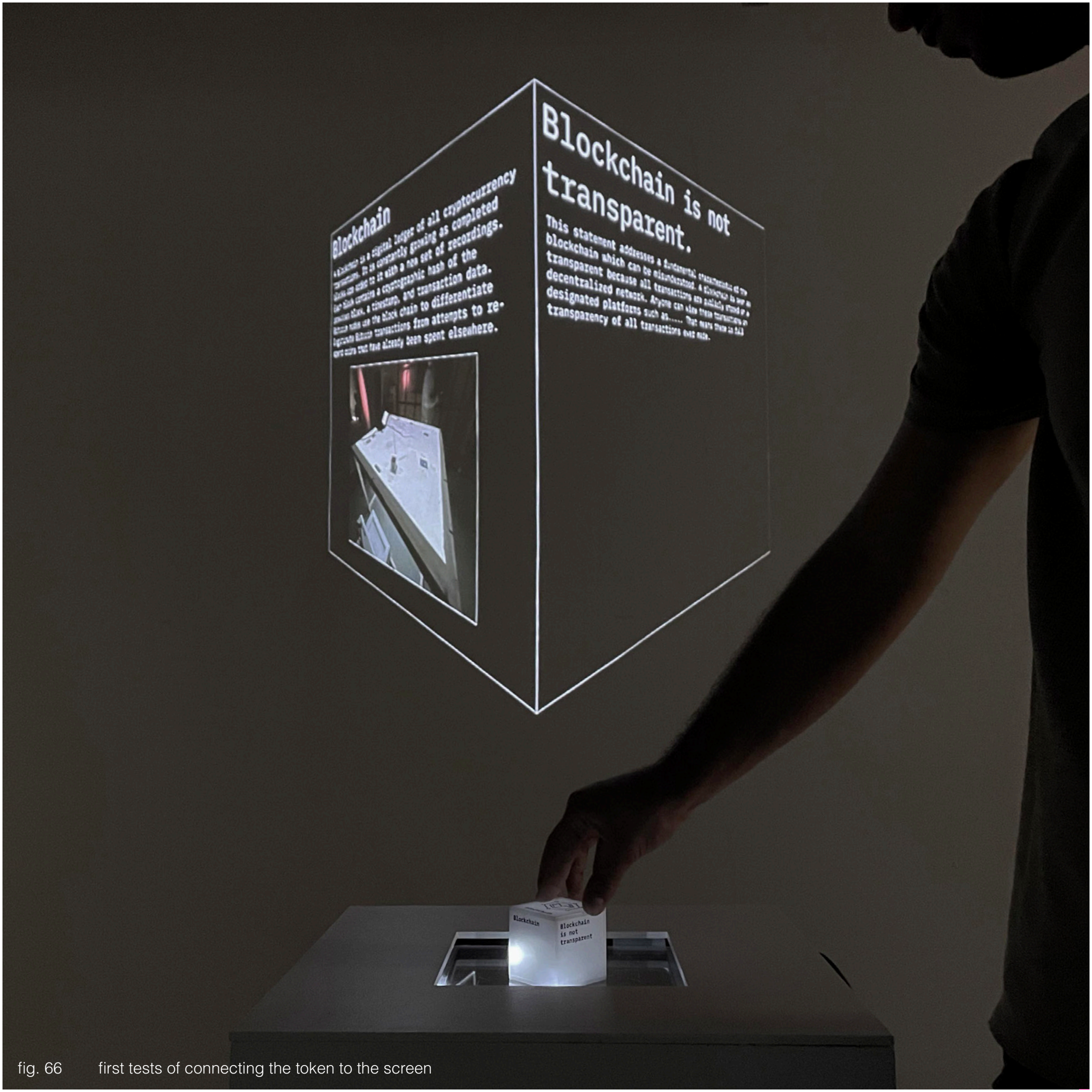


fig. 66 first tests of connecting the token to the screen

Productions

The laser cut machine is first used to engrave the sides of the squares. They are then cut to the appropriate sizes. Sandblasting is applied to the acrylic glass after the cutting process. The engraved sides are first painted with acrylic paint, and then the sides are glued together using an adhesive.

