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UNFOLDING THE METAVERSE STORY

the metaverse concept timeline
based on Wikipedia edits

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ABSTRACT

In 2021, several high-impact businesses made the term metaverse a stimulant in the business market and a focal point of social debate, and it came into the spotlight like a new thing out of nowhere. The metaverse is not a new term "invented" by large technology companies such as Facebook. It appeared as early as Neal Stephenson's 1992 novel "Snow Crash." Similar conceptual descriptions of virtual reality worlds also exist in other fiction novels, comics, and movies. With Google trends showing that metaverse searches are at an all-time high in 2021 and over 2 million Wikipedia page views in 2021, there is an urgent need to understand the past and present life of the metaverse. Therefore, it is necessary to present the conceptual definition and evolution of the metaverse in an appropriate, attractive, and usable way.

This project is an interactive digital website that republishes the history of revisions to the metaverse in Wikipedia, extracting each revision into terms and presenting a timeline of how the metaverse concept has changed. It is divided into two main parts, metaverse timeline and metaverse chronology, which have different meanings. The metaverse timeline represents the process of public awareness of the metaverse, while the chronology is when these terms and keywords first appeared in society or academia. Through communication and visual design, the key events driving the metaverse in the revised records from February 8, 2005, to March 8, 2022, are presented in an interactive timeline that allows for an accurate and intuitive reading. Although the content of the project was taken from Wikipedia and created no new concepts, it would still make sense to visualize the revision process.

By presenting the revised records as a timeline, users can see that as the metaverse has been researched and understood by the community, it has been introduced and enriched with new concepts and more information, gradually expanding from an entry placeholder to a full description. They can understand that the metaverse had a wholly developed process rather than appearing out of nowhere.

keywords: Metaverse; timeline; data visualization; visual model; interaction design; communication design.

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RESEARCH BACKGROUND AND OBJECTIVES

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On March 10, 2021, gaming company Roblox went public on the New York Stock Exchange, dubbed the "first share of the metaverse," and ended its first trading day with a staggering $38 billion market value, sparking a frenzy in the capital markets and launching the metaverse as a successful business concept. In October 2021, Facebook CEO Mark Zuckerberg officially announced that the company would renamed Meta. In addition, the Oculus brand will also merge into the Meta brand. Zuckerberg explained the reason for changing the company's name. "Right now, our brand is tied to a product that cannot possibly reflect everything we do today, let alone the future," Zuckerberg said in the founder's letter. " Over time, I want us to be seen as a metaverse company, and I want the company name to reflect that." It means that in the short term, Meta will continue to develop VR and AR products, and the long-term goal is to create an immersive metaverse for users. Zuckerberg hopes that the metaverse built by Meta will attract 1 billion users within the next decade. This announcement once again sparked a heated discussion about the metaverse. The emergence of the metaverse has brought a new direction of change to existing industries and stimulated the development of emerging industries. Large Internet companies and IT manufacturers have devoted themselves to the investment and transformation of the metaverse. In November of the same year, Nvidia launched Omniverse Avatar to help metaverse creators build virtual characters. Nike and Roblox built a virtual world to build a virtual world NIKE LAND. Disney will use the metaverse as the future development direction to create a supporting IP image. Niantic completed $300 million in financing, and proposed "creating a

real-world metaverse." Moreover, even the political circles have expressed interest in the metaverse. Seoul, South Korea said it would become the first city government to join the metaverse, so 2021 is also called the "metaverse first year." In January 2022, Microsoft acquired Activision Blizzard for $68.7 billion, known as the third-largest gaming company in the world by revenue. "Games are the most dynamic and exciting category of entertainment on all platforms today and will play a key role in the development of the metaverse platform," said Satya Nadella, chairman and CEO of Microsoft. The event's focus gave the public an intense shock and triggered people's cognitive blind spots. People have asked questions, what is the metaverse? Where did the metaverse come from?

1.1 RESEARCH QUESTIONS

Although the metaverse may seem like a sudden new term to many people, it has a long development history. In medieval literature, paintings and plays, people have imagined and described parallel spiritual worlds and closed-loop universes, such as Dante's Divine Comedy, which provides a "soul dwelling" for people going through storms. The word metaverse first appeared in Neal Stephenson's novel "Snow Crash," in which he described the metaverse as "a computer-simulated virtual space parallel to the real world that you can enter as a virtual doppelganger by putting on a headset and goggles and finding a connection terminal. " In other fiction novels and movies, there have been many imaginings of virtual reality worlds. For example, the films "The Thirteenth Floor" directed by Josef Rusnak and "The Matrix" by The Wachowski Brothers describe worlds where the real and the virtual are combined. However, the metaverse has not been clearly defined and understood for a long time. It was not until a series of influential business ventures, such as the launch of Roblox, that the metaverse was introduced to the public and people began to want to understand it.

So the evolution of the metaverse over the last 30 years, from its emergence to the worldwide frenzy in 2021, has made people curious. Although the description of the metaverse in search engines is relatively complete now, they do not provide a visual representation of the development. The summaries in the web articles are also incomplete and only have textual descriptions, which are not vivid and informative enough. Therefore, it is necessary to show the conceptual definition and evolution

of the metaverse.

The main research questions of this thesis are:
(1) How to help people understand more clearly what the metaverse is?
(2) How to show the evolution of the metaverse, including concept definition, the development, and change of related technologies, in which areas are it tried and applied?
(3) How do people pay attention to and view the metaverse, and what are their views on it, encouraged, fanatical pursuit, or considered illusory and unrealistic? How has it changed?

1.2 OBJECTIVES

As a current social hotspot and a new industrial investment direction, metaverse has attracted attention from all walks of life. Based on the current status of metaverse evolution, this thesis collects relevant information and data, visualizes the evolution process of the metaverse through communication design and graphic design, and transmits information to audiences accurately and clearly through digital media. Although it is based on redesigning and re-display existing data, it generates no new concepts. This project creates information transmission channels by reorganizing the evolution of the metaverse, summarizing and organizing different types of information such as concept definitions, application fields, and technology development. It enhances the accuracy of information conveyance, exciting reading, and attractiveness by adding graphic design and interaction design. It provides information to the audience interested in the metaverse but do not fully understand it. The

1.3 METHODOLOGY

metaverse is an evolutionary timeline that can efficiently present to people interested in the metaverse but do not fully understand it. It also promotes understanding of the metaverse by collecting information data on a term based on a particular data platform and visualizing the development process, establishing a related methodology.

Literature research method:
A method of obtaining information by surveying the literature to gain a comprehensive and correct understanding of the problem to be studied. By researching the literature on the metaverse, we can understand the origin of the concept and its development and help determine the direction and content of the research. Literature research can form a general understanding of the metaverse, which can help in subsequent in-depth research. It helps to get comparative information of practical information for comparative analysis.

Case study:
Case study is another research method in which different cases are considered, and the ones suitable for the study are selected. Case studies help shape research ideas. The characteristics, performance methods, and performance logic can be obtained through the investigation and analysis of similar cases, which has important reference significance for project research.

Mixed methods-based research:

Mixed methods-based research attempts to bring both qualitative and quantitative research. It uses qualitative research to explore a situation and develop a potential model of understanding, also called a conceptual framework, and then uses quantitative methods to test that model empirically. Qualitative research utilizes data that cannot be quantified numerically. In other words, qualitative research focuses on words, descriptions, concepts, beliefs, ideas, and other such intangibles—for example, the conceptual description of the metaverse and the linguistic description of the evolutionary process. Quantitative refers to the numbers where data is collected based on numbers, and a summary takes from these numbers. Graphs help to quantify the results in quantitative research. In the data collection of the metaverse, the time of the event, the amount of text, and pageviews on a platform are suitable to show through quantitative research.

Mixed methods-based research can help researchers gain a complete picture than a standalone quantitative or qualitative study, as it integrates the benefits of both methods. Mixed methods-based research has generalizability and can make up for the shortcomings of qualitative research with small sample size. Using qualitative research Data to illustrate quantitative findings can also increase the sense of context, adding rich details to the conclusion and improving credibility.

Therefore, On the qualitative side, we organize the development trends and hot social events of the metaverse by looking for textual descriptions of

metaverse concept definitions, related technologies, and social dynamics. On the quantitative side, we analyze the attention of the metaverse by collecting page views and searches of the metaverse and combining the two to get the evolution process of the metaverse.

METAVERSE

2

2.1 CONCEPT SOURCE AND DEFINITION

The term "metaverse" has its origins in Neal Stephenson's 1992 science fiction novel Snow Crash, where humans, as programmable avatars, interact with each other and software agents (Wikipedia:Metaverse). Literally, "metaverse" consists of "meta" and "universe."According to the Cambridge dictionary, "meta" means "outside the normal limits of something," and "universe" means "a universe that could be imagined to exist outside our own." It means the metaverse is a virtual universe transcending the natural universe.

Wikipedia defines the metaverse is a network of 3D virtual worlds focused on social connection. Stylianos Mystakidis (2021) describes" the metaverse is the post-reality universe, a perpetual and persistent multiuser environment merging physical reality with digital virtuality. It is based on the convergence of technologies that enable multisensory interactions with virtual environments, digital objects, and people, such as virtual reality (VR) and augmented reality (AR). Hence, the metaverse is an interconnected web of social, networked immersive environments in persistent multiuser platforms". Alanah Davis, John D.Murphy, Dawn Owens, Deepak Khazanchi and Ilze Zigurs (2009) say "metaverses are immersive three-dimensional virtual worlds (VWs) in which people interact as avatars with each other and with software agents, using the metaphor of the real world but without its physical limitations" in "Avatars, People, and Virtual Worlds: Foundations for Research in Metaverses". Roblox CEO Dave Baszucki said "we think of it as a human co-experience category that supports people coming together to socialize, to learn, to play, someday to work

to experience entertainment and amazing brands." The Associated Press reports "it's a world of endless, interconnected virtual communities where people can meet, work, and play, using virtual reality headsets, augmented reality glasses, smartphone apps or other devices". Meta (2022) describes the metaverse as "the next evolution of social connection". 3D spaces where people can "socialize, learn, collaborate and play in ways that go beyond what we can imagine". Daren Tsui, CEO of Together Labs thinks "metaverse is a 3D virtual space generated by a computer in which users can interact. The metaverse should have three elements: it needs to have a sense of social presence, it needs to be persistent (when users come back, they can continue their previous journey instead of restarting), and most importantly, it is sharing (a multi-person interactive world)." Carolina Arguelles Navas, Snap Inc Group Product Marketing Manager, says "in Snapchat, we envisioned a virtual world that seamlessly overlaps with the physical world around us. The metaverse is an area (AR glasses) in front of your eyes, where you can take pictures, browse information and interact with the real scene in front of you or digitally superimposed scenes,". Don Stein, the founder of Room key says, "the metaverse is a parallel universe composed of virtual worlds, space, and people." Nie Huihua and Li Jing (2021) believe that the metaverse is a virtual world parallel to the real world and interacts with the real world. It is the third generation of the Internet after PC (computer) and mobile Internet. Yuan Yuan and Yang Yongzhong (2022) believe that the metaverse is a virtual world and survival vision that starts from a game platform based on digital currency and is supported by the simultaneous emergence of integrated digital technologies and

hardware technologies. Human life is deeply involved in it. Fang Lingzhi and Shen Huangnan (2021) suggest that the metaverse is the inevitable trend of social informatization and virtualization, the ultimate stage of Internet development. The metaverse's driving force is the Internet's shift from information to people, which drives the continuous development of media technology, thus bringing sweeping changes to the current human society and shaping a new social form in the future. From the perspective of communication science, Yu Guoming and Geng Xiaomeng (2021) propose that the metaverse is the ultimate digital medium that integrates and fuses all digital technologies of the present and the future, which will realize the revolution of connecting the natural world and the virtual world, and then become a new world beyond the real world and in a higher dimension. According to Shen Yang, the metaverse is a new type of Internet application and social form that integrates reality and reality by integrating multiple new technologies. It provides an immersive experience based on extended reality technology and a mirror image of the real world generated by digital twin technology, which closely integrates the virtual world with the natural world in terms of an economic system, social system, and identity system, allowing each user to produce and edit content.

In general, the metaverse refers to the Internet form based on the Internet, virtual simulation technology, digital twin technology, blockchain technology, and other technologies, which can be immersively experienced in the Internet form. It can also be said to be the future social lifestyle.

2.2 CHARACTE -RISTICS OF THE METAVERSE

Roblox CEO David Baszucki proposed eight basic characteristics of the "metaverse": Identity, Friends, Variety, Anywhere, Economy and Civility. According to Baszucki's standard, "metaverse" = creation + entertainment + display + social + transaction, people can have a deep experience in the metaverse.

Matthew Ball (2020) mentions in "The Metaverse: What It Is, Where to Find It, and Who Will Build It":

1. The metaverse is persistent, it never "resets", "pauses" or "ends", it just continue indefinitely;
2. Be synchronous and live- even though pre-scheduled and self-contained events will happen, just as they do in "real life," the metaverse will be a living experience that exists consistently for everyone and in real-time;
3. Without any cap on concurrent users, the metaverse has no restrictions on users and also provides each user with a unique "sense of presence" so that everyone can become a part of the metaverse and be with other individuals while at the same time participating in specific activities and be present in specific locations;
4. Be a fully functioning economy, in the metaverse, individuals and businesses will be free to create, buy, invest, sell, and be paid for a wide range of work that has social value and personal value, recognized by other users;
5. Be an experience that spans both the digital and physical worlds,

private and public networks experiences, and open and closed platforms;

6. Have unprecedented interoperability of data, digital items, assets, content. For example, users can use skins from a game to decorate another game or give them to friends through social software such as Facebook, which means that digital assets in different software can circulate with each other, instead of the current situation where each software is a separate store, where currencies and identities are not interoperable, and units of measurement and norms are not uniform;
7. Be populated by "content" and "experiences" created and operated by an extensive range of contributors. Contributors are diverse sexual, including independent human users, informally organized groups, and professional business establishments.

Mark van Rijmenam (2020) proposes six characteristics of creators that should be considered when building the metaverse:

1. Interoperability. When users acquire digital assets in one environment, interoperability allows users to transfer assets from this environment to another platform and can use or sell it, which means that if a user want to create greater social value, people cannot stay in one platform all the time, but connect multiple platforms to make the network bigger and increase the external value of the network to users ;
2. Decentralization, which means the exchange of value and

ownership of data assets with explicit norms and complete transparency, rather than a centralized platform used by large corporations or governments to control individual behavior;

3. Persistence. The metaverse is an always-on Internet. Even if users leave, it also always exists unless deleted. Persistence will provide provide artists and creators with unlimited opportunities to earn income; spatiality, which can perpetuate experiences in virtual reality and allow users to interact using senses similar to the real world, providing real-time communication and collaboration.
4. Community-driven. Since humans are social animals, metaverses are also a social experience. Just like the real world, the metaverse is an ample multiplayer social space that allows people to come together and form a community around any topic. Currently, gaming platforms that are considered similar to the metaverse have multiplayer features and provide the function of community interaction;
5. Autonomy. Users can control their own data assets, identity, reputation, and information on the network, rather than being controlled by development companies and governments.

