OPINION N°9
METAVERSES: ETHICAL ISSUES

COMITÉ NATIONAL PILOTE
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OPINION N°9

METAVERSES: ETHICAL ISSUES

OPINION ADOPTED ON FEBRUARY 29, 2024, BY UNANIMOUS VOTE OF THE MEMBERS PRESENT AT THE PLENARY ASSEMBLY OF THE CNPEN

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EXECUTIVE SUMMARY

Immersive digital worlds, which are commonly referred to as metaverses, are gaining traction as scientific and technological boundaries are pushed ever further and several digital technology companies continue driving their development. Contrary to what might be suggested by the adjective "virtual", which is often associated with the metaverse, this kind of immersive experience can have significant effects on users, the environment and society. Despite the lack of hindsight for fully understanding all the aspects of the metaverse's effects, particularly in the medium and long term, this opinion by the CNPEN examines the ethical issues involved and provides a set of recommendations with the aim of informing a collective debate on the subject.

Metaverses are built on pre-existing technologies, such as virtual reality, video games and social media, meaning that they inherit the well-known problems that affect those platforms, such as their impact on the environment, personal data management issues, and harassment or manipulation. Although metaverses raise ethical issues that are shared by other types of digital systems, they also create new issues due to their specific nature, especially their suggestive power and power of conviction through the real-time interaction between users and the system, and also through their immersive environment and first-person perspective. In addition, the integrative nature of metaverses has the potential to amplify certain aspects by combining these different technologies. Although scores of reports and books have already been published about metaverses, the CNPEN notes that most agree on the need to think about the ethical aspects involved, but almost none attempts to address the question presented in the introduction to this opinion.

The second part of the opinion focuses on the technical descriptions that are required to develop the ensuing ethical review. Due to the widespread confusion that lingers between metaverses and virtual (or augmented) reality, as well as the technological complexity surrounding these systems, a technical description is vitally important for gaining a clearer understanding of how they work and defining the terminology. Therefore, this opinion describes virtual reality, augmented reality and avatars, which play a central role in the metaverse ecosystem. Since there are many definitions for metaverses, the CNPEN has pragmatically decided to adopt a descriptive approach by listing the main characteristics, i.e. their three-dimensional nature, their temporal persistence, the interactions that they enable, and the ways in which they can be accessed. In the interests of semantic accuracy and scientific rigour, the opinion concentrates on the distinctions between metaverses and other initiatives, such as Web3, blockchains and crypto-currencies. This opinion endeavours to establish the genealogy of the technologies currently in use, while distinguishing those technologies from the pre-existing applications from which they evolved. This opinion also strives to examine their future by proposing three scenarios for their development. Insofar as metaverses operate by integrating a large number of devices (hardware, software, networks and data), and since several stakeholders are involved in their development, implementation and use (researchers, manufacturers, users, public authorities, etc.), this opinion proposes a typology for these main components.

After setting out the technical framework and highlighting the specific features of metaverses, the ethical issues are brought into greater focus and developed in the third part of this opinion. After drawing attention to certain tensions between such principles as respect for personal autonomy, environmental sustainability and fairness, this opinion explains the issues concerning the individual before addressing, in turn, the physiological aspects (impact on the visual system, cybersickness, etc.) and the psychological aspects (dependence, harassment, aggression, etc.), without forgetting the issues specific to avatars (anthropomorphic illusions) and data (protection, information and consent). Then it looks at certain situations where users are potentially vulnerable, including children, teenagers and people with disabilities. The opinion examines the challenges facing society and addresses such matters as access and fairness, influence and even manipulation, responsibility among both manufacturers and users, and sovereignty in its individual, cultural, technological and national forms. The last part of the opinion is devoted to environmental issues, in terms of the resources required to manufacture the necessary equipment and the energy to power it. This last absolutely essential question encourages the prospect of combining environmental ethics and social ethics by calling for the vital need to reduce digital technology's carbon footprint and urge everyone to take a greater sense of responsibility at a time when question marks are being raised about the metaverse's own footprint.