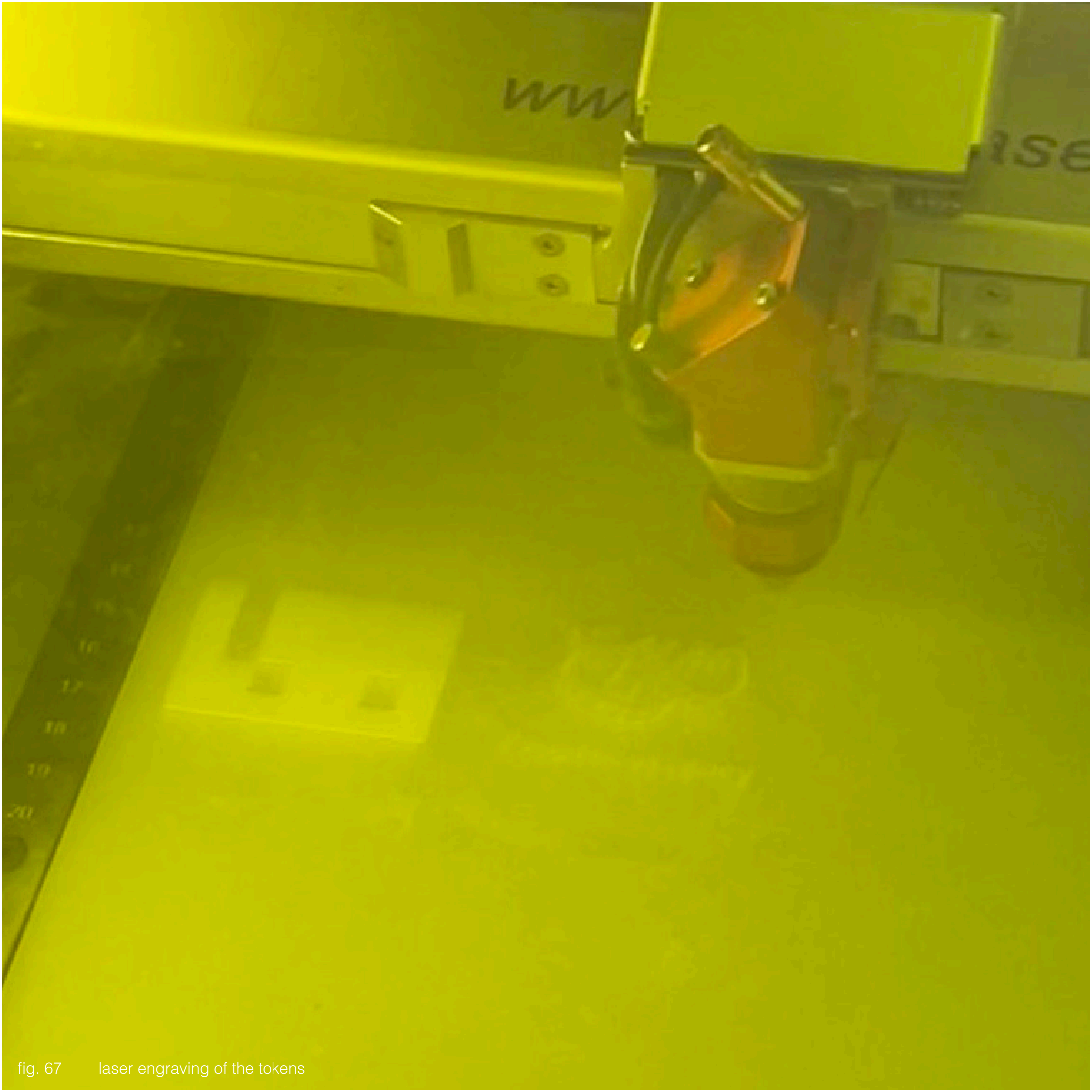


fig. 67 laser engraving of the tokens

fig. 68 fill the engraved tokens with acrylic paint and glue them together

fig. 69 drying final token

Aruco Marker

ArUco is an Open Source library for camera pose estimation using squared markers. Detecting markers with Python and OpenCV is easy to build, efficient and there is no need for big computational effort. Aruco markers are used in the tokens to track their position and identify them in the backend for visualisation of the interface.

fig. 70 testing of the recognition of the Aruco marker with backlighting

4.9 Programming

Recognising the tokens

Every token in the exhibition has a unique ArUco marker below it. This allows us to identify the token and its rotation, so we can dynamically update the Block it's projected on in real time. This creates a playful effect in the exhibition.
We use OpenCV to recognize ArUco ID's and rotations of the tokens. OpenCV is an open source and cross-platform library of programming functions mainly aimed at real-time computer vision. We decided to use OpenCV in Python3 because we both were more understanding the syntax of Python.
We start by using OpenCV for our program. In order to use OpenCV for pose estimation, we need to determine the relation between the camera's natural units (pixels) and the real-world units (e.g., millimeters). To do this, we have used the sample source code of OpenCV and a classical black-white chessboard. We took snapshots of these patterns with our camera and let OpenCV find them. After calibrating our camera, we uploaded our configuration file created by the sample program to our ID and rotation recognizer. OpenCV can now identify the ID, the X,Y,Z position and the degree of the rotation, when a token is placed on the Block. Since our main program for visualizing tokens is running with Node.js, we needed a way to send the real-time information coming from OpenCV. We defined our program as a Socket.IO client. Socket.IO is a JavaScript library for real time web applications that enables real-time communication between different parties. The Socket.IO framework is very fast and can handle our data without doing big computational processing. By connecting to the 3000 port, our Python 3 program can send the real-time information to our main client via Socket.IO.

The large block where the tokens are placed is equipped with blue LEDs. The position of those tokens can be changed because they don’t have any unique place where we place them. To light the nearest LED to each token, another Python3 program with OpenCV is tracking the positions of the tokens. This information is sent to the Node.js to calculate and decide, when which LED will light, and our Node.js program sends this information to the Arduino, which regulates the flow of electricity.

Handling the real-time data

We have written a Node.js program in order to visualize the placed token on the wall, displaying the content for each token, rotating the visual, when the physical token is turning, and lighting the tokens in the large block when there is a relation between the placed token. Node.js is an open-source JavaScript runtime environment.

This program act as a Socket.IO server, which our Python programs can connect to and send data. We have two separate sections that the user can interact with, so we have built different logic for each one. Our Socket.IO connection listens to three clients: the left block, the right block, and the large middle block where all the tokens are placed. When a token is placed, the corresponding ID and rotation is sent in real-time to our Node.JS server.
We have created a JSON file that defines the ID’s and contents of each block in each rotation. Depending on the value that is coming in, the content from the JSON file will be sent to our HTML file via JavaScript. The token is visualized as a 3D cube in pure CSS, and the container for it can be changed by our Node.JS program.

The JSON file provides suggestions for each side of the token, which are displayed by the blue LED below the token in the large block. The tokens in the large block are simultaneously assigned to the nearest LED, and this information is sent to Arduino via the Serial Port to regulate the energy flow of the corresponding LED.