Pu Qingping (2022) also put forward four characteristics in the "metaverse and its influence and change on human society," which tend to be technical.

1. The superposition of technologies. Metaverse is different from a network platform that relies on a single technology. It requires the

joint application of multiple software and hardware technologies, such as extended reality technology to create virtual reality scenes and immersive experiences, artificial intelligence, and digital twins to achieve the mirror construction and identity construction from the real world to the virtual world, the blockchain guarantees the value and rights of digital transactions;

2. Fusion of reality and reality. The metaverse replicates the real-world landscape into the virtual world through digital twin technology and also allows users to build a second identity in the virtual world, through which they can map their actual activities into the virtual world, shaping a "virtual civilization" and creating a new form of human civilization. Integration of reality and reality means that real people in the real world, avatars in the virtual world, and robots generated through simulation technology have the same identity and interoperability in terms of cognition and emotion and experience;
3. Immersion. Different from the current state where the Internet uses PC terminals and mobile terminals, which results in the binary separation of people and the online world, when users enter the metaverse through wearable devices or other means, they can experience a completely immersive experience with a strong sense of reality, reaching the level of digital The state of complete integration of the world;
4. Real-time interactivity. While breaking the barrier of reality, achieving a seamless connection from the real world to the virtual

world, and providing an immersive interactive experience, the metaverse is also compressing the waiting time cycle, ensuring a response after sending a signal with no delay in between, enabling real-time action and communication with the real world.

To sum up, the metaverse is a scene where multiple people jointly conduct social activities online. It has social attributes, including interpersonal relationships, identity authentication, social value, economic transactions, and entertainment, and forms a unique human culture. It will form unified social norms and standards to increase operability. The metaverse will form a persistent virtual world, and people will have an immersive experience in the metaverse, even if not entirely separate from the real world. People will have autonomy and more metaverse individual rights.

2.3 TECHNOLO -GICAL DEVELOPMENT

Technology is the basis for building the metaverse. The development of the Internet has contributed to the transformation of social informatization, which has led to a strong demand for deep interaction and the creation of new media that break through the barriers between the virtual and the real. Tsinghua University Metaverse Development Report 2.0 2022 mentioned that the metaverse ecosystem needs to be built by strengthening vision, extending hearing, enhancing digital taste, consciousness mapping, and somatic interaction, as well as enhancing Spatio-temporal extension, human-computer integration, and economic value-added, corresponding to three directions: computing, technology, and interaction, among which computing includes: spatial computing, cloud computing, pervasive

computing, edge computing, semantic computing, complex computing; technology includes AI, big data technology, blockchain, network communication, Digital twin, game engine; interaction includes extended reality technology, naked-eye 3D, PC interface, Internet of Things, robot, brain-computer interface.

There are many achievements in the academic community in analyzing these related technologies. For example, Eno et al. provided support technologies for exploring the metaverse, a system for mobile phone content from a 3D multi-user virtual world. Sweeney (2019) focused on exploring the essential technologies required by the metaverse. Cheslack Postava et al. (2019) designed a metaverse-oriented Sirikata server. Egliston and Carter (2021) argue that Facebook's Oculus VR technology will be the core of the metaverse. Bowman et al. (2007) believe that extended reality technology is an essential manifestation of social virtualization, in which Immersion, Interaction and Imagination are the main features of Extended Reality. Extended reality is a vital support technology for the entrance and exit between the metaverse and the real world, including virtual reality technology, mixed reality, and augmented reality. Augmented reality (AR) is an interactive experience of a real-world environment in which objects present in the real world are augmented by computer-generated perceptual information, sometimes across multiple sensory modalities, including sight, hearing, touch, somatosensory, and smell (Wikipedia: Augmented_reality, 2022), which integrates people's perception of the real world into the digital world to achieve an immersive experience in the real environment. Virtual reality (VR) is a simulated experience that can

be similar or completely different from the real world (Wikipedia: Virtual_reality, 2022). Mixed reality (MR) is the fusion of the real and virtual worlds to produce new environments and visualizations, where physical and digital objects coexist and interact in real-time, a hybrid of augmented and virtual reality (Wikipedia: Mixed_reality, 2022). In addition, the high intelligence of human software technology can meet the increasing demand for interaction. The development of blockchain technology can ensure the security of digital assets and digital asset transactions, and the development of graphic image technology helps to replicate the real world better. Digital twin technology can completely mirror the real world into the virtual world and create a realistic virtual space including people, objects, environment and other elements of dynamic twin. In summary, technology is the underlying material support for realizing the metaverse. Only with the development of the related technology can we meet the full range of needs of the six senses and build a complete metaverse ecosystem.

2.4 IMPLEMENT FIELD

The metaverse and its related concepts first appeared in science fiction novels and movies. In 1992, Neal Stephenson's science fiction novel Snow Crash proposed the concepts of "Metaverse" and "Avatar." It linked the two together for the first time, laying the foundation for the space-time ductility and human-machine fusion of the metaverse. In 1992, Hollywood introduced virtual reality to the public in the anti-utopian science fiction film The Lawnmower Man. In 1999, the Josef Rusnak-directed film Alter Ego and the Wachowski Brothers' The Matrix featured the concept of

interweaving the real world with the virtual world. 2014, Wally Pfister's "Transcendental Hackers" uploaded human consciousness data to the computer and resurrected it in the virtual world. The dystopian science fiction novel Ready Player One created by Ernest Cline depicts a shared VR space called "The OASIS" where people enter with virtual reality headsets and wired gloves in a world of energy crisis and global warming to obtain spiritual comfort and escape. The film was adapted into the movie of the same name, "Ready Player One," which brings out the possibilities of human-computer interaction in the metaverse.

The metaverse is also well represented in gaming, which is considered the closest thing to a metaverse. In 2003, inspired by Neal Stephenson's novel Snow Crash, Linden Lab created the first phenomenal virtual world, Second Life, similar to a massively multiplayer online role-playing game, considered the first metaverse. By creating their virtual character, players can socialize, shop, build and do business on the platform and have virtual currency Linden Dollar, which can be exchanged with real currency. Users can create and own content within the platform, meaning they can gift and sell their creations in Second Life, which has 2.1 million items listed on its online marketplace. In 2004, World of Warcraft, a massively multiplayer online Role-playing game (MMORPGs), provided millions of players with a three-dimensional, screen-based virtual world. It allows users to create characters and control avatars from another person's perspective or first view to complete game quests and interact with other players. In 2016, Rec Room first released a virtual reality, an online video game with an

integrated game creation system. Players move through the game using motion capture from a virtual reality headset and two handheld motion controllers. The game also allows players to create and publish content, earning an internal currency that can be exchanged for U.S. dollars under certain conditions. In Cyberpunk 2077, an action role-playing video game released in 2020, the player's identity is a mercenary, and the face, body shape, voice, hairstyle, background and clothing can be customized.

At present, the metaverse is constantly deepening and developing, expanding to entertainment, business, education, and daily social life. Many scholars have also put forward views on applying metaverse in education, such as using it as an innovative educational tool to add new concepts and improve classroom teaching efficiency. It can also use for teaching evaluation. The metaverse is available for immersive field trips to any place and any point in history. Currently, Nvidia is working on a metaverse infrastructure project called Omniverse that will allow developers worldwide to collaborate in real-time to build metaverse content creation software. Students can explore the ancient cultural heritage and classical architecture through this project. Together Labs Inc is also working on technologies to create lifelike avatars using artificial intelligence to resurrect historical figures.

Many companies and investors have also jumped into the virtual real estate craze. There are currently more than a dozen platforms selling real estate in the virtual world, the main four being Sandbox, Decentraland,

Cryptovoxels and Somnium. Tokens.com CEO Andrew Kiguel raised a $16 million fund to invest in real estate in the metaverse, almost all of which used to buy land and hire employees. In addition, the company spent $2.4 million to buy land in the Decentraland Fashion District for fashion events and retail stores. Like the real world, the high value of virtual real estate still depends on the location for advertising, leasing and events.

In the field of entertainment, in April 2021, American rapper Travis Scott held a virtual concert "Astronomical" in the game called Fortnite. From April 24 to 26th, Travis concert five songs in total. Like audiences in the real world, players "put on" fantastic game costumes half an hour in advance to prepare for "entrance" according to the concert time. After entering the game map, players do not need to shoot and fight as usual but to find the small stage set in the center of the map and choose the best viewing angle to watch the performance. After the concert, the game official also prepared virtual peripheral gifts for players, like the natural concert organizer and the concert-themed game skin as souvenirs. According to the game's official data, more than 12 million players participated in the event, not counting the 3 million viewers who watched through the live broadcast platform. It isn't the first time Fortnite has hosted a show in the gaming world. In February last year, the game invited well-known electronic music DJ Marshmello to hold a concert, which attracted about 10 million viewers. On November 17, 2017, South Korea's SM Entertainment launched aespa, the first idol group in Korea to combine a real idol with a virtual idol, with each of the four-team members having an AI member modeled after their real-life counterparts to form an eight-

member group. The debut of aespa will mark the beginning of a "future world centered on celebrities and avatars," said SM Entertainment CEO Lee Soo-man. " aespa's name comes from the combination of "ae" (æ) and "aspect" (two sides) of "Avatar X Experience," which shows the group's unique worldview. Aespa's name comes from the combination of "ae" and "aspect" in "Avatar X Experience," which represents the group's unique worldview of "meeting the alter ego and embodying a new world. He also said at the 20th anniversary of Stanford University's Korea Program in May 2022 that SM Entertainment plans to create the SM Culture Universe "SMCU," a character-driven universe similar to the comic book universe. By combining blockchain and meta-boundary technologies, SM's culture will be expanded to include content for everyone and transcend time and space, making this future era of entertainment connected through culture a reality. In SM Entertainment's metaverse, people can use the music STEM (each Layer Source that makes up music), video materials, and IP provided by SM Entertainment. It can improve various creative skills to produce songs, dances, compositions, and choreography, have a free creative environment, and grow into world-class producers.

In addition, the Google I/O conference announced 3D video calling technology called Starline in May 2021. In November 2021, Microsoft announced it would launch Mesh for Microsoft Teams; Seoul, South Korea said it would be the first city government to join the metaverse. Nvidia launched Omniverse Avatar to help metaverse creators. The virtual world NIKE LAND will be built by Nike and Roblox. And Disney will take the

2.5 ATTENTION AND DISCUSSION

metaverse as the future direction and create a supporting IP image. From this, we can see that the concept of metaverse was first developed in the field of movies and games, and in the past two years, it has rapidly spread to other fields and has been precisely connected with the development of many fields.

Since 2021, many technology companies at home and abroad have announced the layout of metaverse-related fields. For example, in March 2021, the sandbox game platform Robles wrote the metaverse concept into the prospectus for the first time, and the market value on the first day after listing exceeded 40 billion US dollars. Baidu released the first domestic metaverse product "Xiyang" in December 2021. July 2021 In March, Facebook CEO Mark Zuckerberg announced the establishment of the "metaverse" product team and then updated the parent company's name to "Meta." Metaverse has become the focus of the capital market and academia and has also become a hot social topic. Especially since Zuckerberg published a press release about the future vision of the metaverse on October 28, 2021, and announced the name change, we can see from Google Trends that searches for the metaverse around this time point reached their peak on Google and Youtube.

