The World as an Interface: Exploring the Ethical Challenges of the Emerging Metaverse

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Abstract

Abstract— Mixed reality is emerging as the next phase of personal computing. Once Apple Glass is released augmented and mixed reality will go mainstream and the impact on our behaviour will be as dramatic as when the iPhone was released. In parallel, what used to be 2D webpages are becoming 3D worlds, collectively forming a meta universe of virtual or mixed reality domains -the 'Metaverse'. Mixed reality is precisely where the best affordances of the digital and analogue worlds should work together to create entirely new interactive learning, social and economic opportunities. In this paper we reflect on how the physical world will itself become an interface making reality even more machine-readable, click-able, and searchable. We further propose how society will need to ensure that the appropriate boundary management is in place to allow us as co-creators of the metaverse to protect our ethical rights of privacy, integrity, and autonomy.

Keywords: metaverse, mixed reality, ethics, digital twins, biometrics.

1. Introduction

A significant component of the metaverse is the merging of our representation and identity in the real world with a digital representation of ourselves in the digital world. Digital twins are formed as the virtual and the digital are connected through a network of sensors. Already the iPhone 12 Max Pro with its inbuilt Lidar technology can create a 3D point cloud of the environment that you are in. This wholesale 'scanning of the world' has direct impacts on our privacy. When Google Glass was released in 2013, it was immediately banned in department stores as it was deemed an unacceptable invasion of privacy [1]. Now however, depth sensors are being built into all sorts of devices and ethical mechanisms for protecting your body-image and possessions have not been well established [2]. Welcome to the digital twinning of your personal context, a democratic way of utilising the senses or sensor extensions of them for future mixed reality experiences, something Alexander Bard has come to call a 'sensocracy' [3]. By wearing an AR headset such as the Microsoft HoloLens you by default are generating 3D scans of everything you see, and that includes people. The issue is that once your body-image has been captured, it can be used, ad-infinitum in deep-fake productions.

Volumetric capture studios are springing up all over the world. As a result of the pandemic, the need for virtual production techniques have exploded, the construction of the matrix is firmly underway. Frameworks for how the products of these studios should be managed have yet to be formulated. The non-fungible token (NFT) or Smart Contract may play a role in protection, as it could be used as one way to protect your body image IP. This means you would be the owner of your digital self. Benefits of this including securing your fingerprint through smart contracting. This form of contracting can also be used to provide clear and valid ownership over personal skills and certificates that authorise them. Tokens related to personal purpose and identity have come to be known as 'Soulbound' tokens (SBTs) [4][5]. This hints at the need for a future where you own designs personal to you before designers own you, a viewpoint covered by Daniel Fraga in his 'Manifesto of Ontological Design'[6].

However, ethical issues will mushroom exponentially once mixed reality headsets and contact lenes are more widely adopted. This is because, through the simple act of looking, we will be making 'new realities with our eyes'. Facebook's Horizon, Unreal and Nvidia are some of the key players creating their own walled gardens of the metaverse.

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This paper will explore and review the knowledge gap in terms of ethics to ensure a fair and just use of data within the metaverse. We will seek to answer the research questions:

1. What are the ethical risks and challenges that arise through user engagement with the emerging Metaverse?
2. How can the technology of the Metaverse be designed with safeguards to protect the user's ethical rights?

The basis of this paper's exploration will be a Case Study analysis of the ethical challenges within the co-authors' project titled XPRIZE Rapid Reskilling [28, 29]. The project applied a bespoke Augmented Reality platform that was designed for upskilling disadvantaged workers in the US. The Case Study reflects on several of the ethical challenges that can be encountered in a "metaverse" user-space. The case project's solution was to create a new form of media called Neuroadaptive mixed reality training. This involves taking the live biometrics of workers to establish their affective state and is done unobtrusively through voice recognition where we could classify up to six different expressions of emotion. The collected data, up to 32 different datapoints highlighting personality, traits, wellbeing and more, then drove the complexity of the mixed reality training in real-time.

2. A conceptual review

Metaverse, a term first coined in science fiction, is a combination of the prefix "meta", meaning beyond, and "universe". It refers to shared virtual worlds where land, buildings, avatars and even names can be bought and sold, often using crypto currency. In these environments, people can meet up in an embodied way with friends, visit buildings, buy goods and services, and attend events.

The concept has surged in popularity during the COVID 19 pandemic as lock-down measures and work-from-home policies pushed more people online for both business and pleasure. The term covers a wide variety of virtual realities, from work-place tools to games and community platforms.