After taking all these factors into consideration, the CNPEN issues a set of recommendations throughout the text in Part III to enlighten public debate on metaverses. They highlight the ethical issues relating to the design, implementation and use of metaverses, which require the following five fundamental points to be taken into account:

- An immersive experience is not neutral and certainly not virtual. It has very real and sometimes intense effects on the individual, our social organisation and the environment in the short, medium and long term.
- Metaverses result from the integration of pre-existing or new digital technologies. They considerably amplify known effects while creating new effects. Therefore, they warrant an in-depth examination involving experts from a wide range of fields.
- It is essential to take account of the physiological and psychological effects that metaverses may have on individuals. Special attention must be paid to potentially vulnerable people, especially children and teenagers.
- Our societies are increasingly being affected by the spread of hate speech and discrimination, as well as by disinformation and hostile information campaigns, which will be exacerbated by metaverses. Societies need to be fully aware of these dangers and take the necessary defensive measures.
- The urgent need to reduce our overall environmental footprint requires, at the very least, a reasoned debate to justify any new applications that could use even more resources and energy.

These recommendations are presented in their entirety below and have been arranged according to whether they are general recommendations or whether they concern individuals, society or the environment.

SUMMARY OF THE RECOMMENDATIONS

In this summary, the recommendations made throughout the body of this opinion are divided into four sections. The first covers general recommendations, while the next three describe those that relate to people (prefixed P), society (S) and the environment (E). A clickable link is used to identify each recommendation, which provides direct access to the associated context described in the rest of the opinion. Similarly, the identifier in the body of the text can also be clicked to return to this summary.

1. GENERAL RECOMMENDATIONS

RESEARCH PROJECTS

(For researchers) Develop multidisciplinary research programmes on a French, European and international level to examine both the physiological and psychological effects of metaverses in the short, medium and long term, with a view to formulating recommendations. Research will need to consider the situations where users are isolated during the immersive experience, since the absence of a third party can amplify some of these impacts and create new effects. Incorporate ethical issues into all these research programmes in liaison with the ethics committees of the associated research institutions. In particular, research projects should:

P1 address the effects on the individual's psychological integrity, such as dependence, harassment, aggression and extortion experienced in an immersive context, or manipulation based on emotional transference and the use of captology techniques when designing virtual worlds;

P10 aim to understand the specific physiological and psychological effects on vulnerable people when using metaverses;

P13 aim to understand the specific physiological and psychological effects on children and teenagers when using metaverses. As recommended by France's Ethics Committee for Educational Data, it is important to understand the potential effects on children's and teenagers' ability to develop their identity before considering any wider deployment of these uses, particularly in schools and extracurricular activities;

P17 identify and analyse the risks of anthropomorphism that may arise from choosing an avatar that incorporates human traits and characteristics into its behaviour;

S10 aim to design behavioural recognition algorithms that are capable of triggering a recording upon detecting what is considered to be a high-risk type of behaviour for the user;

E3 develop a metric for measuring the metaverses' impact on the environment as a system, including the manufacture, durability and recycling of the equipment and hardware on the one hand, and the energy consumption on the other, and consistently display the metric. Define appropriate labelling and certification schemes.

ETHICAL CONSIDERATIONS

(For public authorities, manufacturers, operators and researchers) Carry out ethical studies into:

P21 the use of avatars that look and behave (and talk) like a child or a living or deceased person, with a view to implementing a framework to govern such practices;

P22 the link between preserving anonymity and the obligation for users to authenticate when using digital services.

DUTY TO INFORM

(For public authorities and operators) Bind metaverse operators with an obligation to provide clear and understandable information on the:

P6 physiological effects due to cybersickness that may occur during or after immersion. These warnings must be displayed before users sign in and must be available when offline. In particular, warn users to take a break after an immersive experience before resuming an activity that requires their concentration and attention, such as driving a vehicle;

P11 potential risks, particularly for people suffering from certain conditions or behavioural disorders;

P16 dangers of exploitation concerning children or teenagers;

P18 risks of anthropomorphism;

P19 possibilities for the operator to introduce avatars controlled by a digital system. Consequently, mechanisms should be considered to ensure that users do not forget during their immersive experience that they can interact with these avatars and, if they so wish, identify them as such;

S5 potential modifications to the immersive environment by the operator based on the physiological, behavioural and interaction data collected;

S8 possibilities for disinformation and manipulation from avatars.

2. RECOMMENDATIONS CONCERNING INDIVIDUALS

P2 (For public authorities[1]) Refer the matter to the relevant authorities, particularly ANSES (French Agency for Food, Environmental and Occupational Health & Safety), to follow up on the opinion that it published in 2021 on virtual reality and augmented reality, by extending it to encompass the specific context of metaverses and the new devices available.