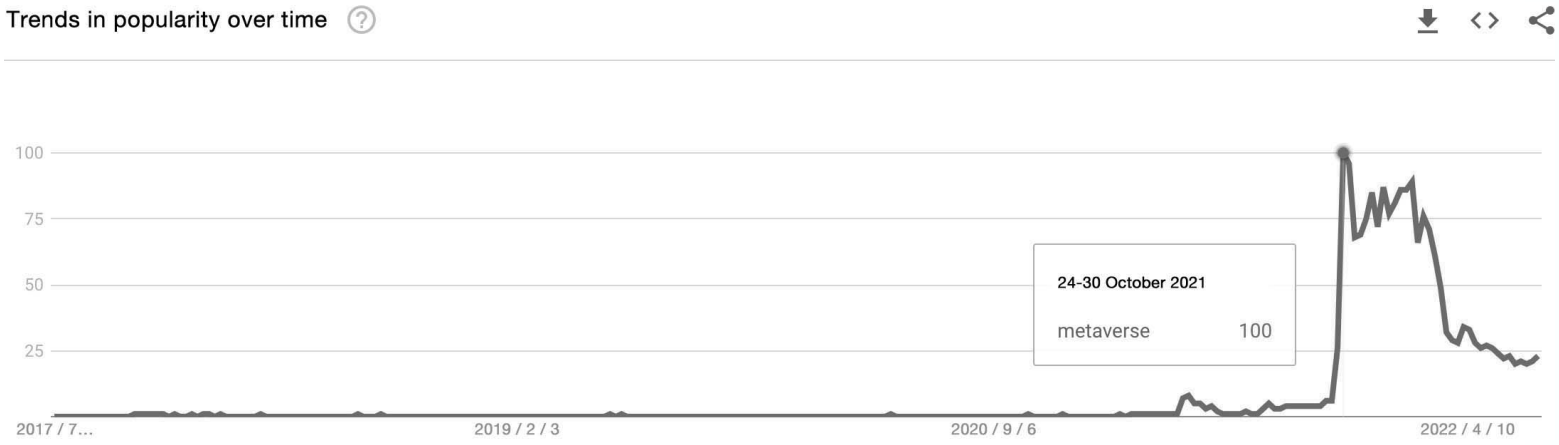

Figure 1. Popularity of metaverse in Google web search in the past 5 years

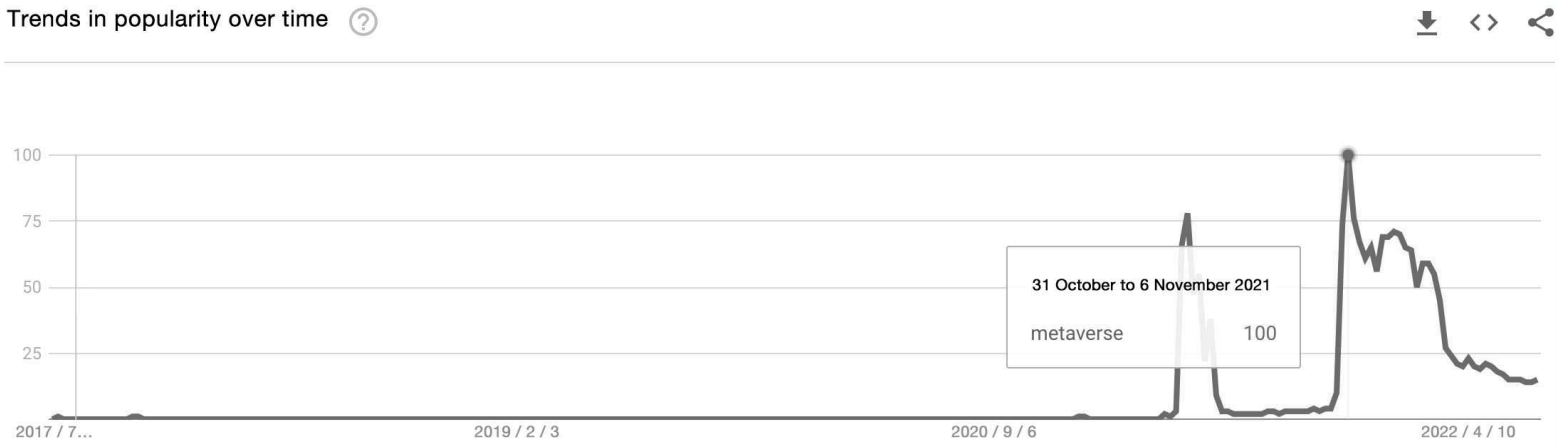

Figure 2. Popularity of metaverse in Youtube search in the past 5 years

However, concerns have been expressed in addition to expectations and curiosity about the metaverse. Some have questioned the metaverse implementation, arguing that it lacks the hardware and software infrastructure to support it and clear, unified governance standards to achieve scale. Current state-of-the-art computing efficiency is far from adequate. It falls far short, requiring at least a 1,000-fold improvement if it is to be a truly persistent and immersive experience and allow billions of people to be online simultaneously. Information privacy is an important concern, and since access to the metaverse requires interaction through wearable devices and augmented reality devices, there is a risk that these technology companies will collect biometric data and users' personal information through their devices. Leenes (2008) argues that the metaverse raises privacy and privacy protection regulation issues. Falchuk (2018) similarly argues that the metaverse raises privacy issues in that virtually, a multitude of data from the world's consumers, businesses, and government agencies will be captured and tracked. In particular, consumers' location, age, shopping preferences, and social connections will become highly sensitive information for business preferences in the real world. Meta Platforms' plans to use targeted advertising in its metaverse have raised concerns related to the loss of personal privacy. User safety is another concern. The emergence of user addiction and video game addiction that typically accompanies social media use can have long-term psychological and physical effects on users, causing depression, anxiety, and a variety of hazards associated with this sedentary lifestyle, such as an increased risk of obesity and cardiovascular disease. Experts are also concerned

that people may use the metaverse to "escape" from reality and become addicted to it, making a distinction between reality and the virtual. Virtual crimes such as sexual abuse, sexual harassment and other user safety issues are significant challenges facing social virtual reality platforms today. They may be equally prevalent in the virtual world. A researcher once reported in the nonprofit advocacy group SumOfUs that she was sexually assaulted in her avatar within an hour of putting on a virtual reality headset and entering Meta's social networking platform Horizon World. Despite having a 4-foot personal security perimeter in Horizon Worlds to avoid unwanted interactions, the security feature turned on.

Even though it happened in virtual reality, the incident left the researcher "disoriented," she said in the report. The researcher noted her controller vibrated when the male avatars touched her, resulting in a physical sensation resulting from what she was experiencing online. In addition, SumOfUs researchers report that they have also encountered homophobic and racial slurs and witnessed gun violence in the virtual world. Although the user is not physically touched, virtual reality immerses the user and triggers the person's nervous system and psychological response, still causing harm to the person. In February 2022, investigations by BBC News and The Washington Post found minors engaging in adult activities in applications such as VRChat and Horizon Worlds despite an age requirement of 13 years or older. So how to ensure that users feel comfortable without being harassed and attacked is also building A much-needed solution for the metaverse. In addition, there are also concerns

about alienating users from the real world, creating negative emotions, and creating prejudice and discrimination.


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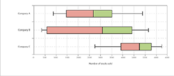
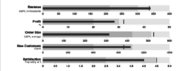
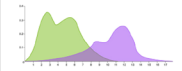
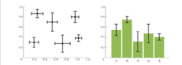
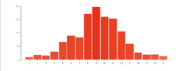
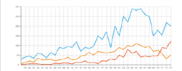
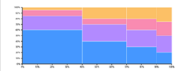
VISUAL MODELS FOR TELLING ABOUT METAVERSE

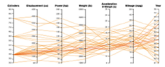
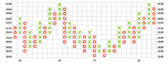
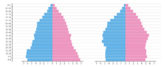
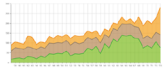
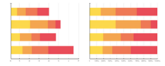
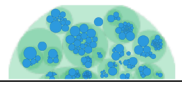
3

3.1 VISUAL MODELS

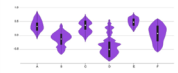
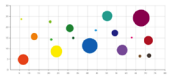
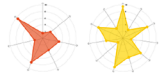
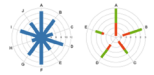
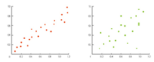
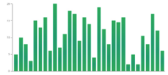
The earliest documented forms of data visualization are various thematic maps from different cultures, ideograms, and pictographs, which provide and allow the interpretation of illustrated information. Since prehistory, stellar data or information such as the location of stars has been visualized on the walls of caves (such as those found in Lascaux Cave in Southern France) since the Pleistocene era. Physical artifacts such as Mesopotamian clay tokens (5500 BC), Inca quipus (2600 BC), and the Marshall Islands stick charts (n.d.) can also be considered as visualizing quantitative information. The first documented data visualization can be traced back to 1160 B.C. with the Turin Papyrus Map, which accurately illustrates the distribution of geological resources and provides information about the quarrying of those resources. Such maps can provide categories as thematic cartography, a type of data visualization that presents and communicates specific data and information through a geographical illustration designed to show a particular theme connected with a specific geographic area. With the development of technology and the popularity of social media, infographics have become popular, usually as static images or simple web interfaces, covering any number of topics for people to browse. There are also various tools for making charts, which are convenient and fast, and people can choose different visual models and tools according to their own needs ("Data and information visualization", 2022).

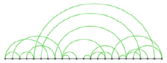
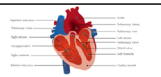
According to infographic websites such as dataviz project, dataviz catalogue, we can organize the common data chart types as follows:

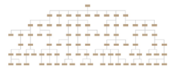
Type of Chart		Chart	Functions
Graphs	Box and Whisker Plot		Distribution Range Patterns Comparisons
	Bullet Graph		Comparisons Ranges
	Candlestick Chart		Data over time Patterns Ranges
	Density Plot		Distribution Patterns
	Error Bars		Ranges
	Histogram		Comparisons Data over Time Distribution Patterns Range
	Kagi Chart		Patterns Ranges
	Line Graph		Patterns Data over time Comparisons
	Marimekko Chart		Comparisons Part-to-a-whole Proportions Relationships
	Multi-set Bar Chart		Comparisons Distribution Patterns Relationships

Open-high-low-close Chart		Data over time Patterns Ranges
Parallel Coordinates Plot		Comparisons Relationships Patterns
Point & Figure Chart		Patterns
Population Pyramid		Comparisons Distribution Patterns
Span Chart		Comparisons Ranges
Spiral Plot		Data over time Patterns
Stacked Area Graph		Comparisons Data over time Patterns
Stacked Bar Graph		Comparisons Proportions
Stream Graph		Data over time Patterns
Treemap		Comparisons Hierarchy Part-to-a-whole Proportions
Circle Packing		Hierarchy Proportions

Donut Chart		Comparisons Part-to-a-whole Proportions
Dot Matrix Chart		Comparisons Distribution Patterns Proportions
Nightingale Rose Chart		Comparisons Data over time Proportions
Pictogram Chart		Comparisons Distribution
Parallel Sets		Comparisons Distribution Flow Processes & Methods Proportions
Pie Charts		Comparisons Part-to-a-whole Proportions
Proportional Area Chart		Comparisons Proportions
Sunburst Diagram		Hierarchy Part-to-a-whole
Word Cloud		Analysing Text Distribution / Frequency Proportions

Plots	Violin Plot		Distribution Patterns Ranges
	Bubble Chart		Comparisons Data over time Distribution Patterns Proportions Relationships
	Radar Chart		Comparisons Relationships Patterns
	Radial Bar Chart		Comparisons
	Radial Column Chart		Comparisons
	Scatterplot		Patterns Relationships
	Area Graph		Patterns Data over time
	Bar Chart		Patterns Comparisons

Diagrams	Arc Diagram		Patterns Relationships
	Brainstorm		Concepts Relationships
	Chord Diagram		Comparisons Relationships
	Parallel Sets		Comparisons Distribution Flow Processes & Methods Proportions
	Flow Chart		Concepts How things work Processes & methods
	Illustration Diagram		Concepts How things work Processes & Methods
	Network Diagram		Relationships
	Non-ribbon Chord Diagram		Relationships
	Sankey Diagram		How things work Flow Process Proportions
	Timeline		Data over time Distribution Patterns

Tree Diagram		Hierarchy Reference Tool Relationships
Venn Diagram		Comparisons Concepts Relationships

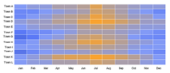
Tables	Calendar		Data over time Reference Tool
	Gantt Chart		Data over time Processes & methods Ranges Reference tool
	Heatmap (Matrix)		Comparisons Data over time Relationships Patterns
	Stem and Leaf Plot		Distribution Reference Tool
	Tally Chart		Comparisons Distribution
	Timetable		Data over time Reference Tool
Maps/Geographical	Bubble Map		Location Proportions
	Choropleth Map		Comparisons Location Patterns
	Connection Map		Distribution Location Movement Patterns Relationships
	Dot Map		Distribution Location Patterns
Flow Map			Distribution Location Movement & Flow

Figure 3. Visual models

3.2 CHOOSING A VISUAL MODELING STRATEGY TO REPRESENT TIME

We can see that these common data charts are classified according to chart types, which are divided into graphs, plots, tables, diagrams and maps. Each chart has different functions, the function categories here are roughly divided into comparisons, Proportions, Relationships, Hierarchy, Concepts, Loaction, Part-to-a-whole, Distribution, How things work, Processes&methods, Movement or flow, Patterns, Range, Data over time, Analysing text and Refernce tool.

This project is planned to show the reader how the metaverse has evolved, from the creation of the term to the present, and how the related concepts and content have been gradually enriched and refined. Based on these requirements, we needed to select the required diagrammatic model, using as the main body a model showing the evolution of the concept over time, combined with other visual visualization methods.

In the visual model table, it can be found by searching that the models with data over time function include area graph, bubble chart, candlestick chart, gantt chart, heatmap, nightingale, rose chart, line graph, timeline... Among them, timeline prefers to show the sequence of events over time, while other models show the trend of data changes over time. Since data about the metaverse are more textual, such as descriptions of the concepts of the metaverse, descriptions of related applications, and the chronological order of related social events, the timeline is suitable for the presentation of the evolutionary process.

Timeline is a graphical way of displaying a list of events in chronological order. Some Timelines work on a scale, while others simply display events in sequence. The main function of Timelines is to communicate time-related information, either for analysis or to visually present a story or view of history (https://datavizcatalogue.com/methods/timeline.html, The Data Visualisation Catalogue, Timeline). Timelines can organize into the following standard forms:

Linear: This is the most common type of timeline model. Each event node on the timeline can be encoded using line, glyph, or icon markers. Linear representations also have the additional directionality property, so these events usually have their dates and do not repeat on the timeline.

Circle: It is usually suitable for representing the cyclical nature of time, such as the natural cycles of humans, weather systems and ecosystems, and contains repeating events.

Spiral: Represented as a dense, space-filling shape that radiates toward or from a central point. It can contain repeating and non-repeating events, where the same events can locate at the same angle relative to the center, and non-repeating events can be arranged in chronological order.

Arbitrary shapes: visually similar to connected scatter plots and time curves, but in that the paths depicting time are defined by time-varying quantitative or relational properties, resulting in non-arbitrary representations. As with spiral representations, these representations may help present many events in a single dense display, improving the memorability of stories told with a timeline.

3.3
CASE STUDIES

The project will show the evolution of the metaverse, from the emergence and refinement of the metaverse concept to the advancement of correlation techniques to the ongoing introduction of relevant applications in the commercial sector, with a text-based approach with an apparent chronological order and non-repetitive events. Making the linear timeline more suitable allows large amounts of text to mark on the timeline more flexibly. And with a strong sense of direction and guidance, users can feel the apparent period in the horizontal browsing process and a stronger sense of interaction.

1. MeToomentum

It is a self-initiated data visualization project exploring themes, geographical footprint and key moments of #MeToo (#MeToo is a social movement against sexual abuse, sexual harassment, and rape culture, in which people publicize their experiences of sexual abuse or sexual harassment. Following the exposure of numerous sexual-abuse allegations against Harvey Weinstein in October 2017, the movement began to spread virally as a hashtag on social media). The medium is a poster, with three sheets containing three themes: spreading, trending and rooting, and a website with a visualization of "trending" as the main theme. This section shows tweets with the hashtag #MeToo that had more than a thousand retweets between October 2017 and March 2018, as well as their comments, likes and retweets.