Many of the new platforms are powered by distributed ledgers (i.e., blockchains), using crypto-currency and non-fungible tokens (NFTs), allowing a new kind of decentralised digital asset to be built, owned, and monetised. The combination of the metaverse with blockchain provides a feasible way of providing non-repudiable proofs-of-ownership.

As noted in the introduction, body scanning threatens personal privacy and sovereignty due to the ability to abuse deep-fake technology to replicate a human being to near biometric accuracy. The advent of neural radiance fields (NeRF) technology means the time to produce an accurate three- dimensional model from two- dimensional photographs is greatly reduced. A way of mitigating this form of personal 'bio-data attack' would be to ensure that your digital biometric likeness has been secured as either an NFT or via storage on IP file servers, thereby allowing you to prove ownership of a version of your digital self.

2.1. What is the Metaverse?

A term originally established by Neal Stephenson in his novel, Snow Crash [7], in which he describes a virtual world that is ubiquitous within his imagined future, it has become an expression to describe stacks of web 3.0 technologies focusing on human-centric experiential modalities. What does all that mean?

According to Mathew Ball, a venture capitalist and angel investor who has written a series of essays about the future and infrastructure of the metaverse;

"When these two technologies (internet and computing) first emerged, all interactions were primarily text-based (emails, messages, usernames, email addresses). Then they slowly became more media-based (photos, videos, livestreams). The next elevation of user interface and user experience is into 3D. Secondly, if we think of [a] mobile [phone] as placing a computer in our pocket and the internet being available at all times, think of the metaverse as always being within a computer and inside the internet." [8].

Many professionals and experts are looking at the metaverse as a three-dimensional model of the internet, a place where you and other people, represent themselves using infinitely customisable avatars, permitting a level of self-expression previously impossible. At its core the metaverse can be viewed as a three-dimensional version of the internet, as represented in Table 1, that is seen as the next step in its evolution, ideally accessed through a single gateway. Search Engines will need to take account more of context and engineering around that will need to be created for the metaverse. A discipline for engineering context, Context Engineering, has been developed for exactly this purpose [9].

Table 1. Metaverse a three-dimensional model.

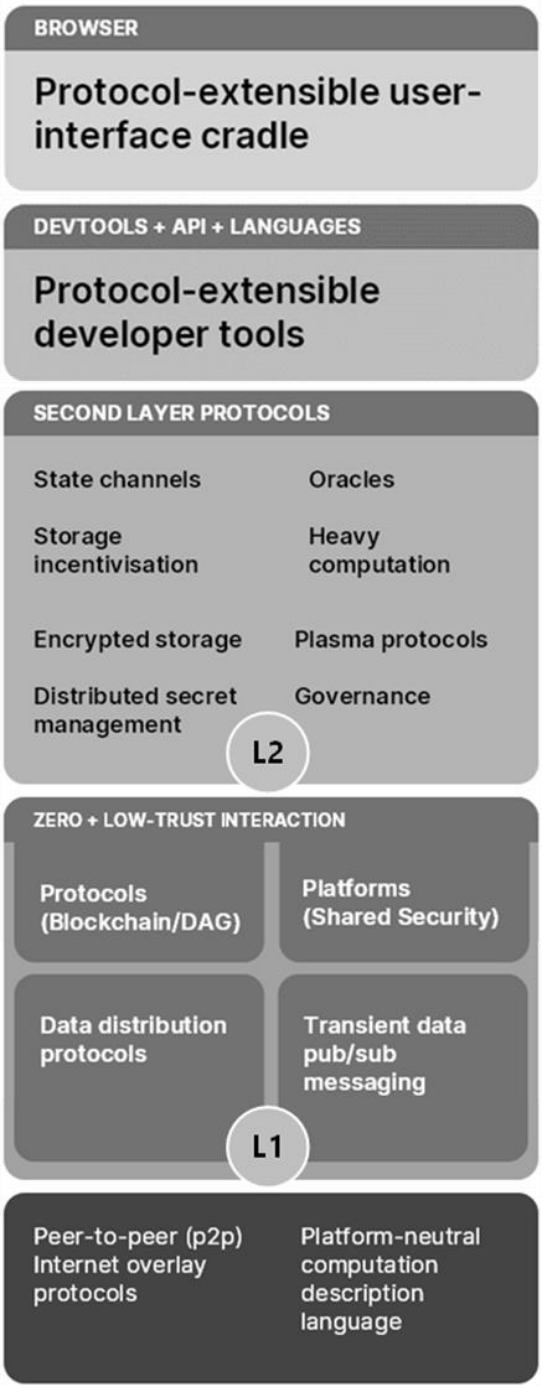
	WEB 2.0	**WEB 3.0**
Communication	Interactive	Engaged/ Invested
Information	Dynamic	Portable/ Personal
Focus	Community	Individual