Program Architecture

Server.js

Creates a Socket.IO server that can receive and send data from a Serial Port. It also calls the content of an ID from data.json, calculates the rotation of a block, and states the next suggestion tokens. Finally, it sends the corresponding content to Block_Sketch.js.

Block_Sketch.js

Responsible for the displaying the content coming from data.json. It gets the each side of the cube as div classes, and changes the value simultaneously.

ledData.py

The camera capture is processed from the bottom of a large block in order to identify the positions of tokens.

`leftData.py - rightData.py`

The camera captures from the bottom of the left and right blocks are processed in order to ArUco ID’s and rotations of the tokens.

`data.json`

Corresponding content of each token which will displayed are stored in data.json

`ledLogic.ino`

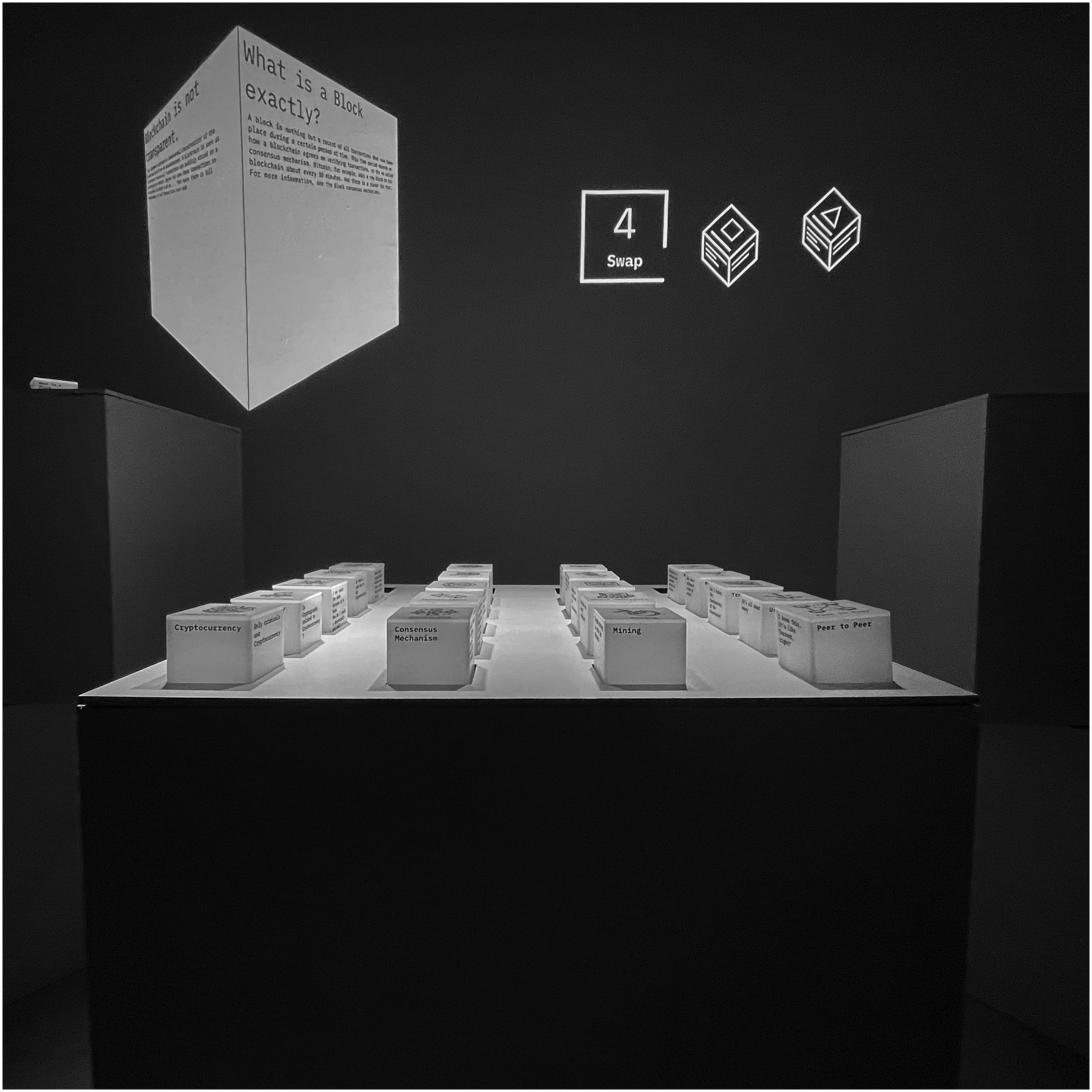
Received data via the serial interface switch the OUTPUT LED to high/low.

Accessing the code

Our GitHub repository is public and can be seen or downloaded under https://github.com/ipekli/Block_Ausstellung_Diplom.
In case of bugs, questions, problems or other concerns, Issues section be used to report them.

5 Block

The final execution of our Block prototype in its simplified form taught us that even by reducing the possibilities for interaction, an exciting interactive installation can be created. It was the right decision to break away from the complexity of the table. In the end, the simplified concept grew on us even more, because it is our own technical and design solution.