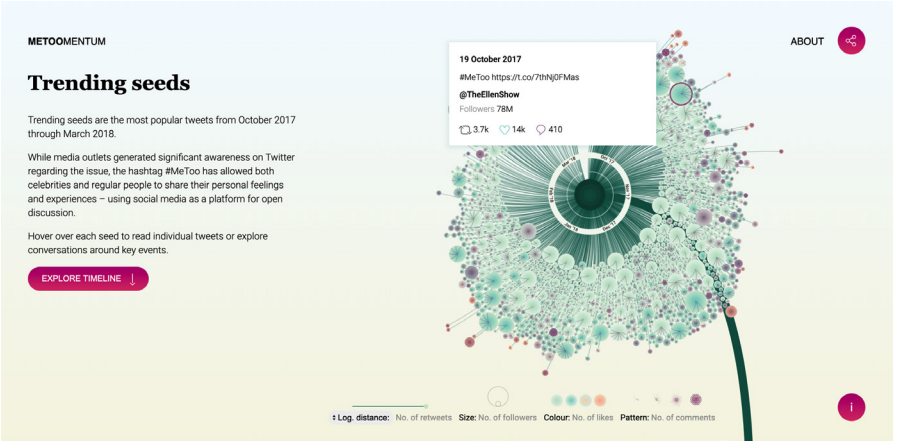


Figure 4. MetooMENTUM 1

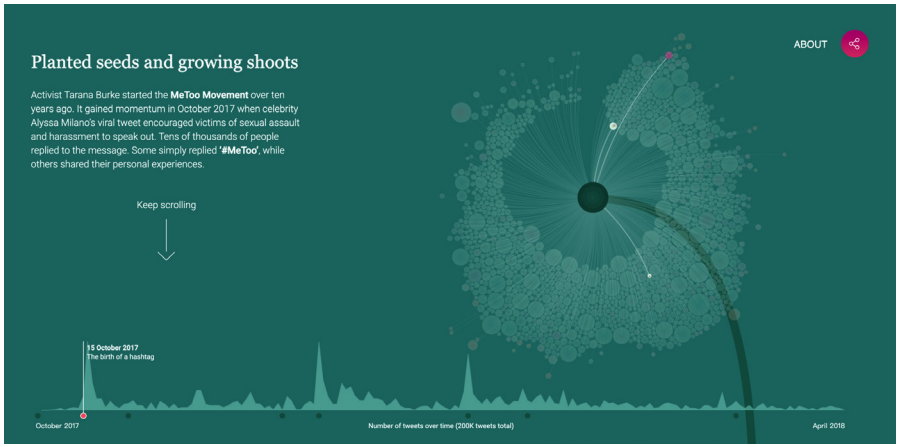


Figure 5. MetooMENTUM 2

Medium: website.
Data source: Twitter, containing English, Spanish, German and French;
Data visualization: a circular timeline represents the data distribution clockwise from October 2017 to March 2018. The shape uses the dandelion as a visual metaphor - a beautiful and fragile plant with great vitality and power to spread. The "dandelion" consists of dense circles. Each circle represents a tweet, the size of the circle indicates the number of followers of the tweeter who posted the tweet, the circle's color represents the number of likes, and the line or ring inside the circle represents the number of comments. The distance of the circle from the center of the circle represents the number of retweets.
Interaction: When the user's mouse hovers over the circle, the time, content, username, number of followers, comments, likes and retweets of the tweet are displayed, which is the overall display of the whole timeline. After scrolling down the page, we can see that the page has a dark green background, with some essential time points listed on the horizontal timeline at the bottom, the text description of the critical event in the upper left corner, and the corresponding tweets on the "dandelion."

2. Backstory: 13 years of HIV/AIDS on Wikipedia-Florian Kräutli
The project is based on a visualization tool built from more than 8,000 Wikipedia articles on AIDS and HIV to represent the changing perspectives on AIDS and HIV through a visual revision history.

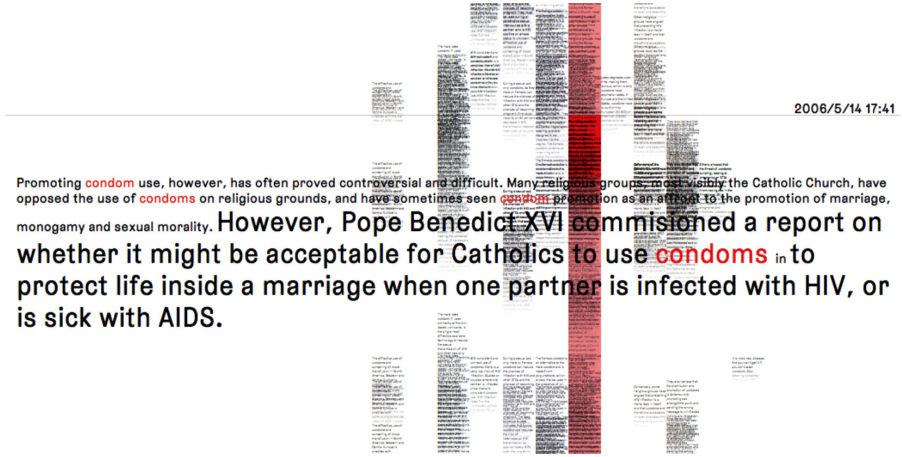


Figure6. Backstory: 13 years of HIV/AIDS on Wikipedia

Medium: website, with the first page containing a description of the topic and an explanation of the context, data collection and usage, and the second page containing the data visualization.

Data source: based on more than 8000 versions of HIV/AIDS Wikipedia articles, filtered around three keywords: condoms, viral load, and safer sex practices. Only paragraphs containing these keywords are displayed.

Data visualization: paragraphs contain keywords compressed into long bars, distributed chronologically from top left to bottom. Overlaps and gradients reduce readability, and the exact content can only be viewed in the center of the screen when the mouse hovers.

Interaction: The mouse hovers over a paragraph, the entire bar background

changes to a red state, the paragraph is the darkest, the timeline appears to flush above the paragraph, the specific content of the paragraph hovers in the center of the screen, keywords mark in red, and the numbers and specific phrases or sentences show zoom and motion effects. Three keyword filter items at the top of the page to view the article edits for each keyword.

3. Milestones in the history of thematic cartography, statistical graphics, and data visualization

This project provides a timeline visualization of milestone events in the history of data visualization.

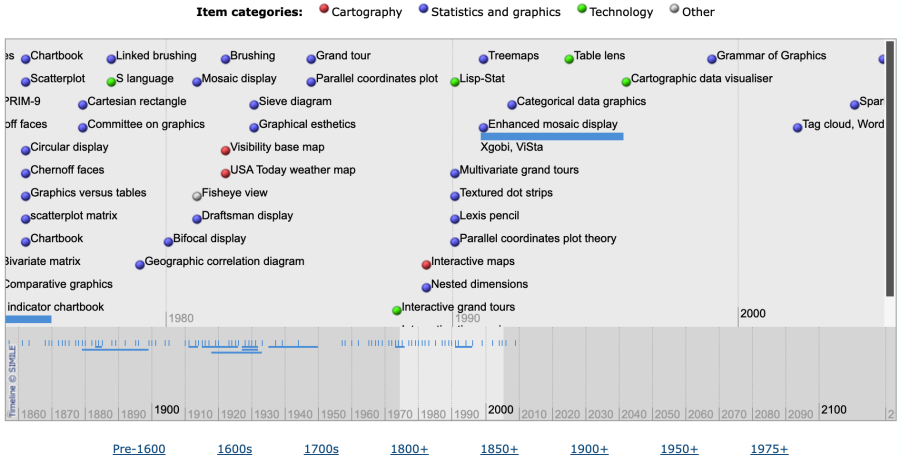


Figure 7. Milestones in the history of thematic cartography, statistical graphics, and data visualization

Medium: Website
Data sources: Starting with the development project listed by Beniger and Robyn (BenigerRobyn:1978), merging primary data from Hankins (Hankins:1999), Tufte (Tufte:1983, Tufte:1990, Tufte:1997), Heiser (Heiser: 2000) and a large number of other primary and some secondary data.
Data visualization: The authors display milestone events as terms on a timeline with dots to indicate categories, including cartography, statistics and graphics, technology and others.
Interaction: Milestone events in an interactive timeline are divided into two vertical sections and can be swiped left and right to view different periods. The top is a detailed, zoomed-in timeline where users can see the milestone events for each year. The bottom is an abbreviated timeline version where they can see the distribution of milestone events. Users can mouse-click on a term to see its year, author and profile and further click to go to the milestone details to see a drop-down table-style display of milestone events or to go to the category in which the event is located see details of events within the category. Users can also view the corresponding stage of development by clicking on time below.

Summary: The three cases have a commonality in that they all visualize text-based data as a timeline to show the evolution of an event. In the first project, Twitter was chosen as the data source, and the authors used metaphors to present the data related to tweets in a detailed and harmonious way, forming an irregular and exciting timeline. The content of specific tweets can be viewed by hovering the mouse and pulling the

timeline. The data of the second project comes from the revision history of Wikipedia, by selecting three keywords as three main lines to show the development of Wikipedia articles about them. One of the exciting forms of overlaying text as a bar chart is that although the text is not viewable, the visuals formed can show the volume of edits, and the height of the location shows the time. The theme and expression of the third project are similar to the research theme of this paper, where the critical times of a topic are presented in a timeline model to express its development. Time appears only by name in the timeline, and if the user wants much information, users need to click to jump to another page. There are many filter items to interact with within the project, and users can view any category of events or any period. There is much inspiration in terms of presentation and interaction in the research of related visualization cases, which is beneficial for the design project to move forward later.

DESIGN PROJECT

4

This project uses the website as a medium to extract the editorial history of Wikipedia on the metaverse into terms and keywords, as well as simple sentences, presented in a timeline. We can see from the Wikipedia page that from the creation of the entry on February 8, 2005, to March 8, 2022, the content related to the metaverse has continuously improved and enriched, including a description of the definition of the metaverse, the technology, the applications in different fields including games, economy, business and film, as well as the increasing criticism and concerns that emerged in the later years. Users can find out what the metaverse is, how it has developed, and how the public perceives it.

Target Audience: People interested in the development of the Internet and the metaverse, probably Internet industry practitioners, technology workers who are active members of the Internet and followers of financial and social hotspots, who do not fully understand the metaverse but want to know more.

4.1 DATA COLLECTION

4.1.1 Wikipedia as a source

Created in January 2001, Wikipedia is a multilingual encyclopedia-style collaborative project based on wiki technology, an online encyclopedia written in multiple languages, designed to serve as a widely accessible and free encyclopedia containing information on all branches of knowledge. As the world's largest reference site, Wikipedia is open to anyone with internet access in good standing to write and change. Hence, the sources of knowledge are comprehensive and extensive and now have over 6.5 million articles that accurately explain the metaverse.

Wikipedia is updated quickly, with articles about new events appearing within minutes, reflecting timely developments in social events and academic fields.

According to Alexa.com, a web tracking company owned by Amazon, Wikipedia averages more than 18 billion page views per month, making it one of the most visited websites in the world. When people want to learn about the metaverse, they usually consult Wikipedia, which is a good indicator of how much the public knows about a particular point of knowledge and the state of browsing.
Wikipedia is full-featured and structured. Not only can people view the entry pages, but every edit record, every day's viewership record, and the editors' edit records are all kept.

Wikipedia's current description of the metaverse is relatively complete and accurate, and its revision history function keeps all the editing records, so people can see how the metaverse expands from a placeholder to a full page after

multiple edits. Because of the timeliness of Wikipedia updates, when a new relevant event appears, it can be quickly edited into the page. The interval between the real occurrence time and the editing time is short and the delay is low, which can be accurately edited to respond to the development dynamics. Because Wikipedia has a wide range of editors, new content edited into the page indicates that the public has new knowledge of the metaverse, which can reflect the public cognitive process more accurately. Wikipedia can also be viewed as pageviews. As the most significant reference site, Wikipedia is often the first choice when people want to learn about the metaverse, so its pageviews are a good indicator of the global trend of interest in the metaverse. Therefore, using Wikipedia as a data source is an ideal way to explain the meaning and concept of the metaverse comprehensively and to show the development of the concept in its entirety, as well as to keep track of the dynamics of the public's browsing of the metaverse pages.

Wikipedia is available in 280 languages, including English, German, Japanese, Swedish, and French. But the English version has the most significant number of articles, reaching 5 million at the end of 2015. The English version is also the most visited item on the site. For example, in 2015, the English version of Wikipedia was viewed a 97.2billion times more than the second-ranked Japanese version (15 billion). It means that the English version, as the primary language version, has the complete data and the most extensive viewership, so this project focuses on the English page of the metaverse.

Wikipedia's page edit history shows the order, time, content, word count, and differences between the two revised versions of a Wikipedia entry, making it easy to retrace the history of edits to that entry. The edit history clearly shows the history of "metaverse" from the first edit of "Placeholder for metaverse article" on February 8, 2005, to a relatively complete home page. The emergence of new editorial records means that people's knowledge of the metaverse is growing and the metaverse concept is being refined and developed. Organizing and visualizing the entire editorial record can help people understand the development of the metaverse and form a complete lineage of development.

4.1.2 Designing the dataset

4.1.2.1 Downloading data

The data consists of two parts: the revision record and the pageview. The revision history is located in the upper right corner of the Wikipedia entry page, where people can see all versions of the entry, when it was edited, who edited it, and how many words were added or subtracted, showing the evolution of the entry. The option at the top of the revision history page allows people to view the pageview, which records the number of searches on Wikipedia entry pages, including the mobile app, mobile web, and desktop platforms and can be viewed by week, month, year, or any period in the schedule.

Revision history:

Since the "metaverse" entry was created on February 8, 2005, there have been about 1500 revisions in Wikipedia's revision history. We can use the "Compare selected revisions" function to view two adjacent records and compare them in a two-by-two way to find out what was added and subtracted each time, then use a crawler tool to export the data and get an excel table as follows:

id	sort_id	year	month	day	time	change	left_color	left	right_color	right
10079117	2	2005	February	8	22:26	add				The Metaverse, a phrase coined by Neal Stephenson's science fiction novel Snow Crash (1992), permeates ruling-class activities, and constitutes Stephenson's vision of how
								Placeholder for metaverse article.		
10079125	3	2005	February	8	22:41	delete				ass
								The Metaverse, a phrase coined by Neal Stephenson's science fiction novel Snow Crash (1992), permeates ruling-class activities, and constitutes Stephenson's vision of how		
10079159	4	2005	February	8	22:41	add				The Metaverse, a phrase coined by Neal Stephenson's science fiction novel Snow Crash (1992), permeates ruling-class activities, and constitutes Stephenson's vision of how
								ass		
10079678	5	2005	February	8	22:43	add		The Metaverse, a phrase coined by Neal Stephenson's science fiction novel Snow Crash (1992), permeates ruling-class activities, and constitutes Stephenson's vision of how	[[ ]] [[ ]] [[ ]] [[ ]] [[ ]]	The Metaverse, a phrase coined by [[Neal Stephenson]] 's [[science fiction]] novel [[Snow Crash]] (1992), permeates ruling-class activities, and constitutes

Figure 8: Data of revision history

The data includes revision time and revision content. The table records the year, month, date and time. Left-color text represents the content deleted in the previous version in this revision, and the left paragraph is the complete text of the paragraph where the content is located. Right-color text represents the new content added in this revision, and the right paragraph is the complete text of the paragraph where the content is located.

Pageview:

In the pageviews section of the view history, we can view and download data on Metaverse page views from July 2015 to the present.

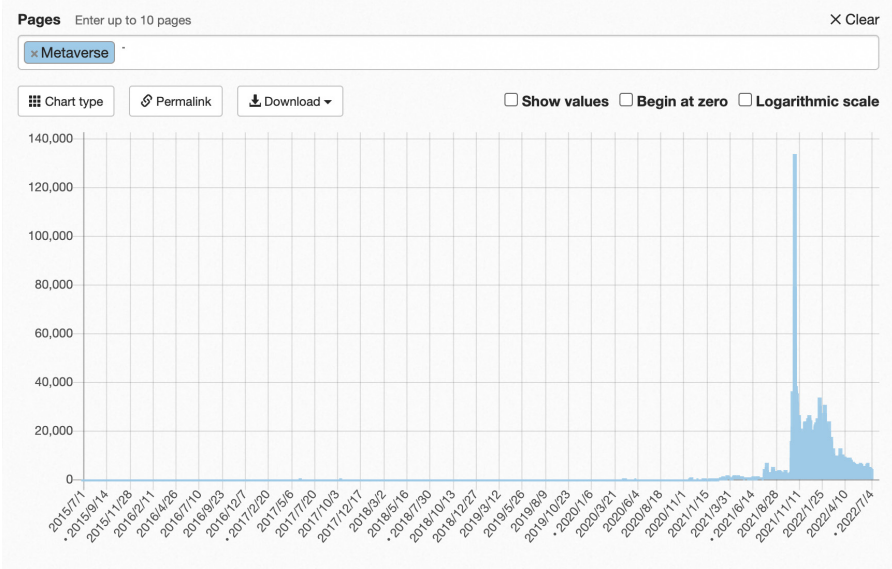


Figure 9: Data of revision history

4.1.2.2 Data filtering

After downloading the data, the data in the revision record form were first filtered to remove invalid content, including punctuation revisions, typo corrections, grammatical corrections, references and the addition followed by deletion or deletion followed by addition of the same content within a

few minutes, obtaining about 950 entries.