	WEB 2.0	WEB 3.0
Personal	Blogs/ Wikis	Lifestreams
Content	Sharing	Curation
Interaction	Web Applications	Smart Applications
Search	Keywords/Tags	Context/ Relevance
Metrics	Cost per Click	User Engagement
Advertising	Interactive	Behavioural
Research	Wikipedia	Semantic Web
Technologies	Flash/ Java/ XML	RDF/ RDFS /OWL

Web 3.0, the stack of layers of technologies that enables and empowers the metaverse can be defined as a vision of the serverless internet, the decentralised and intelligent web. Leading to an internet where users are ultimately in control of their own data, identity, and virtual destiny, true personal data sovereignty.

The underlying technology that powers the metaverse is similar in nature to the open systems interconnect (OSI) conceptual framework that describes networking or telecommunications systems used in Web 2.0 technological stacks [10]. Our layered Metaverse OSI model is depicted in Figure 1, is based on Webb-Benjamin's experience with Web 2.0 technologies.

- Layer 0 or Legacy Foundation- The Web 3.0 and blockchain is based on pre-existing Web 2.0 protocols. This layer includes the standardised building blocks of which Layer 1 tech can be assembled, including p2p (peer-to-peer) internet overlay protocols and platform neutral computation description languages
- Layer 1 or Foundation- Core blockchain foundations are an integral part of this Web 3.0 layer. This layer is responsible for distribution and interaction, including data distribution protocols such as IPFS, zero/low-trust interaction protocols, Bitcoin and Ethereum etc. al, and temporary data messaging.
- Layer 2 or Middleware- The middleware stack that solves inherent blockchain issues. This layer is an enhancement of the lower layers and includes meta-protocols and solutions to scaling, privacy, computation, or storage including the possibility to add multiple components from this layer to existing tech stacks.
- Layer 3 or Tooling- Tooling allows more people to work with the core protocols. This layer includes human-readable languages, code libraries and other developer tools which should make development easier and accessible.



- Layer 4 or Browser- Users desire efficiency, convenience, reliability, and easy payment systems. This is the user-facing layer which makes it easy for everyone to interact with the underlying technology, for example users using MetaMask can access data

objects and assets from the blockchain via their desktop and mobile browser.

2.2. Volumetric capture

Volumetric video represents a joining of traditional linear workflows with interactive media like games and digital environments. As more industries adopt volumetric video, content creators will have the opportunity to add richer, more immersive elements, engaging the viewer in the experience. The benefits can be profound, but businesses, teams, and software must evolve to meet future demand.

Volumetric video capture technology is a technique that digitises a three-dimensional space, i.e., the volume of space, object, or environment in real-time using an array of cameras set around a target. The captured object can be digitised and transferred to the web, mobile, or virtual worlds and viewed in 3D. What makes volumetric video so powerful is that the final product does not have a 'directors view' meaning there is no set viewpoint and as a result it becomes a declarative space where the end-user can watch and interact with the footage from all angles, enhancing their experience and heightening their sense of immersion and engagement.

The difference between 360-degree video and volumetric video is the depth provided with volume. In a 360-degree video, users can only view the video from a single, constant depth. With volumetric video, the end-user can play the director and control how far in or out they want to explore the scene [11].

2.3. Defining ethics in the Metaverse

Prior to defining ethics in the Metaverse, we need to examine the meaning of ethical rights of privacy, integrity and autonomy. Privacy is associated with the right to protection of personal identity. European data protection laws provide definitions of personal identification rights. Often however, the concept of privacy is tied to personal integrity (validity and authenticity) and personal autonomy (management and control) over one's own data. This may include extending protection of our personal rights to control over our biological data and materials, including many forms of biometric data (e.g. heart rate, temperature, emotional data points through voice analysis, etc.). Some have argued that laws cannot provide this level of personal control and protection over personal data [12]. Even as early as 2003, the Australian Office of Federal Privacy Commissioner had recognized the challenges presented by the ties between personal information privacy and personal bodily integrity, then stating,