What is a Block exactly?
Blockchain is not transparent.
4
Swap
Cryptocurrency
Consensus Mechanism
Mining
Peer to Peer


Blockchain
Blockchain
Blockchain
is not
transparent


What is a Block exactly?
Blockchain uses a lot of Electricity
Is it true that if I have a bad wallet, I could lose all my assets?
What is a Block exactly?
tocurrency

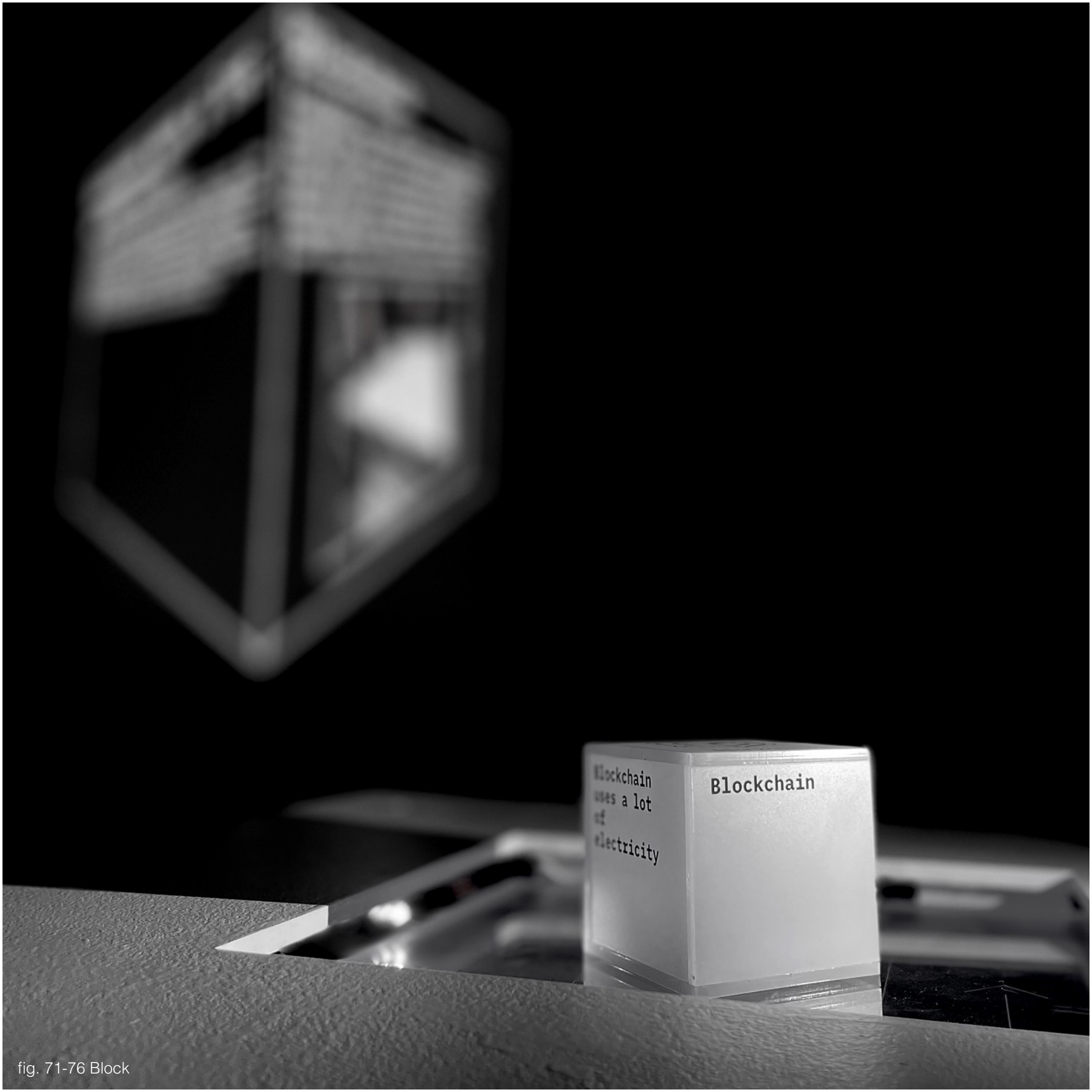
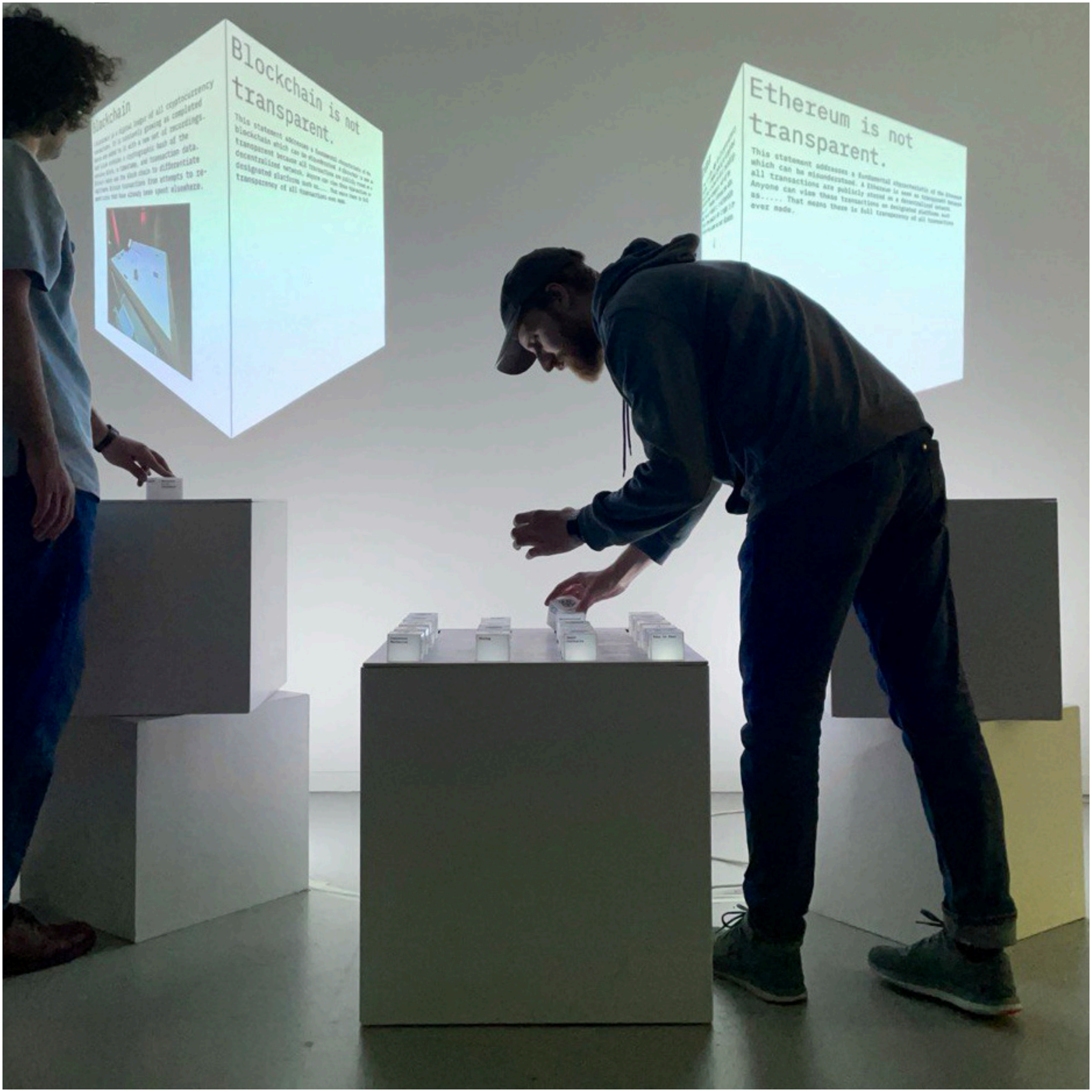
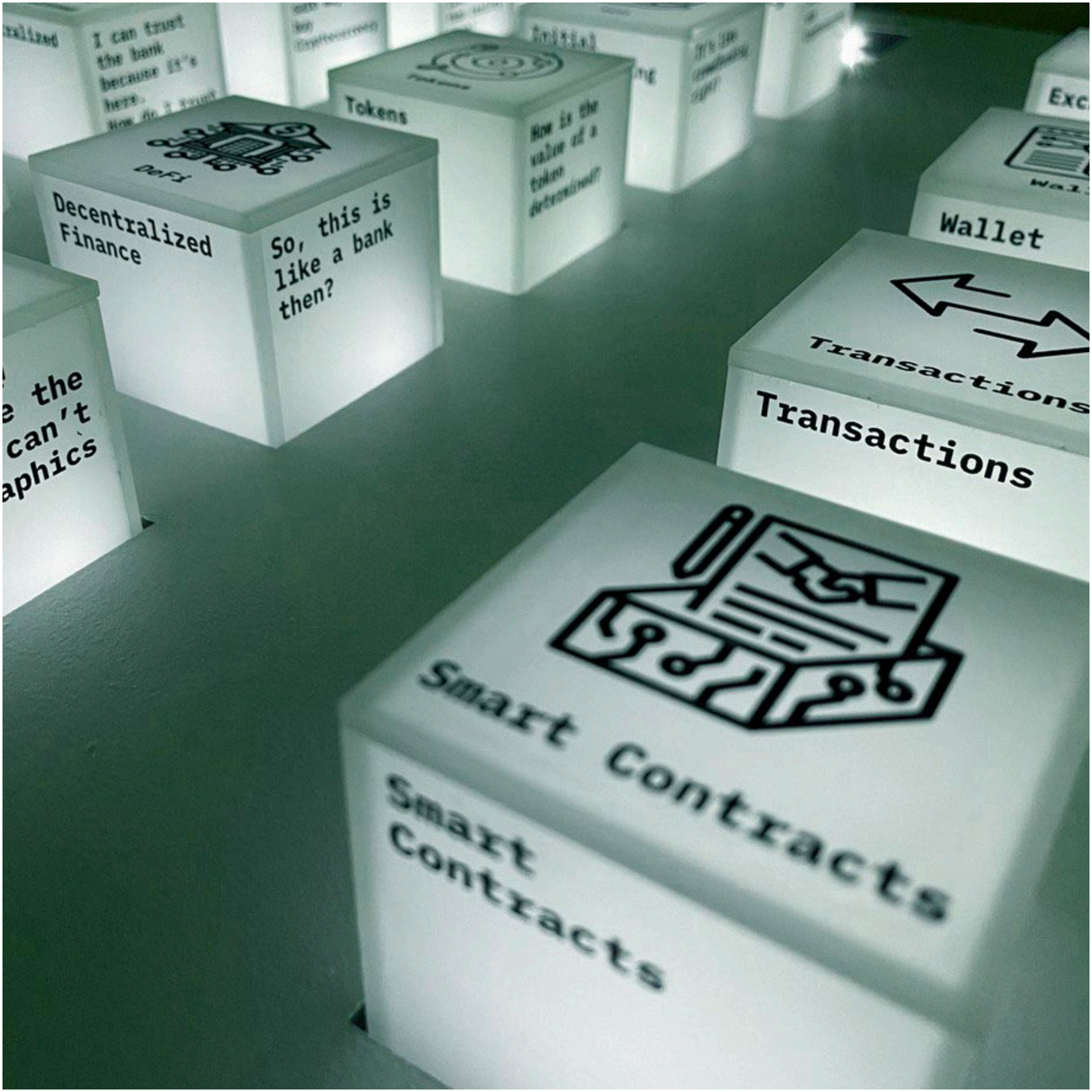


fig. 71-76 Block


Blockchain
Blockchain is not transparent.
Ethereum is not transparent.