Since some of the texts were very long, leaving them untouched was not conducive to visualization and reading. Therefore, the conjunctions and adjectives in the paragraphs were removed. Most of the nouns were extracted as phrases or sentences to facilitate quick reading by users, with a total of about 2100 words.

Since the purpose of this project is to show users the development process of the metaverse and the public's awareness of it, when a new concept appears in the revision record for the first time, it means that the concept has already appeared and is known. Therefore, only the first appearance of a term in the dataset is kept, and it is not repeated in the timeline afterward.

Phrases and sentences are grouped into six categories, depending on where they appear on the Wikipedia page:

1. Definition(yellow): Definitions of the metaverse, in other words, phrases and sentences that explain what the metaverse is.
2. Technology (purple): The technology that facilitates the implementation and development of the metaverse, such as Virtual Reality, Augmented Reality, and the equipment needed to implement the metaverse, such as lightweight wireless headsets.
3. Fiction(green): Science fiction works related to the metaverse, including the origin of the "metaverse" - Snow Crash, and other

later fiction novels, movies and comics that contain the metaverse concept.

4. Implementations(orange): The development and realization of the metaverse concept in different fields such as games, education, business, economy, estate and politics.
5. Criticism and concerns(cyan-blue): Criticisms and concerns about the viability of the metaverse and the privacy issues, user safety issues, and other social issues that the metaverse might raise.
6. Related terms(blue): Others do not belong to the above five types, indirect Internet technology terms related to the metaverse, such as Megastructures, Human-computer interaction.

metaverse

The Metaverse, a phrase coined by Neal Stephenson's science fiction novel Snow Crash (1992) constitutes Stephenson's vision of how a virtual reality-based Internet might evolve in the near future.

The word "metaverse", without capitalization, is becoming a general term for the "[[universe]] within a [[universe]]" that is created by extremely popular [[fandom]].

Metaverse is a compound conjuction of "meta" and "verse" and has been used by Ervin László as an extension of Multiverse. The Metaverse contains the Multiverses and all universes past and present.

immersive 3D virtual spaces
humans interact
software agent
cyberspace
metaphor of the real world

Metaverse also refers to a content management system.

technologies have already been developed within modern internet-enabled video games.

The"Metaverse" is a fictional virtual world , described in Neal Stephenson 's 1992 novel Snow Crash, where humans, as Avatar (computing), interact with each other and software agents, in a 3Dcomputer graphics space that uses the metaphor of the real world.

The word "metaverse" is a compound of the words "meta" and "universe".

The Metaverse is our collective online shared space, created by the convergence of virtually enhanced physical reality and physically persistent virtual space, including the sum of all virtual worlds, augmented reality, and the internet.

The word metaverse is typically used to describe the concept of a future iteration of the internet, made up of persistent, shared, 3D virtual spaces linked into a perceived virtual universe.

Conceptually, the Metaverse describes a future internet of persistent, shared, 3D virtual spaces linked into a perceived virtual universe,

Metaverse is a speculative future iteration of the Internet, made up of persistent, shared, 3D virtual spaces linked into a perceived virtual universe.

Christopher Bernard

In 2021, the social media company Facebook changed its name to Meta to reflect its new focus on building technologies that "bring the metaverse to life." Its version of the metaverse is described as "an embodied internet where you're in the experience, not just looking at it."

transferability
digital persistence
synchronicity
real-time
permanent effects

An ideal metaverse would allow the user to do any experience or activity or address almost any of their needs from a single starting point, so in its completed state the metaverse could be applied to anything.

a future digital world

The metaverse is a hypothesized iteration of the Internet, supporting persistent online 3-D virtual environments through conventional personal computing, as well as virtual and augmented reality headsets.

The metaverse is often imagined as a means of manufacturing immersive digital spaces for a broad range of human activity.

The term "metaverse" has been used as a buzzword for promotion.

driven by creative democratisation

The technology company Nvidia has suggested USD should be the data interchange language of the metaverse.

In futurism, metaverse is often described as a hypothetical iteration of the Internet as a virtual world that is facilitated by the use of virtual and augmented reality headsets.

Several components of metaverse technologies have already been developed within modern internet-enabled video games.

In a January 2022 interview with Wired Second Life creator Philip Rosedale discribed the

Metaverse as based in two big transformative ideas. One is moving the Internet from a [[Two-dimensional space]] to a [[Three-dimensional space]], and the other which he described as "more complicated, dangerous, and important," is to move the internet from something that is condidered empty and lonely into being a space that always contains other live people.

Will the massively multi-user metaverse architecture becomes a massively regulated architecture as the applications and infrastructure scale up to global metaverse dimensions, or will regulation be achieved in code.
What does the framework for a massive virtual economic and social space look like? Who will control the metaverse?

metaverse ecosystem
Content Creation
Social Acceptability
Security and Privacy

public relations
over-hyped technology

impact on modern societies

There are concerns about the impact on modern societies when person to person interactions may be anonymous.

"Information privacy
users' personal information,
wearable devices
the spread of misinformation
loss of personal privacy"

User addiction
Internet addiction disorder

video game addiction
depression

anxiety
obesity
an ‘escape’ from reality

polarization within society
online echo chambers
media fragmentation

more of an illusion than a reality
more of a phenomenological observation and less of an ontological experience
more of an individual approach to knowledge and less of a personal relational dynamic
relationship with the educational good

Critical questions of pedagogical, philosophical and theological nature will arise.
digital intangible ""experiences"" will weak their personal creativity and freedom with the mass vehicle.
critical thinking

a dynamic alienation

refuge and escape
like in a fantasy mirror

The alienation of the human personality
the digitization of the human experience

problematic social media

AR pionee Louis B. Rosenberg

information bubbles
custom realities
reality block

restricting third-parties from injecting paid content into the metaverse that is indistinguishable from natural content

Zuckerberg's promotional video, some commentators have criticized Facebook’s conception of the metaverse as “vaporware”.
safety, privacy, and inclusion

SpaceX and Tesla CEO Elon Musk

sedentary lifestyle

biometric data

abuse social media engagement strategies

Frances Haugen

sexual harassment

transparency and privacy

Cardiovascular disease

fraud
sexual abuse
user safety
right to free speech
a regulatory minefield

Virtual crime

Religion sharia
haram
Expediency Discernment Council

Keza MacDonald
worker exploitation, prejudice and discrimination

The Guardian criticized the utopianism of technology companies.

potential effect on children and teenagers
physical injuries

a lack of infrastructure for both hardware and software

a marketing tool

Child Safety

child predators

In February 2022 Raja Koduri senior vice president of Intel said that "Truly persistent and immersive computing, at scale and accessible by billions of humans in real time, will require even more: a 1,000-times increase in computational efficiency from today’s state of the art."

minors engage in adult activities in applications

misinformation

lack of moderation

mental health

"Neal Stephenson, science fiction novel, Snow Crash, ruling-class, virtual reality
Internet, public-access, social stigma, visual quality, avatars, users, Metaverse, restricted environments, Black Sun, Metaverse club, technical acumen, sophistication of one's avatar"

Science fiction

upper and middle classes

"cyberscape, a big black ball, real-estate, insert name of the Metaverse protocol specfication group"

Express Ports

"virtual sphere terrestrial estate"

"private terminal portable devices"

Hiro Protagonist computer's user interface

immersive requirements description

scalability

"access levels public terminals goggle-based heads up

bio-integrated (gargoyle)"

usability

code protocols as law

"economics power structures mini-country (franchulate)"

"a single privately-owned managed environment co-operative network peer-to-peer networks"

True_Names

bandwidth

"black spherical virtual real estate Global Multimedia Protocol Group Association for Computing Machinery"

"goggles sub-culture portable terminals First person (video games) "

"analogs of reality monorail"

Bulletin board system

Burning Chrome
Neuromancer
William Gibson
Omni (magazine)

Cartesianism
invisible to visible(I2V)
Nissan

Earth1.io

"Ready Player One (novel)
Ernest Cline
OASIS
Virtual reality headset
wired gloves"

"Ready Player One (film)
Steven Spielberg"

"the Matrix dystopia"

Ready Player Two

Despite being written as a warning by Stephenson, numerous people, namely Mark Zuckerberg have committed to using the work of fiction as an instruction manual.
The Congress

OASIS can be accessed with visor and haptic gloves.

The book raises themes surrounding advertising and decentralization in metaverse-like environments.

Sword Art Online

virtual-reality

Virtual Object System

object-oriented programming

Mauz's History of Web3D

3D Web

Web2.0

"Mellanium Design Tele3DWorld"

"Steve Jackson Games online BBS system Illuminati Online virtual shop"

Virtual Real Worlds from MellaniuM Design provide hi-poly/hi-re environments for P2P and global access.

X3D
ISO
Virtual Reality Modeling Language (VRML)
interactive real-time 3D (web3D)
mixed reality
augmented reality
mirror

"Several collaborations and working groups interoperability"

Virtual Worlds - Standard for Systems Virtual Components Working Group (P1828), IEEE (2009-Present)

Information technology -- Media context and control -- Part 4: Virtual world object characteristics (ISO/IEC 23005-4:2011), ISO (2007-Present)

Immersive Education Technology Group (IETG), Media Grid (2007-Present)

Virtual World Region Agent Protocol (VWRAP), IETF (2009-2010)

The Metaverse Roadmap, Acceleration Studies Foundation (2006-2006)

extended Reality
User Interactivity (Human-Computer Interaction)
Artificial Intelligence
Computer Vision,
Edge and Cloud computing,
Future Mobile Networks

"powered by computers
Access points for the metaverse include general-purpose computers and smartphones, in addition to AR,MR, and VR technologies."

Oculus (brand)

Snapchat

A virtual environment the lack of high quality graphics and mobility

lightweight wireless headsets
wired VR goggle systems
HTC Vive Pro 2 headset

"More sophisticated sensors
visual overlays
visual anchoring
movement tracking"

OpenXR
Khronos Group

a proposed expansion to existing internet technologies

colonization of the Metaverse, a technology is needed.

"Epic Games' Unreal Engine 5
The Matrix Awakens"

Pixar
Blender (software)
SceneKit
Autodesk 3ds Max

Ray-Ban Stories
first-generation smart glasses
dual integrated 5MP cameras

World Augmented Reality Rendering Passport (W.A.R.R.P.)as a NFT to 3D rendering blockchain protocol (2022-Present)

haptic technology

Current hardware development is focused on overcoming limitations of Virtual reality headset, sensors, and increasing immersion with haptic technology.

"retina display
pixel density"

Used Imaging techniques in this field, Holograms, Monoculargrams

Holograms

Monoculargrams

"World Wide Web Consortium
the WebXR Device API
Augmented Reality Module"

Human-computer interaction

Simulated reality

Megastructures

Internet metaphors

Open Metaverse Foundation's VWRAP

Supranet

Alternate reality game

Metaverse Blockchain

multiverse virtual worlds

“NFTs are the atomic unit of the metaverse” - Andrew Steinworld

Alternate reality game

Crypto Currency

Universal Scene Description

Closed platform

Internet of things

Solipsis

Open Source Metaverse Project

Second Life

Croquet project

There

"Virtual Worlds
player
ActiveWorlds
metaverse engine"

Metaverse Messenger

"The Palace
Uru
massively multiplayer
online RPGs"

"Virtual Worlds
player
ActiveWorlds
metaverse engine"

Dotsoul

SenseMedia
MOO
a text-based online
virtual reality
system,
SnowMOO

CyberTown

"3D multiplayer
first e-economy
virtual Linden Dollar
first authentic U.S.
Dollar Millionaire by
the name of Anshe
Chung (aka Ailin
Graef)
supercomputers
broadband"

Metaverse is also an Enterprise Content

Management
appplication, provided
as a hosted service,
accessed over the
Internet.

code protocols as law

"economics
power structures
mini-country
(franchulate)"

"a single privately-
owned managed
environment
co-operative network
peer-to-peer
networks"

gaming community

"ChibaMOO (aka The
Sprawl)
William Gibson's
Cyberpunk literature"

"World of Warcraft
social networking
space
interactions"

3D immersive virtual
space

"microcurrency
economic platform
IP"

"Google Earth
GIS
satellite imagery
real earth data"

"mesh networking
One Laptop per Child
Sugar
social connectivity"

financial and virtual
asset management

"Economic activity
within virtual worlds
cannot stay
unregulated
John Perry Barlow"

"Inworld transactions
Edward Castronova,
A First-Hand Account
of Market and Society
on the Cyberian
Frontier
Second Life's LindeX
illegal financial
transfers
great firewall of
china"

normal currency

Massively mutliplayer
virtual environments
"game" and "role
playing"

"social networking
space
economic framework
economic gain"

Intellectual property

"virtual currency
therebucks
real money"

Linden Lab

Google_Lively

ExitReality

"Koinup
Myrl
AvatarsUnited
DataPortability"

"OpenSimulator
Open Life Grid
open-source free
software"

Playstation Home

Open Cobalt

Entropia Universe

IBM Virtual Universe
Community

"IMVU
Will Harvey
Matt Danzig
Eric Ries"

"blaxxun
vrml technology
iCity
jewel of indra"

SenseEarth.com
Explorer

Habitat (video game)

Wreck-It_Ralph|Game
Central Station

High Fidelity Inc

"Sansar
creator beta
speech-driven facial
animations
motion-driven body
animations"

Xenoverse

DC Comics

"Doctor Manhattan
DC Universe
Superman
Alan Scott
Justice Society of
America
New 52 Universe
events of Flashpoint
Wally West"

"Watchmen
Speedster (fiction)"

Doomsday Clock
(comics)

Persona 5

"NeosVR Metaverse
Solirax"

"The Sandbox (video
game)
a voxel metaverse
Animoca"

Facebook announces its
attempt at development
of a Metaverse.