".. an attempt to maintain a clear demarcation between different types of privacy protection may be problematic in light of new technologies which involve the merging of biology, mathematics and computer science, namely, biometrics and bioinformatics. Such developments give rise to new forms of body templates or records which further blur the distinction between personal information and its source in individual humans, rendering the concepts of information privacy and bodily privacy inherently interrelated." [13, p.280]

In developing Metaverse experiences a major concern will be privacy and general ethical frameworks around extended reality, which includes virtual reality, mixed reality, and augmented reality. Investigation into what data is collected through these metaverse systems will be needed as well as where that data goes and how is it used. Collection of biometric and physiological data will generate intelligence on user neural activity and that will require rights frameworks to support ethical utilization and exploitation. Kent Bye comments, "If we don't have mental privacy and biological privacy, some of the new technologies could essentially read our minds, model our identity, reach fine-grained and contextually relevant conclusions, and then nudge our behaviours to the point where it undermines our intentional actions. [14]" Problems could get tougher in the metaverse because of the addition of a layer of immersiveness to the technology. New metaverse oriented standards are being created by groups like the Khronos Group and Open XR with a strong focus on interoperable interfaces [14].

3. Ethical concerns- a dark side of the Metaverse

Metaverse interactions will inevitably not just be played out through AR or VR headsets but will utilise affordances of brainwave capture to optimise experiences. This will have issues regarding the ethics of how that data is used as well as who can afford the technology. There are already technology 'poverties' and 'divides', especially regarding internet access [15] [16] [17]. How will these translate into accessibility for the metaverse?

In 2010 Tan Le did a TED talk on how her companies technology could read brainwaves [18]. Could brainwave datasets be processed to forecast our own potential thoughts and actions? If so, what precautions and constraints as well as regulations will be required to protect user rights? [19]

In 2008, Edward H. Spence proposed a framework for operating in a virtual world with morality and ethics centering on a framework of shared consent [20]. Spence proposed that as people adopt virtual avatars as identities in the metaverse these characters can be viewed as virtual representations or modes of presentations of real people so must be afforded the

same rights as actual people as well as behave, comply, and act in alignment with the moral principles of real-world human beings. Spence establishes moral and ethical drivers for virtual worlds based on the work of Alan Gewirth and his argument for the Principle of Generic Consistency (PGC) [21]. PGC demonstrates that any person acting with a purpose, embodied as an avatar or agent in virtual spaces, has rights to freedom and wellbeing that are generic. This is the case as if the person was acting with purpose in the real world, they would have such rights and so by extension these rights should be maintained if they are acting with purpose in a virtual world.

Cathy Hackl, a futurist on AR and VR, in 2020 wrote for Forbes on the emerging Metaverse, also highlighting how tracking would happen of body movement, brainwaves, and physiological responses [22]. She expressed concern that privacy violations and data piracy would spill over from current 2D internet and mobile platforms into 3D virtual spaces where terms and conditions people might need to agree to might be even more extensive. As users so often gloss over such agreements, hastily agreeing to them, what would be the consequences in expanded realities of virtual worlds associated with the Metaverse where complexity of interactions and datasets would be considerably more complex? Kavya Pearlman is Founder & CEO of XR Safety Initiative. Her organisation is trying to help build guidelines around privacy, Ethics, and Safety for the emerging realities. She has declared that organisations like hers must enable trust and help build safe, immersive ecosystems. Amongst her concerns are those in Table 2 [22].

Identities, particularly in the form of digital avatars created by Artificial Intelligence metaverse algorithms, may also cause disruption and moral dilemmas. In Metaverse interactions, particularly in video games, how would we treat AI-based realistic characters with almost human personalities and emotions? Bartle raises concerns over toxicity, or bad behaviour where players are harassing or bullying someone. There is a need for creators of metaverse environments to make them a safes space for everyone, since just about everyone is likely to be in them. As norms change, such as around sexuality, so must virtual affordances and types of moderation. [23][24][25].