DeFi
Decentralized Finance
So, this is like a bank then?
Tokens
Wallet
Transactions
Transactions
Smart Contracts
Smart Contracts

6 Conclusion & Reflection

At this Point, we will conclude our thesis. For this we will first summarise the development of the last four months based on the most noteworthy steps and decisions. Followed by a reflection of how our process went, where we found strengths and weaknesses in our approach, as well as how we need it to improve or want to maintain our procedural approach in a next project. The subsequent paragraphs will discuss what we learned from the thesis as a whole, argue our contribution to the field of interaction design and our contribution to people interested in Web 3.0 as well as blockchain technology, ending with a proposal for additional steps that could be taken to advance our concept.

6.1 Conclusion

At the end of our thesis stands the concept of Block as a physical representation of what we have been grappling with over the last four months. But it's not just Block, it's also an incredible wealth of knowledge that we have been able to acquire through our constant engagement with Web 3.0 and blockchain. Our vision of the resulting project was constantly changing in relation to our level of knowledge and findings resulting from our different methodological approaches. We started with the initial idea to investigate the new and emerging topic of Web 3.0 in order to first, understand what it is all about or in our case also not about, and second, identify possible shortcomings that would be of potential interest for Interaction Designers to probe further. We have remained true to this fundamental idea, however, over the course of our work, our focus has shifted from Web 3.0 to blockchain, as well as from wanting to familiarise and break down the existing practices to familiarising and informing about basic technologies and their interconnections.

Despite having been somewhat involved in the world of Web. 3.0 and blockchain, we were not prepared for the technological depth of insight that would be required to understand why and how different components work together as they do. It quickly became apparent that we needed a reference point such as the vending machine prototype in order to proceed with our research in a structured manner and not get lost. The prototype made it much easier for us to immerse ourselves in the topic and enabled us to recognize that there is a specific design and branding conflict with the wallet, and a general problem of the incomprehensibility and confusion about various interdependent technologies or processes in relation to the blockchain. Furthermore, we had to admit that our background knowledge about the general origin of the web and its ideology, as well as its evolution, was not particularly profound. These findings have significantly influenced the further course of our work and informed our research questions of:

How might we create an experience that makes the use of Web 3.0 technologies more understandable and tangible?

How might we leverage existing user knowledge to facilitate their introduction to and engagement in the subject matter?

Applying different methodologies helped us to work our way closer to answering these questions. Beginning with interviews to deepen our understanding of the origin of the web, we understood that the challenge of communicating technical details in an understandable way on the side of developers is nothing new. There even seems to be an interest in the fact that it can be abused as an element of dominance in some situations. We acknowledged this communication bias and subsequently redefined our position as designers in the context of this project, as a bridge or translator between developers and users. Moreover, we found in interviews with experts that Web 3.0 does work in terms of financial services, but the tools such as certain wallets and programs that have to be utilised are not well received or sometimes even condemned by long-time users. To investigate these findings further, we decided to conduct user tests regarding the creation of wallets at a later point in time. Discussions with different people revealed that there is a broad interest in understanding what Web 3.0 and blockchain are all about. Based on this insight, we came up with the idea of a participatory talk. We invited people for dinner and a glass of wine and gave a presentation on previously gathered interests, which could be interrupted at any time and included an active part of creating an account on a cryptocurrency exchange. The talk revealed that there exists a tremendous amount of unanswered questions, misconceptions and assumptions regarding blockchain technology in general. For some these unresolved issues had to be clarified before they felt confident enough to create an account. Others didn't bother, as they only wanted to buy cryptocurrencies or tokens. Even though we tried our best to answer all open questions and demonstrate practices for 4 hours, the participants were definitely still completely overwhelmed at the end. This experience slowly but surely made us doubt that it would be wise to commit our time and energy to optimising a specific process, such as signing up with a cryptocurrency exchange. It was painfully obvious that unanswered questions about the fundamental principles had to be resolved first. In addition, we have learned that the lack of trust in the technology can not primarily be explained due to bad publicity, but rather needs to be attributed to plain confusion.

Even though we had these findings and now intended to adopt the approach of translators and explainers, we were still interested in how first time users would behave in the process of creating a MetaMask browser plugin wallet. We therefore set up a small separate environment in which we could observe users creating a wallet based on the explanations on the website. This observation reinforced our view that it didn't make sense to address only this process, because after creating it, questions already arose like, “What can I do with this now?”
Since we wondered whether it would be possible for us to implement a solution on a real blockchain created by us, we investigated this possibility repeatedly in passing and ultimately managed to launch our own blockchain and carry out transactions on it. It was an interesting feeling to be able to implement something that seemed so complex, in such a short time and

without any expert development knowledge. We therefore kept this possibility in mind as we proceeded. As we started with the focus on the topic of Web 3.0, we initially played with the idea of illustrating or interactively visualising the various versions of the web and their technological differences as well as their interrelationships. For this purpose we built an analog paper prototype and a digital interactive prototype. Both prototypes were examined more closely and commented on by the test users, but it soon became evident that the approach of working on the basis of the different versions of the web generated only little interest. However, connections between different topics have been perceived as very helpful and intriguing.