P3 (For public authorities) Prevent metaverse manufacturers from developing interfaces that force users to remain online, and when users sign out, prevent manufacturers from depriving them of certain features when they log back in at a later date.

P4 (For manufacturers and operators) To take account of the possibility that cybersickness may occur and cause uncomfortable situations while users are isolated during their immersive experience, implement a procedure enabling users to assess the main risk factors that specifically concern them, especially before their first full immersive experience; for example, investigate the idea of implementing questionnaires or a step-based immersive experience with stopping points and questions.

P5 (For manufacturers and operators) To reduce the risk of cyberattacks and, where applicable, their effects, continually implement the necessary cybersecurity mechanisms.

P7 (For public authorities) Impose mechanisms to make users aware of the amount of time that they have spent connected to a metaverse, such as displaying the time or the daily, weekly or monthly total.

P8 (For manufacturers) Develop protection mechanisms (exclusion zones, immediate disconnection, etc.) that are clearly identified, always available and thoroughly described in the documentation.

P9 (For public authorities) Draw up legislation to classify new types of offences if users suffer a traumatic experience in the metaverse, whether psychological (even where there is no physical aggression) or physical.

P12 (For public authorities, manufacturers, operators and users) Recommend that people suffering from certain conditions or behavioural disorders should either avoid using the metaverse or be accompanied before, during and after using the metaverse at these different stages, and provide advice for carers on the potential risks of using metaverses.

P14 (For public authorities) Without waiting to see the results of any current scientific studies, consider which measures should be taken to protect the youngest users with a view to imposing age restrictions on the use of certain devices such as headsets, and regulate access to metaverses by looking into the prospect of implementing effective parental controls or access restrictions.

P15 (For public authorities) Draw up legislation to classify new types of offences if children or teenagers are exploited while using metaverses.

P20 (For public authorities and operators) Educate users, especially vulnerable people, on the risks of being manipulated or developing an attachment to fictitious entities.

P23 (For public authorities) Investigate the need to strengthen the protection of physiological and behavioural data by classing such data as sensitive within the meaning of the GDPR, and even consider the prospect of banning sensitive processing operations on such data when there is a substantial risk of undermining the individual's privacy or limiting their autonomy, decision-making process and freedom of choice.

P24 (For public authorities) Require metaverse managers to set up a mechanism that respects the principle of data protection by design in accordance with the GDPR, which specifically indicates the risks and types of personal data processing operations; in addition, require metaverse managers to take all measures to prevent a substantial violation of the user's autonomy.

3. RECOMMENDATIONS CONCERNING SOCIETY

S1 (For all stakeholders) Raise awareness and encourage participation in standardisation activities. Create a French and European strategy to drive participation, including at the international level.

S2 (For public authorities) Require metaverse manufacturers to implement technical solutions so that their products are digitally accessible to people with disabilities

S3 (For public authorities) Prohibit the use of the metaverse as the only option for carrying out certain procedures, especially administrative formalities ; maintain the option of using other solutions, particularly involving real people.

S4 (For public authorities) Analyse the existing legal framework to ensure that it can effectively prohibit and punish deceptive or manipulative practices resulting from a modification to the immersive environment according to how data are used and how users interact with the metaverse, while paying specific attention to the use of artificial intelligence systems for this purpose.

S6 (For manufacturers and operators) Develop a settings system that can easily be understood and accessed at all times, so that users can choose from a range of options:

1. National or European.

- Do not adapt the immersive environment (all users who choose this option «see» the same thing).
- Adapt the immersive environment to reflect their explicitly stated interests.
- Adapt the immersive environment to include modifications based on the use of the user's data by the metaverse operator or third-party companies developing activities in the metaverse

S7 (For all stakeholders) Be fully aware of the potential for social harm (disinformation and destabilisation) and the type of anthropological impact when using metaverses, resulting from changes in the relationship between individuals and the relationship between information and knowledge.

S9 (For manufacturers and operators) Implement measures to detect and characterise any illegal acts committed in a metaverse, and identify the offenders. Where applicable, enable evidence to be gathered for use in legal proceedings.

S11 (For public authorities) Assess whether there is any need to adapt — on a national, European or international level — the liability rules to take account of the specific issues, legal problems and ethical issues raised by metaverses, while especially considering European regulations on digital technology.