Table 2. Ethical risks [22]

Category	Risks
Negative Physical Responses	• Sensory overload can trigger seizures in some people who suffer from epilepsy. • Low frame rates improve may cause users to get motion sickness.
Children in the metaverse	• Virtual reality can create false memories • Can desensitize them to real world threats or lack of moral actions • Issues with proof of age and ID. A user can appear as an adult so companies must have frameworks in place to manage ID verfication.
Biometric Data	• Tracking users environment may reveal private locational information • Tracking physical movements may reveal confidential or illegal activity • Eye movement tracking can show overt as well as hidden preferences • Private physiological response to an experience can be measured through a metric like heart rate.
Brainwaves from Brain-computer interfaces (BCI)	• Brain-computer interfaces (BCI) technology tracks brain wave patterns and deducts thought processes through machine learning. • New types of data can be collected and analyzed. • Thought patterns might be accessible and unprotected.
Protection of Digital Twins	• Unacceptable or unpermitted digital recreation of buildings, objects in the home, items in a store
Deep Fakes	• False, AI or Machine Learning representations (Deep fakes) • Hacked avatars
Alternate Repre-sentations of Reality	• Manipulated objects • Manipulation of brands • Malicious behavior • Fake news
Consumer Disrespect	• Data scandals especially related to identity theft • Lack of government regulation for new technologies and metaverses • No established best practices or ethical frameworks to protect consumer data. • Little proactive measures to address safety, privacy, and ethics in this domain. • Terms and conditions as well as privacy policies for other platforms

	are not suitable for Informed consent in the Metaverse. • No clear, regulated systems to establish trust via ethics • No concensus on accountability, transparency, and human-centric design.

The Integrity and Autonomy needed for designing human experience can be architected through Fraga's view of Ontological Design. Ethics for the Metaverse, has come to be called Meta-Ethics as in the paper discussed earlier by Spence. Janko Roettgers in 2021 took this on in his article "How To Build A Safer, More Inclusive Metaverse" [26]. Roettgers highlights how Tiffany Xingyu Wang, co-founder and president of the OASIS Consortium, is establishing processes for safety for emerging social platforms [26]. In August 2021, OASIS relaunched as an industry consortium that promotes ethical standards and practices for the metaverse. Wang indicated that over 40% of U.S. internet users have experienced online harassment. Current social platforms were built without safeguards with moderation added late in the process. The metaverse is likely to attract questionable audiences without guardrails. A key issue of potential harassment may feel even more personal and threatening in life-like virtual environments. Safety will need to be a priority supported both by junior moderation staff as well through executive roles. Diversity will be critical in the safety workforce. Safety, privacy, and inclusion for the metaverse will need to be established with a panel of experts that are diverse and inclusive. A major output will be a consensus document of shared standards in 2021, one whose values are hoped to be adhered to by companies across the industry. This will be necessary to not repeat the lack of safety foresight seen in creation of previous platforms [26]. In a July 2021 article, Benjamin Bertram Goldman highlights that the ethics of designing virtual worlds will lead to interactions that are more face-to-face and direct rather than impersonal and distant as seen in current social media channels. Reactions will be live and not asynchronous. Conflict is more likely so will need more effective forms of real-time moderation and regulation [27].

4. Metaverse Shared Consent Framework

The OSI-like architecture of the Metaverse illustrated in Figure 1 must be overseen in its layers by systems of consent that moderate everything from the foundational network hardware to the high-level applications such as browsers and other applications. As Metaverse architecture is emerging as a decentralised, serverless ecosystem it is critical that any consent frameworks also operate through similar protocols and processes for a balance between respecting data integrity and focusing on performance-oriented strategies.