"University of
Michigan
affirmative action in
the United States
underprivileged
minority
Bhargav Sri
Prakash#Vmerse
alumni relations
donor campaigns
emergency response
training"

The elements of the
metaverse include
"video-conferencing,
games like Minecraft
or Roblox,
cryptocurrencies,
email, virtual
reality, social media
and live-streaming."

Minecraft

"Girls' Generation,
life-size holograms"

"COVID-19 pandemic
SM Entertainment
Naver Corporation
V Live
Intel
Beyond LIVE"

KAIST

"Park Jun-young,
""City, Open the Sky""
Infrastructure and
Transport (South
Korea)
Seoul Metropolitan
Government
Lee Soo-man"

SM Culture Universe
(SMCU)

"Bharat Metaverse
a virtual India"

KPop agency

The parent company of
the social network
Facebook is renamed
from "Facebook" to
"Meta". It's chairman
Mark Zuckerberg
declares company's
commitment to
developing metaverse
ecosystem. A lot of
new VR hardware and
software is
announced.

StarbaseC3

Habbo

STRUQT
Vueport
mobile app Cobble

Duran Duran

Avatar_(Xbox)

OpenSimulator grids
Open Grid Protocol
(OGP)

Twinity

"MUDs and MOOs

KAIST

"Park Jun-young,
""City, Open the Sky""
Infrastructure and
Transport (South
Korea)
Seoul Metropolitan
Government
Lee Soo-man"

SM Culture Universe
(SMCU)

"Bharat Metaverse
a virtual India"

KPop agency

The parent company of
the social network
Facebook is renamed
from "Facebook" to
"Meta". It's chairman
Mark Zuckerberg
declares company's
commitment to
developing metaverse
ecosystem. A lot of
new VR hardware and
software is
announced.

StarbaseC3

Habbo

STRUQT
Vueport
mobile app Cobble

Duran Duran

Avatar_(Xbox)

OpenSimulator grids
Open Grid Protocol
(OGP)

Twinity

"MUDs and MOOs

multi-user virtual
environments"

aliens empire

Saints Row IV

"business sector
virtual office
platforms"

education sector

"Nvidia
Omniverse
the historical
heritage of ancient
civilizations and
architectures"

Together Labs Inc

"estate sector
virtual home tours"

Mars House

"online shopping
experience
virtual shopping mall
virtual 3-D items"

There is a significant
interest in developing
the metaverse for
online retail.

"immersive digital
spaces
increase work
productivity"

more focused and
interactive
environments for
learning history and
human geography.

business and
commercial interests

Clive Thompson

(journalist)

Microsoft Teams

fashion

HTC
VIVERSE
digital ecosystem HTC
Vive

Decentraland

"Aespa
K-pop record label
SM_Entertainment"

"VRChat
a social VR platform"

AltspaceVR

Rec Room (video game)

"Facebook Horizon
Facebook"

Sinespace

Anyland

Modbox

"Core (video game)
Manticore Games"

Roblox

"Rival Peak
Facebook Watch
a cloud-powered
reality show
AI contestants"

"Microsoft Mesh
Microsoft devices
HoloLens 2"

AfterEarth

"Epic Games
Fortnite"

"Cryptovoxels
Ethereum blockchain"

Somnium Space

"Sensorium Galaxy
VR concerts
electronic music
artists like David
Guetta
PRISM
MOTION worlds
native SENSO tokens"

"South Korea
AR"

cryptocurrency

Figure 10. Data categories

4.2 VISUALIZING DATA

Pageviews:

Importing the pageviews data from 2015.7.1 to 2022.3.22 into the data visualization tool RAWGraphs 2.0 to get a line graph, we can see that the number of views on the metaverse page was relatively low and stable at around 80-120 for a long time before. After entering 2021, the number of views started to rise, especially from September to October, reaching a peak of more than 130,000 on October 29, 2021, which reminds us that on October 28, the famous American social media platform Facebook announced that the platform's brand would be partially renamed as "Meta." It aroused the public's curiosity about the metaverse.

Figure 11. Pageviews on metaverse page of wikipedia (days)

Figure 12. Pageviews on metaverse page of wikipedia (months)

Revision records:
The contents of the revision records are then extracted into terms and sentences, categorized, tagged and displayed on a timeline with images.

After filtering, the number of words in the valid revision records is counted and visualized using a bar chart, where the number of words deleted is in blue and the number of words added is in orange. From 2005 to 2011, the community of volunteers' editorial activity for the metaverse page showed a trend of increasing and then decreasing, tending to zero in 2012 and increasing significantly in 2021, and peaking in November.

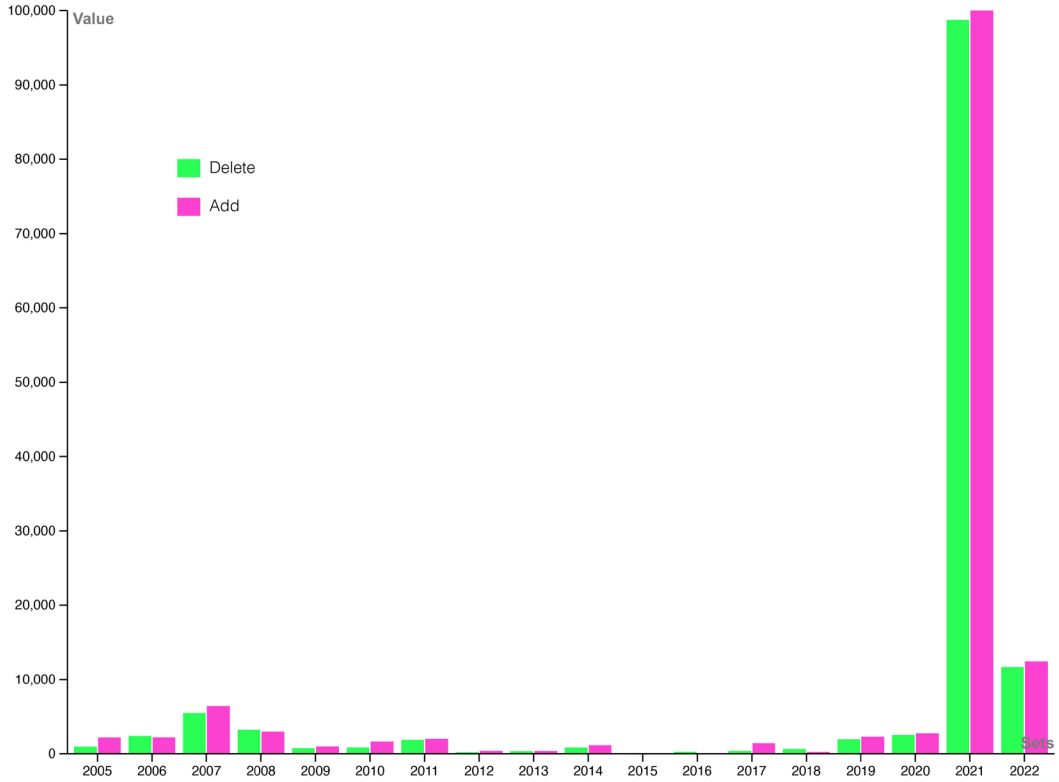


Figure 13. Number of words in the revision records

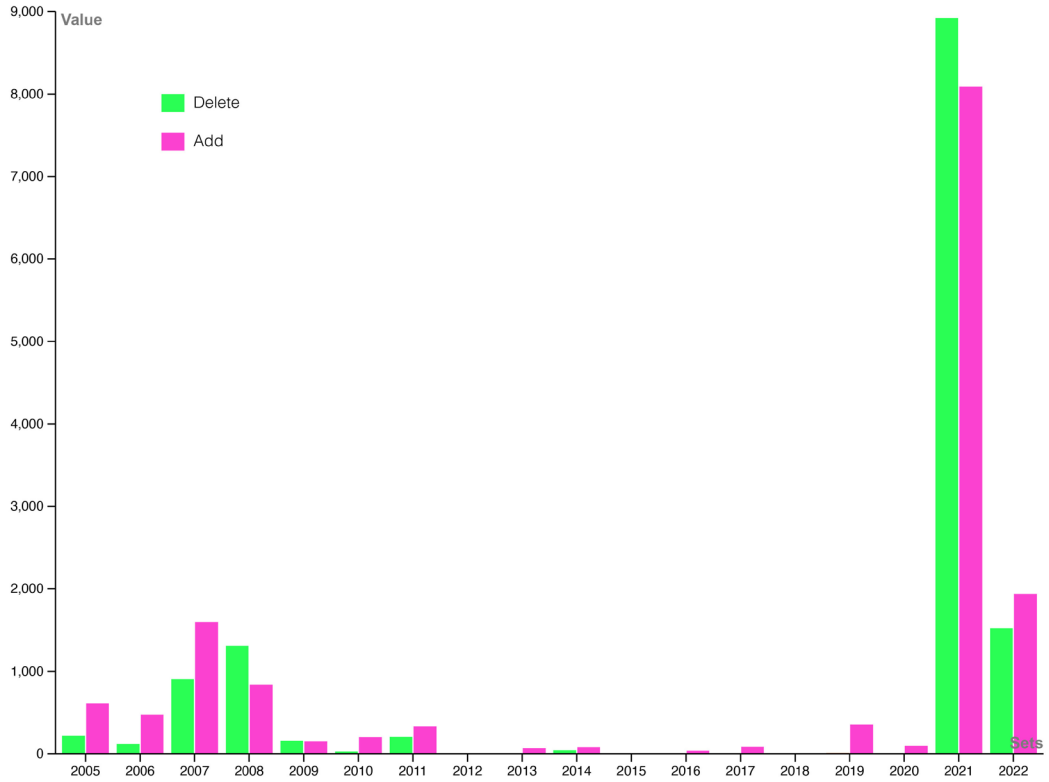


Figure 14. Number of words in the valid revision records

4.3 MEDIUM AND INTERFACE DESIGN

4.3.1Choosing medium

The project hopes to show the development of the metaverse by presenting a timeline of the metaverse's revised Wikipedia-based record. The target audience is people who follow the development of the Internet and the metaverse, such as Internet industry employees and technology workers, active members of the Internet and followers of financial and social hotspots, and regularly browse the web for cutting-edge social and economic developments. The electronic medium is more in line with their reading habits. Therefore, a website was created as a medium for the project, enriching the reading experience by adding interactive effects and presenting a definitive evolution timeline of the metaverse.

4.3.2 Interface design

The website structure is divided into four parts: homepage, metaverse timeline, metaverse chronology, and about.

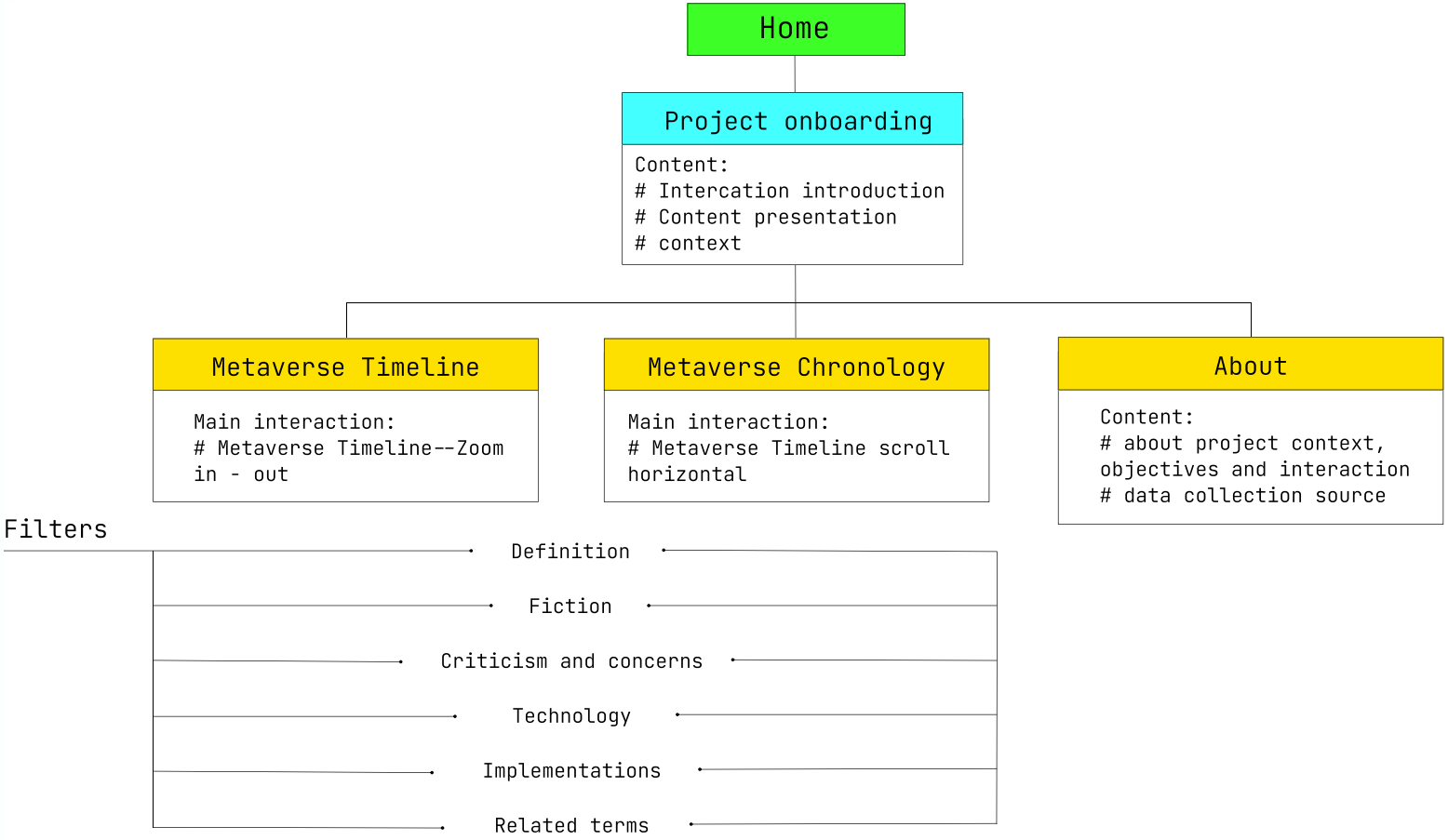


Figure 15. Information architecture

Homepage:
The project name is "unfolding the Metaverse story" and the subtitle is "the Metaverse concept timeline based on Wikipedia edits." Swiping down to see an introduction, descriptions and demonstrations of the main interactions as users read. This project republishes the revised history of the metaverse in Wikipedia, showing a timeline of how the metaverse concept has changed from the creation of the placeholder on 8 February 2005 to 8 March 2022, including definitions of the metaverse, technologies, applications in different fields, criticisms and concerns. It can show that the metaverse did not appear out of anywhere, but that there is continuous exploration and discovery behind it.