S12 (For public authorities and operators) Educate users on how metaverses work and raise awareness of the ethical issues arising from their behaviour in metaverses and their effects on other users in the so-called real world. Alert users to the risks associated with their interactions in metaverses with the aim of developing their critical faculties.

S13 (For all stakeholders) Have access to the software and hardware technologies required to develop sovereign metaverses, i.e. allowing for democratic expression that respects national and European values, particularly relating to the scientific, cultural, linguistic, legislative, financial and security aspects.

4. RECOMMENDATIONS CONCERNING THE ENVIRONMENT

E1 (For operators) Before developing a metaverse, think about its purpose and the environmental consequences arising from its implementation and use in order to promote applications that benefit the common good.

E2 (For public authorities) Develop arrangements for sharing the infrastructures and equipment used by public institutions for accessing metaverses. In addition, immersive hardware can be made available to the general public in third places that also provide support for the immersive experience.

E4 (For public authorities) Require manufacturers to display the environmental impact of the hardware used and its energy consumption.

E5 (For manufacturers) Allow users to configure their environment so that they can reduce their energy consumption when using metaverses, such as by lowering the display resolution.

E6 (For public authorities) Prevent manufacturers from developing manipulative interfaces that encourage long connections with the aim of reducing the energy used by immersive worlds.

E7 (For users) Adopt a responsible attitude towards the environmental consequences of using metaverses, especially when acquiring new hardware or using a mobile network.

E8 (For all stakeholders) Consider developing mechanisms to preserve human interaction or compensate for the economic losses sustained by populations living near tourist sites that are reproduced in metaverses.

FOREWORDS

This opinion is a result of the CNPEN's own inquiry into the report entitled "Enlightenment in the digital age", whose Recommendation 30 calls for the CNPEN to "refer the issue of digital worlds and virtual and augmented reality to the CNPEN".

Therefore, this opinion focuses on the ethical issues associated with the deployment of three-dimensional (3D) digital worlds known as metaverses, which incorporate pre-existing technologies and applications such as virtual reality, online games and social media, and which are characterised by their immersive qualities, temporal persistence and widespread use. They offer various types of activities, including online dating, shopping, and visits to tourist sites. Since metaverses are still in the early stages of deployment, it is neither possible nor desirable to offer a definitive opinion about their use. Nevertheless, the ethical issues specific to metaverses can already be identified in terms of their short, medium and long-term effects on individuals, society and the environment. This opinion endeavours to contribute to developing discussions about the ethical issues of metaverses. It examines the topic without any preconceived ideas and is aimed at all the stakeholders involved in various capacities. It offers to help the various interested parties deliver a responsible response to the specific questions raised by metaverses, based on tangible arguments and a rigorous approach.

1. INTRODUCTION

1.1. MOTIVATIONS

Before considering the ethical issues and providing recommendations, it is worthwhile explaining the rationale that prompted the CNPEN to take an in-depth look at metaverses by answering several questions that are often asked about this particular subject[2].

1.1.1 WHY PRODUCE AN ADDITIONAL REPORT ABOUT THE METAVERSE?

In October 2021, Meta (the new name of the Facebook Group) presented its strategic focus of "helping bring the metaverse to life". Since this announcement, scores of publications have appeared with their analysis of the existence, development and potential applications of metaverses, and sometimes making recommendations. These include the report by the interministerial exploratory mission[3], the work of the European Commission and Parliament[4], and publications from numerous think tanks such as CERRE[5], Respect Zone[6] and Renaissance Numérique[7], as well as various works, including the book by Matthew Ball[8]. Other analyses drill down into specific subjects, such as personal data[9] and security considerations[10]. Almost all these documents explicitly mention the need to ask questions about the ethical implications, but virtually none of them actually addresses those questions.

On the other hand, some work has been carried out into the ethical issues, but most of it tends to give greater focus to virtual or augmented reality[11,12] than to the specific context of metaverses, with the exception of the report from the EU-funded TechEthos[13] project, which deals with different technological contexts, including metaverses.