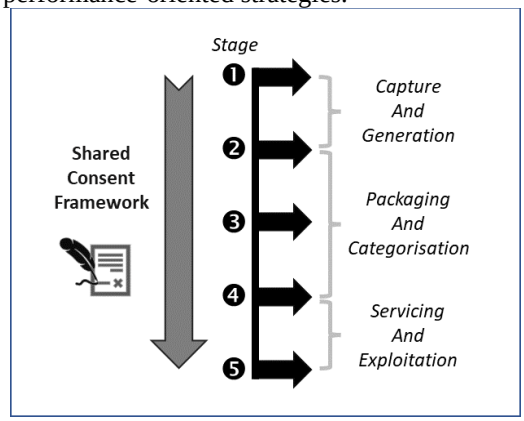


Figure 2. Workflow for Metaverse Data Capture and Utilisation

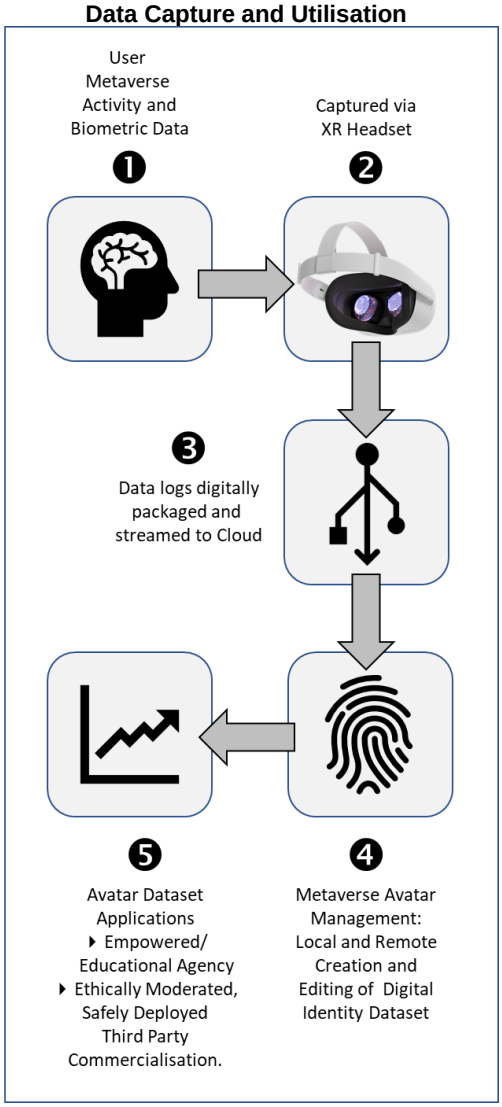


Figure 3. Example Spatial Data Capture and Utilisation

The five stages in Figure 2 need to have Ethical Data Oversight, Management and Deployment. The stages need to be overseen by a Shared Consent Framework that manages every data handling point or process centering on sequential stages of (i) Data Capture and Generation, (ii) Packaging and Categorisation as well as (iii) Servicing and Exploitation. The framework polices and authorises data permissions, access, and utilisation.

The policing process is illustrated in Figure 3. This begins when User's metaverse activity and biometric data is captured via an XR headset's sensors. The data is digitally packaged to generate a Digital Identity Dataset that can utilised for enhanced empowering experiences or be exploited for manipulated experiences or controlled commercial gains. These stages are overseen by a Shared Consent Framework outlined in Figure 3.

5. XPRIZE Case Study: Ethical Challenges and Possibilities for better Engagement

XPRIZE is a $5 million Rapid Re-skilling Competition based in the US [28]. The competition is organized by XPRIZE, a non-profit organisation, that creates innovative competitions to solve the world's greatest challenges.

In this case study we consider ethical challenges and explore possibilities for better engagement with safeguards in the Metaverse. We reflect on the entry solution in XPRIZE, that is called "Rapid Employment Accessibility Platform" (REAP) [29]. The REAP solution helps protect long-term employment for vulnerable workers.

REAP in September 2021, is amongst the 8 Semi-final teams, who were shortlisted from 118 teams across 20 countries. An expert judging panel assessed all the submissions based on how useful and engaging the training ideas were.

The XPRIZE REAP team leader explained, "Now more than ever, we need reliable ways of upskilling the whole of society, by taking full advantage of the latest learning technologies. We are incredibly proud of the fascinating work that our community is doing to empower those vulnerable to job loss."

5.1. REAP technologies and platforms

XPRIZE Rapid Re-skilling challenges teams to create effective rapid training and re-skilling options for people who are most likely to face unemployment in the United States. The aim of the competition is to reduce training time by at least 50% and will provide this training to jobseekers for free.

The REAP team consists of Kryotech, Maaind and Ravensbourne University London. The consortium is developing a Neuro-Adaptive Mixed Reality Training platform in order to place 350 participants into full-time jobs.

The REAP Multi-disciplinary Training environment has AR/VR elements that are mixed with live training, of for example "machinist in an auto-repair industry" or "operation of CNC machines and lathes" [30].

A typical use case, of how an XPRIZE "customer" goes through the Rapid Reskilling experience begins by assessing experience of a user of virtual training through a voice analysis app on their mobile phone. This establishes what state they are in emotionally and then can suggest guidelines to optimise how they are for improved learning, a flow of guidance that is explored more in the next section.