The project is divided into two main sections: metaverse timeline and metaverse chronology. A Wikipedia revision of the historical timeline of the metaverse, representing the process of public awareness of the metaverse. Metaverse chronology is when terms and keywords from revision history first appear in society or academia. The users can select a timeline to enter from the buttons here. Instructions for interaction methods include zooming of the page, mouse hovers, mouse clicks, and filter buttons.

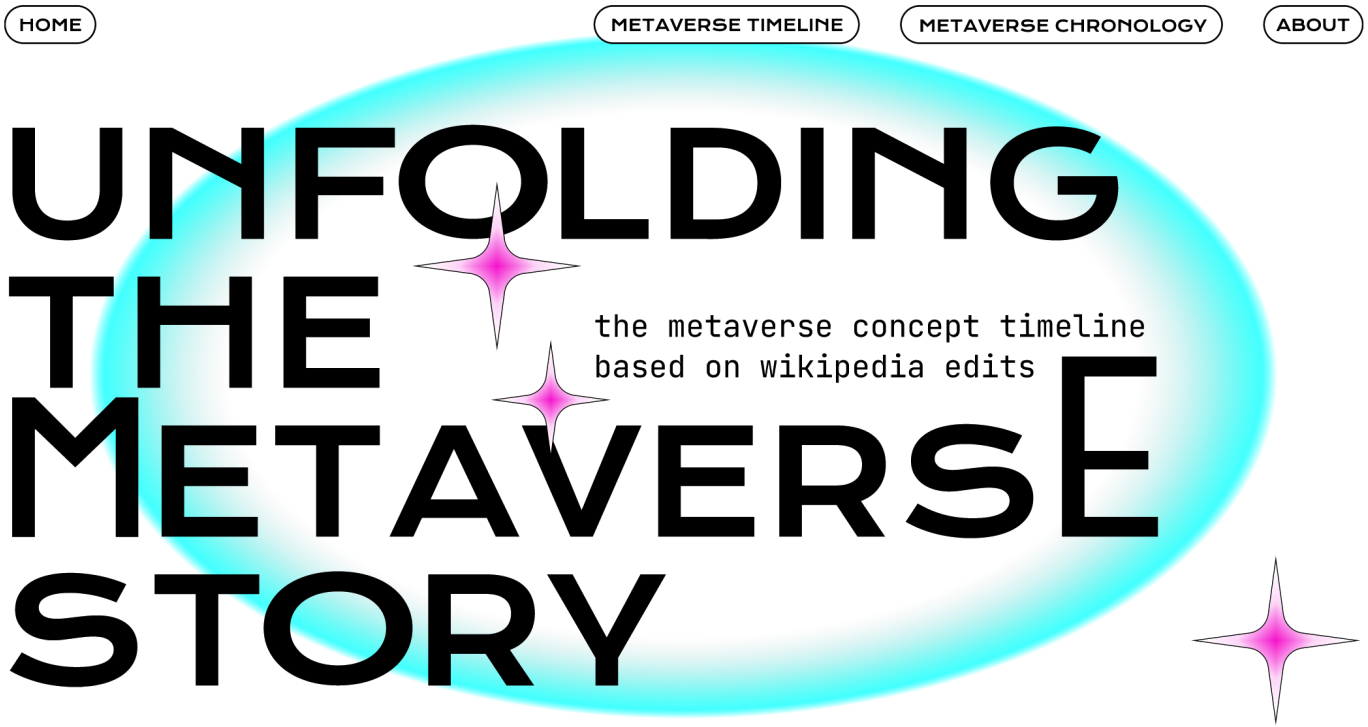


Figure 16. Homepage

Metaverse timeline:

When users enter the metaverse timeline, it is an overview timeline from February 2005 to March 2022. The background is the editorial records for each year, which are placed in a uniformly sized square, with paragraphs with more words repeatedly overlaid, and those with fewer words to fill the square by increasing the line spacing to fit the square, resulting in images of varying shades of color, corresponding to the years filled into the background. Although some of the text thus becomes invisible, we can see how many words were edited from the changes in the overlay shades. From 2005 to 2011 the number of pages edited showed a rise and then a fall, with a small peak in 2007 and a smaller amount of content in 2009. It is followed by lighter background color and less edited content from 2012 to 2019, except for 2014, which maintains a certain amount, with a sudden massive increase in the number reaching a peak in 2021, where the text is overlaid several times becoming completely unseen as a dark gray color block. Then it is followed by 2022, which despite having only three months of content, still far exceeds the other years in number, becoming a gray with a color depth second only to 2021.

The dark blue polylines on the background are pageviews, starting from July 2015 to March 2022. The polyline initially showed a deficient number and began to fluctuate and rise after entering 2021. It reached the highest point when Facebook announced its name change to Meta on October 28, and the second peak occurred when Microsoft acquired Activision Blizzard in January 2022.

The display on the timeline adds new concepts every year. Because the text size is too small to be seen, they almost look like color blocks, representing different phrase categories. Users can understand the addition of concepts and the increasing number and trends of concepts in different categories. It can be seen from the page that a certain number of new concepts were edited between 2005 and 2007, however, there were only a maximum of 7 sets of terms per year for an extended period, until 2021 when a lot of new content appeared. Implementations have the most phrases among the added content, and new content has been edited into the metaverse page. Phrases about fiction were added more in 2005 and 2007, because metaverse comes from fiction novels, so the editors have introduced a lot of Snow Crash descriptions on the metaverse page. The definition of the metaverse is being updated and refined on and off. In 2021, each category was added, with criticism and concerns accounting for a large percentage of the content, yet it has only appeared once in the past 16 years, so it is clear that as the metaverse has been noticed and discussed, the attitude toward it is not only one of anticipation and fervor but also a great deal of concern and doubt. As a new thing that is complete for development and lacks clear and unified norms, it is worth considering the social problems that may arise.

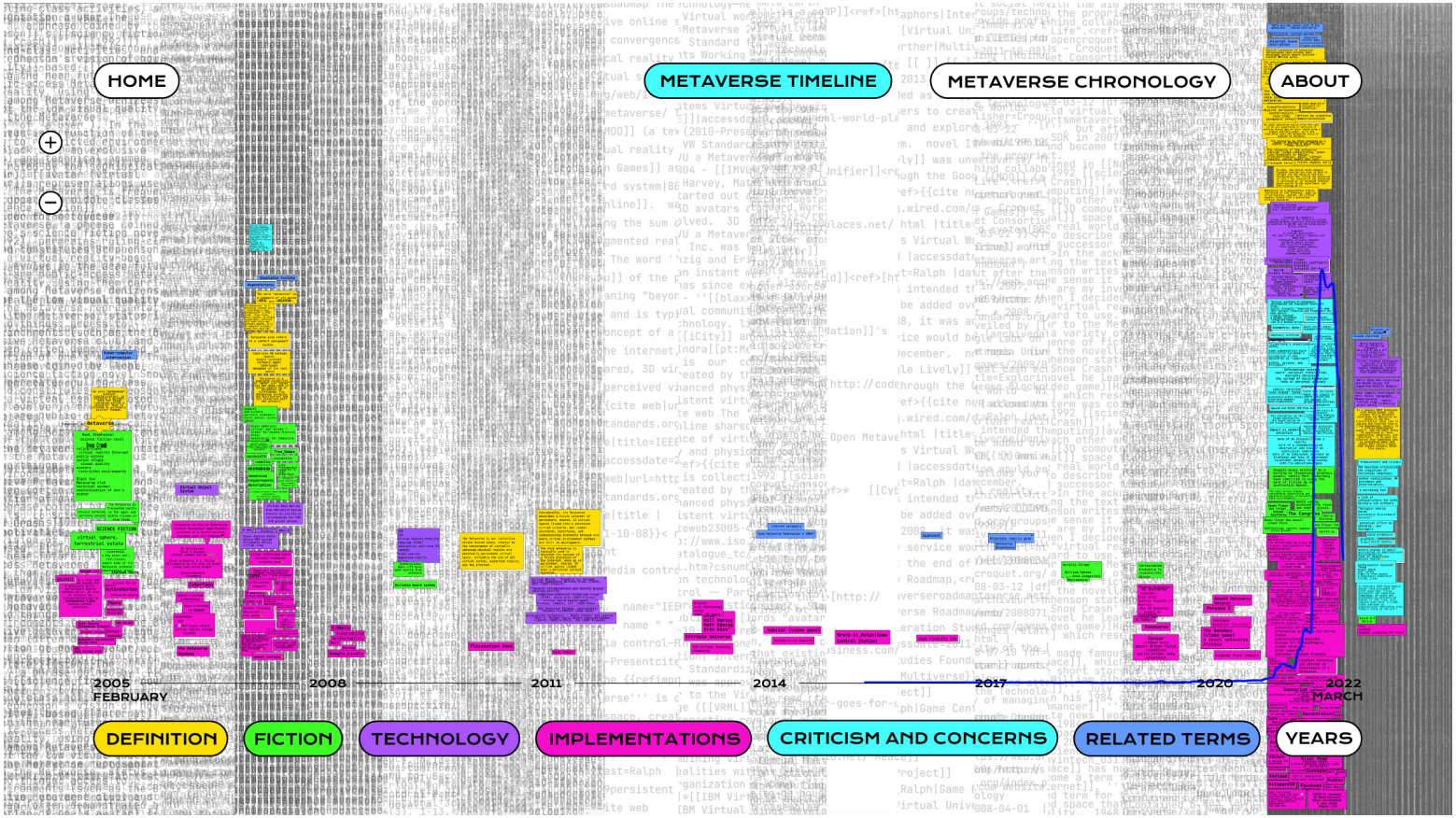


Figure 17. Metaverse timeline 1

After the page is zoomed in, users can swipe left and right to view the detailed graphic content. The timeline changes from year to month, and the background is the monthly edit record content. Words appearing in the same revision record combine with the corresponding picture in the same box. The font sizes are 15, 16, 18, 22, and 36, and some fonts are bold, with emojis interspersed in the middle to increase the sense of interest and visual diversity. Because the pictures are from different games, animations and novels, a color halftone filter has been added to unify the visual style. Users can more accurately see that much new content was added to the metaverse page in 2005, and more content appeared in February 2007. After that, the number of new content added for a long time was very small and scattered until December 2020. A small peak appeared again, adding a lot of game and social platform content. October 2021 to January 2022 is the period with the most content added, including definitions, technologies, implementations, criticism and concerns, fiction, and related terms. Among them, definitions, implementations, criticism and concerns are the most content, especially criticism and concerns, which only appeared once in the previous timeline. With the increasing attention of the public to the metaverse, many entrepreneurs regard it as future development. At the same time as the direction, many people have raised doubts and criticisms, believing that it is difficult to achieve due to the lack of relevant infrastructure, will lead to Internet addiction and game addiction, and bring the risk of loss of personal privacy.

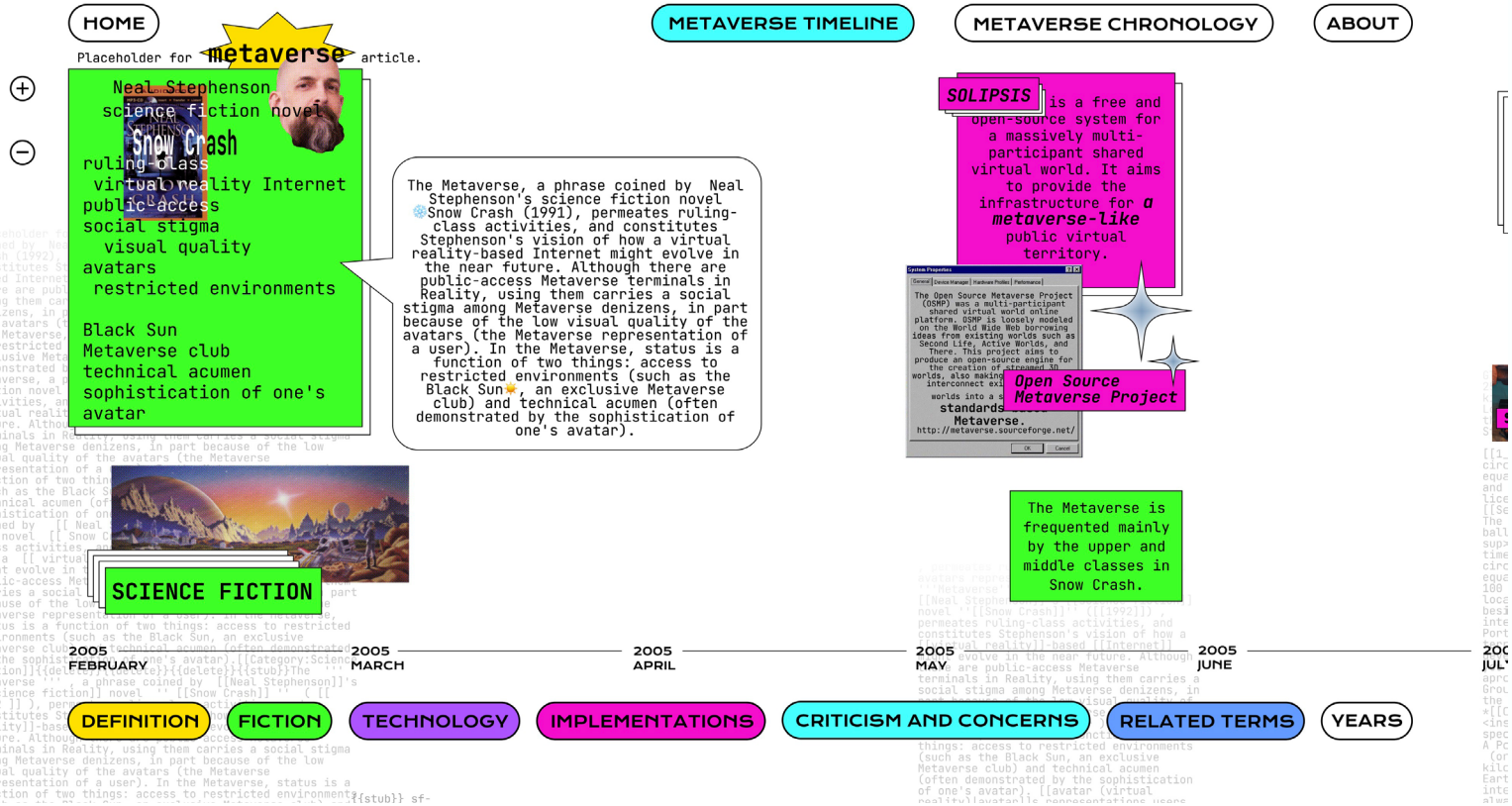
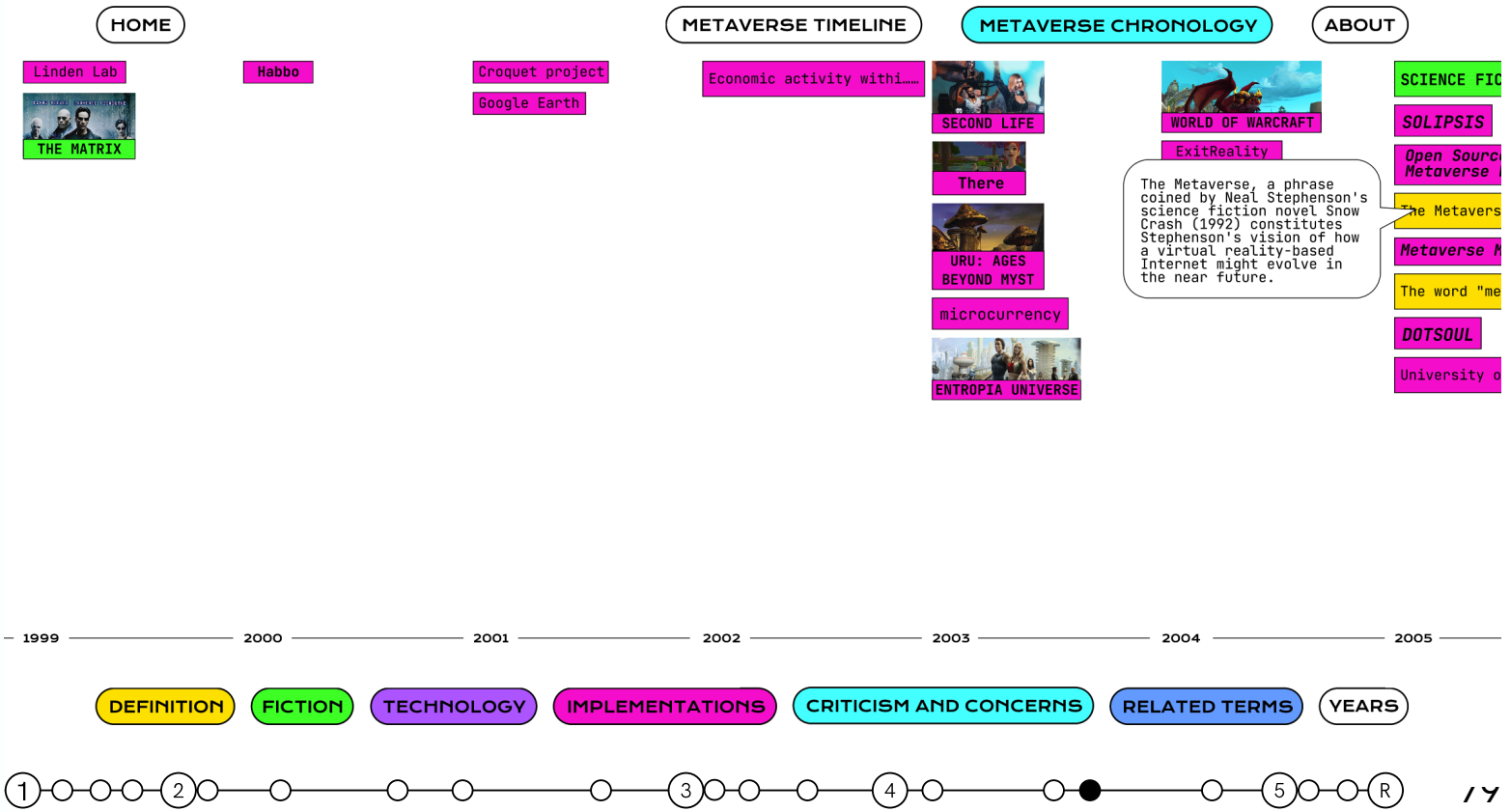