These were the last insights we needed to ultimately put aside the versions of the web and move on to the central building block of Web 3.0 applications, the blockchain and its associated technologies. Digital literacy is lacking in regards to the functions and capabilities of blockchain technology. If this deficiency is not addressed through an intervention in the area of communication and information, Web 3.0 might for some time still be able to develop as it pleases, but It will not bring in new users. In our opinion, if no new users are acquired, Web 3.0 will not survive and will go down with a big roar, reminiscent of the dot-com bubble. Due to our shift in focus to blockchain, we also had to reformulate our research question.

How might we create an experience that makes the use of blockchain technologies more understandable and tangible?

In the subsequent days we focused on the question of how we could make blockchain more tangible. As a purely digital construct, there is nothing substantial to display physically. Through bodystorming and artefacts, we tried to physically recreate how it would feel to fill a block and move it through all the important stages of attaching it to a blockchain. Several different variations of this bodystorming finally led us to decide that we would embrace the concept of an interactive table.

Based on the aforementioned findings, we developed our concept of Block. Block is designed to help newcomers to blockchain learn the basics, the applications, and what to look for so they can develop a full understanding of blockchain's features and capabilities. The Block concept revolves around a square, block-like, interactive table that enables users to explore and learn about blockchain. As a design basis we use the shape of the block and try to incorporate it as beneficial as possible. Thus, we will also be using acrylic glass blocks for the interaction on the table. These blocks will be labelled with assumptions, statements and questions that we have encountered in our process and that we deem valuable to clarify. The tokens will be equipped with an Aruco marker that can be traced through a camera located under the table top. This allows the interface projected from under the table onto the plate to be precisely tailored to the token placed on it. The tokens address 20 different aspects of the blockchain and are interconnected in the interface to make their interdependencies more understandable. The size of the table is larger so that several people can use it at the same time, exploring different topics by reading texts, looking at visualisations or images, or following instructions. Our user group is very broad, as we are keen to address as many people as possible. As a result, we have chosen an easy-to-understand language for the interface and will not go into too much detail. It is important to us to clarify general questions as well as to visualise important interconnections and to provide further information, which will enable people to deepen their knowledge on their own, if they wish to do so. We note that there is no comparable work in our thematic area. However, we have let ourselves be inspired by several interactive works as well as related projects that are aimed at facilitating comprehension of similarly complex topics, such as for example Artificial Intelligence.

Subsequent steps in our work now consisted primarily of examining the possibilities for implementation of an interactive table. Since we were not yet familiar with the required infrastructure and materials, we had to familiarise ourselves first and identify various key aspects about which we needed to deepen our knowledge through prototypes, material tests and experiments. We are confident that we will be able to complete the interactive table and the tokens with the prepared materials prior to the start of the exhibition. The last step was to design the interface. Several iterations were made and finally we agreed on a plain design that incorporates the block as a design element.

6.2 Reflection on Process

Thinking back to the past few months, we realise that our process of research followed by the conception phase and the execution phase did not quite conform with our subject matter. Constantly faced with unknown new functionalities or concepts, we were constantly shifting between research and concept. Even if incomprehensible and unnecessary for some people involved, the early prototype of the vending machine was a fantastic decision. It helped us to find a common thread, without which we would not have been able to move as easily into the concept generation phase. In general, it improved our mood, because it allowed us to think about something digital without having to be in front of the screen all the time.
At first, we fixated on the idea of identifying a process in the existing Web 3.0 that we could enhance. In hindsight, this has been too closed-minded of us. If we had opened up more quickly and tried to zoom out and also consider the bigger picture, we would probably have realised more quickly that there is a general confusion that needs to be addressed. In a certain way, however, we did not want to accept this at first. In general, in a future project, it would be important to apply a methodology that would help us to get our head out of some rigid ideas and into an approach that commences from a more holistic perspective. Perhaps the early prototype with its specific technologies was not as helpful in this case. However, we also were aware of the limited time frame and at first seemed to want to settle for a safe project that we could complete easily.

In our process, we used a wide range of research methods, which helped us to come to a conclusion that enabled us to justify most of our subsequent decisions. What we neglected to do in our process was to interview or engage with a person professionally involved in our field of research. The Participatory Talks, which occurred almost organically, were very enriching and we would organize them again in such a way in the future, for more detailed investigations. In a further edition it would probably make sense to specify the program instead of letting the audience decide. Ultimately, bodystorming pushed us tremendously because it forced us to break things down, to use one Post-it as a blockchain, and to think about the intermediate steps.

We recognize that it might have made sense to focus more on the concept than on technological and material investigations. However, from our very first edition of the research question on, we were keen on making the digital realities more tangible, more physical. That‘s why we placed equal importance in this essential research.

Due to our rather late decision to build the Block, we are now a little pressed for time to get it done, but we are confident that we will manage until the exhibition.

6.3 Learnings

We have gone through different phases in the course of our work. From excessive euphoria about the success of our first own blockchain to days when we wondered whether Web 3.0 was not just a marketing campaign with no substance, to severe disappointment about the fact that constant involvement with a new technology also brings with it a degree of isolation and loneliness. We had to learn to admit to ourselves that we are no developers nor computersientists and that is a good thing. In the spirit of Don Norman, taking a look at what people are doing with the technology, or in our case, investigating why they are not doing anything with it. It helped our process more than just conducting further technological research. We also found that even with more complex issues, sometimes thinking through a basic use case is needed to better understand in which direction to take the next step.