5.2. REAP challenges on ethics

Within the XPRIZE Foundation Rapid Reskilling project, that two of the authors of this paper have led in delivering, it was found that biometrics were notoriously difficult to monitor in industrial environments within which participants were to be upskilled [31][32]. As a result, voice stress analysis was chosen as a profiling tool, and associated machine learning utilised to determine a psychological state mix of up to 32 different datapoint emotions that could be transformed, guided or channelled for enhanced learning and skill practice. Having any kind of data or algorithm that frames content created by users, like voice responses, requires appropriate securing of permissions to qualify a right to process the content as well as to how it will be stored, shared, made accessible or destroyed. These permissions cannot be small print in terms and conditions or privacy policies of vendors.

Ownership must not be implicitly transferred or utilised without explicit consciousness, awareness and understanding informing the users agency and authority to share their personally generated data assets. A priori awareness and contract must be accompanied with regular assessment of consequences of use. In the case of XPRIZE participants this authority was contracted and clearly registered with participants at the onset of them getting an account to access training services on the project mobile app that utilised voice analysis profiling for refining delivery of the delivered training. As the data generated was being collaboratively harnessed and channelled in a bespoke personalised way with training participants the opportunity for abuse or risk of ethical violations around its use was regularly tracked and overseen by the participants as well as stakeholders delivering the programme.

One of the biggest issues with the Metaverse is the need for end-to-end encryption in order to protect body image and biometrics. Kryotech's post-quantum encryption algorithms technology was brought into the REAP Platform solution to ensure end-to-end encryption of the voice data as collected through the mobile app. Kryotech specializes in advanced cyber security solutions for the edge of computational innovation. They are a company based around an ethical framework of humanity and ecology before profit, they're passionate about securing our future in the metaverse and ensuring that we own our virtual identities now and forever. As humanity adopts the metaverse ensuring that our personal identities, avatars, and data are secured and protected with post-quantum encryption becomes paramount. Kryotech is passionate about ensuring that our data and digital selves remain our own.

Users were exposed to learning materials that adapted to their analysed vocal inputs. Learning materials were delivered across desktop, mobile and virtual platforms to provide access to as many users as possible of varying levels of technological skill and access. By deploying these novel mechanisms for training machinists, REAP were able to demonstrate increased knowledge retention and absorption in users of the platform during the testing period. Feedback tuned real-time learning is not easily possible outside of a metaverse environment due to the varying nature of each human's capabilities. Therefore, by leveraging enabling technologies REAP were able to provide equitable access to learning and upskilling without disparity between users of different socio-economic backgrounds. The experiences also informed soft-skill development for employability self-empowerment of participants as well as guided the facilitation of collaboration practices and dynamics when doing group immersive activities. This allowed the tutors to become informed of ethical adjustments that needed to be applied for individual challenges and also how approaches needed refining for collective dynamics of the group. This was noticed when teaching participants migrating from individual collaboration literacy development to group collaboration literacy.

6. Case Study analysis – Implications for addressing ethical challenges in the Metaverse

User's metaverse activity and biometric data is captured via an XR headset's sensors. The data is digitally packaged to generate a Digital Identity Dataset that can utilised for enhanced empowering experiences or be exploited for manipulated experiences or controlled commercial gains.