Figure 18. Metaverse timeline 2

Figure 19. Metaverse chronology

Metaverse chronology:

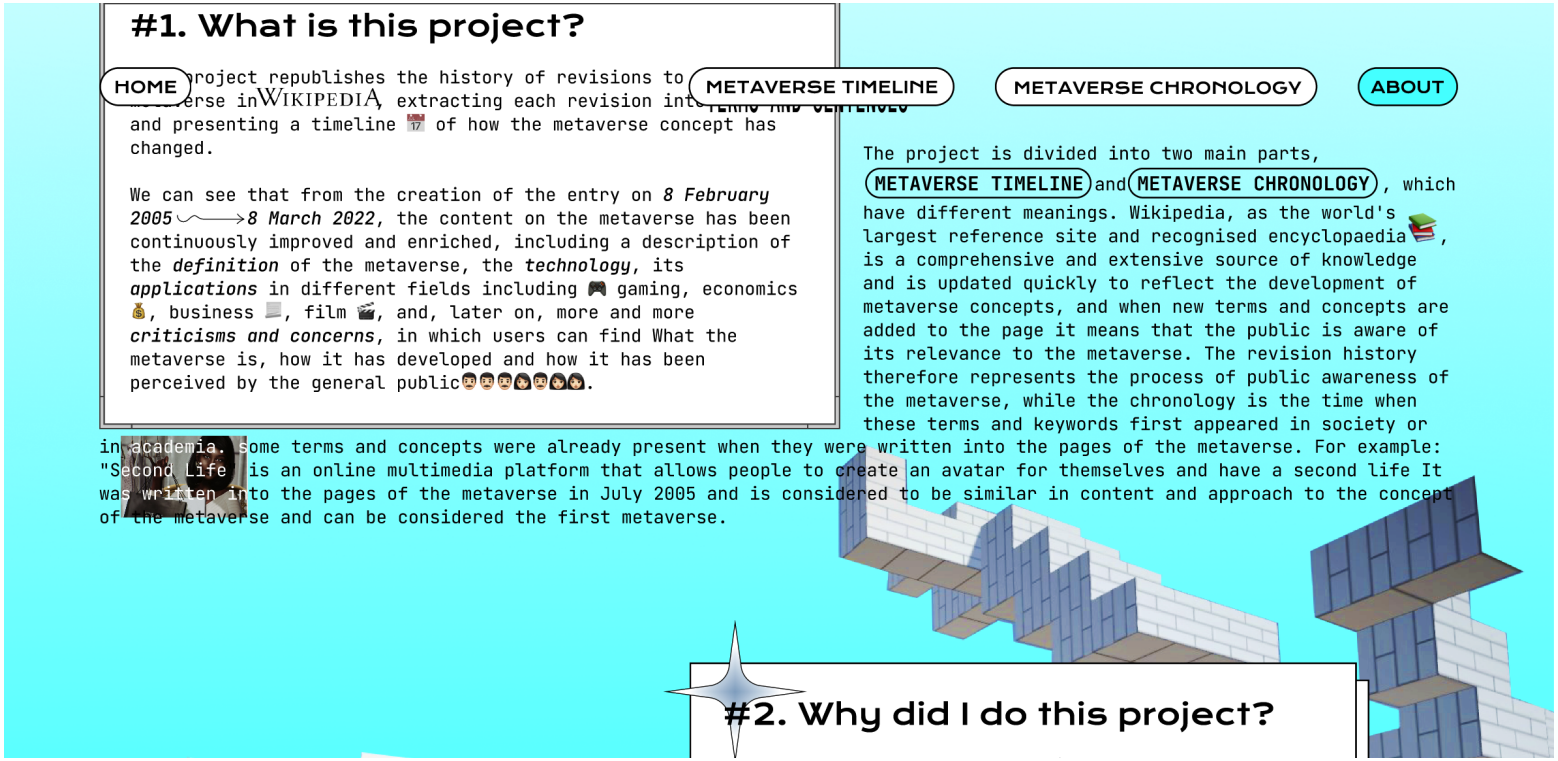
Compared to the metaverse timeline, metaverse chronology is much cleaner in terms of visual and interactive features. The timeline runs from 1940 to 2022, with a unified visual representation of words in the same category.



About:

It is divided into four parts, a short self-introduction and three questions, "What is the project?" "Why did I do this project?" "How did I do this project?" Compared with the home page, about is more detailed content, purpose and design process of the project are explained. Black-and-white processing and collaged in the timeline as visual elements.

Figure 20. About



4.4 INTERACTION DESIGN

The overall visual style of the page is a white background with a blue gradient, the text is equipped with a black thin line frame, and the filter items are in a color with high saturation. The title is Krona One, and the body text is JetBrains Mono, a font designed for developers that people often see in code to make the text feel more digital.

The project also includes an interaction design part to support users to communicate and interact accurately and efficiently when using this website, promoting users to achieve their goals.

The five dimensions of interaction design were first defined by a professor at London's Royal College of Art, Gillian Crampton Smith, and a senior interaction designer, Kevin Silver, which represent the aspects an interaction designer considers when designing interactions:

1. Words (1D) encompass text, such as button labels, which help give users the right amount of information.
2. Visual representations (2D) are graphical elements such as images, typography and icons that aid in user interaction.
3. Physical objects/space (3D) refers to the medium through which users interact with the product or service—for instance, a laptop via a mouse, or a mobile phone via fingers.
4. Time (4D) relates to media that changes with time, such as animations, videos and sounds.
5. Behavior (5D) is concerned with how the previous four dimensions define the interactions a product affords—for instance, how users

can perform actions on a website, or how users can operate a car. Behavior also refers to how the product reacts to the users' inputs and provides feedback.

Words (1D): There are four buttons at the top of the page, namely home, metaverse timeline, metaverse chronology, and about, which represent the four components of the website. Users can click to jump to any page. The home page's introduction includes introducing the two timelines of metaverse timeline and metaverse chronology. Users can click the button here to enter if they are interested in any of them. There is a row of filter buttons at the bottom of the metaverse timeline and metaverse chronology pages. When the user enters the page, the filter buttons are all selected. The buttons are definition, technology, implementations, criticism and concerns, fiction, and related terms, which guide users to reset the categories they are interested in or close them all. The last button below is years. When the mouse hovers over the button, all the years on the timeline will pop up so that users can also select any year to view.

Regarding Visual representations, the timeline contains many pictures, some pictures arranges with text, and some hidden pictures need to be triggered by a mouse hover or click to help users better understand the meaning of the word.

Time (4D): In Implementations, most words are game applications. They have sufficient visual materials such as pictures, animations and videos, which can significantly enrich the project's visual style and information

content and add more interactive forms. When the user clicks on the game's name, movie or animation, the page's background changes to the related animation or video. As the user continues to slide, the background will gradually disappear and become a white background again, or click the next word and be replaced by a new video background.

Physical objects/space (3D) and Behavior (5D): The user views the website using a computer and interacts with it through mouse actions. After entering the site and clicking to enter, the users need to swipe vertically to read the homepage and about page and horizontally to view the two timelines. In the metaverse timeline, users can zoom in and out of the page by clicking the circular button on the left side. When the page is in the zoomed-out state, users can see the complete status of the whole timeline, including the change of edit volume, the overall trend of view volume, the overall number and trend of concept additions, and the number and trend of additions for each category. Users can view the page by sliding the mouse horizontally when the page is in the zoomed-out state. While browsing, images will pop up when the mouse hovers over the text; the background will change when the mouse clicks on words within certain Implements. When a text box contains multiple words, a bubble box can appear when the mouse hovers over the text box as an extended reading for that group of words. Each month's phrases arranges in a relatively flexible way within the scope of that month. When there are too many phrases in a month so that they overlap each other, the users can over a particular word text box of interest and the phrase will reach the top.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SUMMARY AND REFLECTION

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5.1 DESIGNING TIMELINES

This thesis collects and analyzes the current social hot phenomenon metaverse, focusing on concept definition, characteristics, technology development, application areas, concerns and discussions.

The current common visual models summarize in the selection of visualization models, and about 61 graph models were obtained in five categories: graphs, diagrams, maps, tables, and plots. By analyzing the functions of each model, such as concepts, how things work, relationship, flow, proportions, and distribution, the most suitable model for the project was selected, which was the timeline that could best express the data change over time. Then collect similar design cases and analyze them to get enlightening ideas.

When choosing data sources, considering that Wikipedia has a broad audience, rich knowledge sources, timely updates, and complete data retention, people can not only view daily page views, edit word counts, and edit counts but also view revisions. It records the content, compares the content of different versions, and retains the complete evolution process of the entry. It can show the evolution process of the metaverse and the public's cognitive process, which is an ideal data source. The data collected on Wikipedia includes the text content and revision time of the metaverse revision records and the daily pageviews of the metaverse pages from July 2015 to the present. On this basis, the text content is supplemented by queries to add the actual time of appearance, relevant pictures, and video clips. Firstly, the data is initially screened and counted.

The invalid information such as spaces, punctuation marks, and misspelled word corrections in the revision records are removed and extracted as phrases and word groups. At the same time, duplicate information was removed, and only the time and content of the first occurrence of the exact text retain. The data was then visualized by importing the pageviews data into a visual graphing tool to obtain a line graph. The word count of the revised records calculate in years, and the data was imported into the visual charting tool to obtain a bar chart. The extracted text is displayed on the timeline in order.

The website was chosen as the communication medium, and the website prototype builds on Figma. The website structure was divided into four parts: home, metaverse timeline, metaverse chronology, and about. The visual design enabled the website information to be conveyed intuitively in a distinctive and attractive style. By adding interaction design, users can accurately and actively receive information and create a sense of interaction. The project's final presentation shows the evolution of the metaverse for users by showing how many revisions are recorded each year, how the number of views changes, the types of new terms, their number, details, and the time of editing and appearance.

This project republished the revision records of Wikipedia, visualizing the 17 years of revision of the metaverse as a timeline model from the perspective of communication design, which can show the evolution of the metaverse more clearly and intuitively and achieve effective information

5.2 LIMITATIONS AND FUTURE WORK

transfer.

Although the project has basically achieved its initial purpose, there are still some problems to be improved in the process. In the process of filtering data, invalid and duplicate information needs to be deleted, and manual removal generates much workload. Confirming whether the text content has been repeated requires accurate judgment, which consumes a lot of time and energy. When dealing with text information, artificial intelligence crawling software was used to try to crawl terms. However, the results were not accurate, so it changed to manual extraction, but the problem involved is how to define terms and unify crawling standards to avoid too much subjectivity to the maximum extent, resulting in objective scientific results? Furthermore, manual crawling still generates a massive consumption of energy and time, and the more significant the amount of text, the lower the feasibility. Therefore, in this step, finding a more intelligent way of data filtering and text processing is conducive to forming a methodology that visualizes the evolutionary process as a timeline based on the text description, which can improve efficiency.

Second, for a prototype, it is crucial to perform an evaluation. By inviting testers to test the prototype and then filling out a questionnaire to get the test results, we analyze and evaluate how well the prototype meets the expected goals and what unexpected results it produces and make changes and upgrades to the prototype. Due to the project's time constraints, there was not enough time for testing, and this is the part that needs to be

followed up in subsequent work.

In the future, the project will continue to be refined, go through further website creation, refine the interactive features, improve usability and user experience, and after testing, continue to improve based on the issues raised in the feedback. The whole visualization process will be further standardized and summarized to form a methodology that can apply to other themes of timeline visualization design.

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