From a methodological point of view, we have realised that the toolset and procedures that we have acquired over the last three years are an incredibly versatile set of techniques. We have learned that similar methods can be applied in different ways. For example, hacking can also take place on a purely conceptual level or user observation can also be carried out during a joint dinner.

Something specific that we will very much remember is that when one deals with a complex issue, one must be prepared to be treated with reservation or even aversion. Particularly in moments like these, one should always remember why one takes the trouble to invest time and energy in a topic for the benefit of others. In the end, one has to come to terms with the fact that certain people just don not want to or can not understand and that is fine as well.

6.4 Contribution

Being able to understand new technologies and use them in a targeted manner is a key qualification today and will become even more important in the future due to the ever-increasing megatrend of digitalisation. With our work we contribute to enable more people to make informed decisions about their digital future. Block provides users with the information they need to educate themselves and become independent actors in the world of Blockchain and Web 3.0. Our work is unique in its scope as well as in its visual and interactive approach.

In our work, we address a problem inherent in the new technologies of Web 3.0 and blockchain, which does not seem to receive much attention on the part of developers. By embodying this shortcoming and at the same time proposing a possible solution, our work contributes to starting a discussion about this shortcoming that is long overdue.

By reviving the Reactable ethos of table like touch interface in combination with tokens, we are bringing back to life a somewhat forgotten type of interactive user interface. By documenting our approach, the exact materials, as well as our code, we contribute to the interaction design community by creating a framework that makes it possible to quickly and easily recreate such interfaces. By using OpenCV, in contrast to reacTIVIsion, we deliberately leave significant room for further experimentation for computer vision in combination with interactive touch interfaces.

Finally, we also see our work as a contribution to the design community in general. With our written thesis we provide a playful and non computer science approach to a rather complex topic. We acknowledge that the technical nuances are limited and there is much more to be said, but the fundamentals are there to get someone started.

6.5 Is there a Web 3.0?

Given all the research we've done on Web 3.0, we'd like to include a personal assessment of its existence and future viability in this thesis. For us, one of the cornerstones of Web 3.0 is the ideology of moving away from expectations that a service or company will deliver on its promises to technology-enforced regulations that cannot be circumvented. However, what became apparent to us is that most of the services and implementations that currently exist and are usable are almost exclusively concerned with financial issues. People are not wrong when they say that it is all about money anyway. At the moment, the few offerings that fall outside this spectrum can hardly compete with this overwhelming majority. We see that financial offerings seem to be easily adapted to the new technologies of blockchain, smart contracts and so on. This is surely why they predominate. Alternative uses like social media are just emerging. So we are still in the early days of infancy of Web 3.0. What we have seen is that we have been able to use certain services and even create them ourselves. But what is sobering is that it is only transforming the backend. Yes, Web 3.0 sites usually have a very modern UI, but a money transfer remains a money transfer. It's like you suddenly make e-banking very modern with animations and gifs. It doesn't change what is fundamentally happening. Web 3.0 partially exists for us. Our realization is that a unique use case is missing that would show why it makes sense to transform Web 2.0 offerings or use its Web 3.0 version. Ironically, the majority of financial offers are also reflected in the definition of terminologies. If we think back to Web 1.0, we are talking about a Server, which serves a Web Page. If we look into Web 3.0, the Log-in is a Wallet, a Transaction can also be the exchange of a file and a Ledger also know as Blockchain stores all of these transcations, which do not have to be financial. Another sign that the topic is still in its infancy is the fact that we mainly found blog posts on this topic from 2022. The debate is only just beginning. We see it the same way; for us, the discussion about existence is just beginning. It's not far enough along to say whether Web 3.0 is or will become a reality, but what we're seeing right now is still very sobering. On the positive side, there is a huge shift towards the new web and designers have started to move away from the familiar big companies to dive into this new web. It will remain exciting for us to see what will come next. But let's learn the basics first.

6.6 Further Steps

It is predictable that further questions will arise during use that our first iteration of the tokens and the interface do not take into account. It would therefore be reasonable to find a format in an additional step, which would help people contribute to the extension of Block. Another function that is being considered is that one could place a block in the middle of the surface and its content would be displayed on all four sides at the same time. This way one could use the interactive elements of the table in a new form of presentation. However, one of the most important next steps would be an evaluation of our concept and its impact on user understanding. Of course, we have roughly tested our simplified prototype with some users, but a systematic evaluation is still missing.

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9 Figures

fig. 26 Material-Archiv in Gewerbemuseum Winterthur, 2022, Gewerbemuseum Winterthur, https://www.gewerbemuseum.ch/_Resources/Persistent/7/0/8/b/708b8dae6538cbb12291ab109d4b5e82c5991064/Materialarchiv_Musterslg_FotoMichaelLio%20-%20Kopie-2658x1772-860x573.jpg

fig. 27 Nike Digital Retail, 2022, Demodern, https://home-prod-craft-cms-assets-volume-ioeiz1.s3.amazonaws.com/amazon/Cases/Nike-Seamless/_autoHeightThumb750/ftw-5.jpg

fig. 28 bodystroming screen sizes, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 29 IR-Diode touch detection, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 30 projection film test, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 31 1510 Galicot 100% cotton fabric test, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 32 scan test 1510 Galicot 100% cotton fabric, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 33 OpenCV blob detection, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 34 different size & material tests for Aruco Markers 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 35 tokens for connection prototype, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 36 reflecting on connections of tokens, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 37 first connections of tokens, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber

fig. 38 final interface mockup, 2022, Baran Yüksel Güneysel & Gian-Carlo Huber