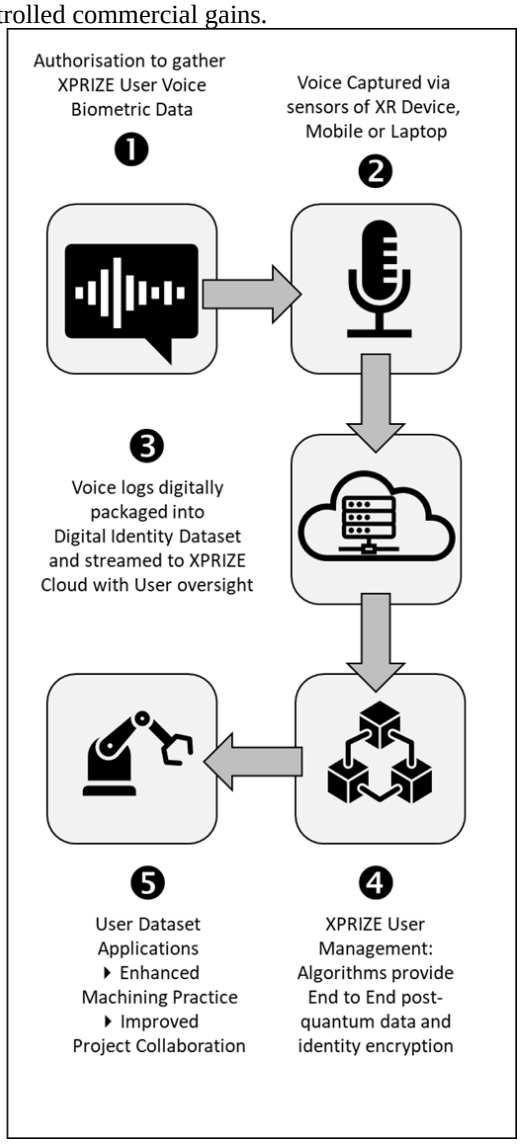


Figure 4. XPRIZE Workflow for Data Capture and Utilisation

These stages are overseen by a version of the Shared Consent Framework shown in Figure 3. The XPrize version of the framework and flow of experience is outlined in Figure 4.

The first stage of the process for taking a participant through Machinist training involves getting permissions and authorisations to capture the user's biometric voice data.

Once authorisation has been obtained the participant is taken through the second stage of capturing voice data through the sensors of an XR Device, Mobile or Laptop.

A third stage ensures the data gathered related to the voice recordings and logs is packaged into a dataset related to the person's identity and streamed to the

XPRIZE Cloud storage in a way that can be monitored and overseen by the participant or user.

A fourth stage running alongside the third stage ensures all processes related to user data capture and transportation are encrypted end to end using post-quantum encryption of identity data. The raw data is then processed data to extract salient features such as emotional state and focus.

The extracted features are then collated in a final fifth stage to generate VR and AR app and in person guidance that will improve focus, learning as well as self-confidence, a delivery stage prescient of future production to be done in Metaverse environments. This is done alongside the practice of machining skills to provide enhanced precision and exercise of skill. In addition, the features observed are utilised to enrich personal development and group collaboration.

Ethical rights were protected throughout by ensuring users had oversight of data gathered, its processing and its sharing. Prior authorisations determined the level of privacy while encryption and user moderation ensured autonomous access. With all this monitoring in place, integrity of data collected and shared, as well as of participant identity was ensured.

These five stages reflect a shared consent process that mirrors what will need to be enshrined in Metaverse related journeys curated via biometrics and encrypted data management to enhance application engagement, experiences, education, and accountable outcomes.

Metaverse experiences, like many existing AR and VR curated experiences, are likely to be experienced at first individually but social elements will inevitably take the experiences down roads that are more interactive as well as collaborative. It may appear that ethical oversight for Metaverse technologies is difficult to enforce at the individual level but that is the priority. When individual oversight is effective then group and community oversight will have more integrity and sustainability.

7. Reflections and concluding remarks- Implications for future users of the Metaverse

In this paper we have explored and reviewed ethical risks and the knowledge gap in in society that needs to be addressed to ensure that users of the emerging metaverse will have a fair and just use of data within the metaverse. We have introduced a Shared Consent Framework and have assessed a case study through the lens of that framework. Our case study analysis of the ethical challenges within the project XPRIZE Rapid Reskilling, REAP, gives an example of how the technology of the Metaverse can be designed with safeguards to protect the user's ethical rights.

In future research we are looking to apply our Shared Consent Framework to other contexts, such as protecting the ethical rights of workers using advanced technologies in the workplace. Further ethical issues in the emergent design of the metaverse will be explored, such as the big challenge of ownership of our digital data, and with that the underlying ethical rights of privacy, integrity, and autonomy [33][34].

With regard to other types of biometric data, the original design of REAP was intended to acquire not just voice but also pupillary reaction data. It was soon realised that pupillary reaction data would not be easily acquirable in most industrial environments without design and making new hardware for distribution to those users. That is pupillary reaction data collection in industrial environments were associated with environmental dust and particulate matter and exposure. Therefore, exploration into environmental factors and effects on various forms of biometric data in industrial environments were slated for future research.

The metaverse promises to be one of the biggest employers of the future. What we need to ensure is that we do not make the same mistakes that we did when we built the 2D internet. Facebook knows us in 2D better than our parents know us, but when we move into 3D, Facebook will know us better than we know ourselves. How can an open metaverse counteract such an affront? How can we educate ourselves in our own contexts as to what the metaverse means to us? What does it mean to our businesses? What does it mean for our relationships, our identities, and the human condition? Further research should seek to answer these questions, to protect our ethical rights of privacy, integrity, and autonomy while still fostering user agency through experiences that are empowering, educational and entertaining.

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