2. The technical concepts used in this section and which concern metaverses and the pre-existing technologies and applications are described in detail in Part 2 of this document.
3. C. François, A. Basdevant and R. Ronfard (2022), Exploratory Mission on the Metaverse, Ministry of Culture - Ministry of Economy, Finance and Industrial and Digital Sovereignty. https://www.economie.gouv.fr/metavers-premier-grand-rapport-exploratoire.
4. European Parliament (2023), Draft report on virtual worlds - opportunities, risks and policy implications for the single market (2022/2198(INI)). https://www.europarl.europa.eu/doceo/document/A-9-2023-0397_FR.html https://www.europarl.europa.eu/doceo/document/IMCO-PR-751902_FR.pdf
5. F. di Porto, D. Foà (2023), Defining virtual worlds: main features and regulatory challenges. CERRE, *Issue Paper.*
6. Respect Zone (2023), Toolbox report, How to build metaverses that promote respect and diversity? https://www.respectzone.org/metarespect.
7. Renaissance Numérique (2023), Representations and uses of the metaverse. https://www.renaissancenumerique.org/publications/representations-et-usages-du-metavers
8. M. Ball (2023), The Metaverse: And How It Will Revolutionise Everything. *De Boeck Supérieur.*
9. CNIL Digital Innovation Laboratory (2023), Data, Footprints and Freedoms, *IP Report* no. 9.
10. Interpol (2022), Technology assessment on the Metavers. https://www.interpol.int/content/download/18440/file/INTERPOL%20Tech%20Assessment-%20Metaverse.pdf
11. D. Adams, *et al.* (2018), Ethics Emerging: the Story of Privacy and Security Perceptions in Virtual Reality, Fourteenth Symposium on Usable Privacy and Security (SOUPS 2018).
https://www.usenix.org/conference/soups2018/presentation/adams.
12. M. Slater *et al.* (2020), The Ethics of Realism in Virtual and Augmented Reality, *Frontiers in Virtual Reality,* vol. 1. https://www.frontiersin.org/articles/10.3389/frvir.2020.00001
13. *TechEthos* D2.2: Identification and specification of potential ethical issues and impacts and analysis of ethical issues", L. Adomaitis, A. Grinbaum, D. Lenzi. (2022), https://zenodo.org/record/7619852

1.1.2 WHAT IS NEW ABOUT THE ETHICAL ISSUES RAISED BY METAVERSES?

Metaverses are built on a number of pre-existing technologies, mainly virtual or augmented reality, massively multiplayer online games and social media. Therefore, questions need to be asked about whether metaverses are specific in terms of the ethical issues that they raise. First of all, it can be seen that they inherit a number of well-known issues, such as environmental impacts, personal data, and harassment or manipulation, while bringing a new dimension to those very issues. Therefore, metaverses spawn a new set of problems when it comes to the data collected, which are much more voluminous and of a different nature (particularly physiological), compared to the data collected when browsing the web or interacting on social media.

In addition, the evocative and persuasive power of immersive visualisation significantly amps up some of the effects experienced when using metaverses. If any convincing were needed, compare the persuasive power of an oral description of a specific situation, a text that explains the situation, a photo depicting the situation, a video showing the situation and finally the creation of a 3D digital world that reproduces the situation and in which users can move about to change their perspective, and interact with certain elements or other people represented by avatars. This progression, which can be attributed to developments in technology, can be summarised as follows: I heard (oral tradition), I read (printed text), I saw (photo), I watched (cinema) and I experienced (metaverse).

Lastly, new questions have emerged, such as the physiological effects of wearing a headset for long periods of time by users who are sometimes minors. These differences are described in detail in Section 2.1.3 Where do metaverses derive their knowledge?".

Finally, it is important to stress that combining these different digital technologies does not produce a cumulative effect, but considerably amplifies each of their consequences. Therefore, the originality of **metaverses lies in their integrative** nature, meaning that they should be analysed as such.

1.1.3 HOW CAN WE EXAMINE AN INTEGRATIVE TECHNOLOGY THAT IS STILL BEING DEPLOYED?

There are currently no studies that offer an in-depth analysis of metaverses and their effects, since the technology is still being rolled out. Consequently, full advantage needs to be taken of the work being done on the pre-existing technologies and applications (i.e. the foundations of metaverses), whether virtual reality, video games or generally digital technology. Naturally, these analyses are not perfectly suited to metaverses, and it is essential to take account of the differences between the technologies when interpreting them. One of the main shortcomings is the lack of hindsight when observing how metaverses are used. Therefore, a long-term analysis must be carried out by means of longitudinal studies.

1.1.4 CHOSEN APPROACH

The development of metaverses elicits a number of questions about their ethical implications, and the aim of this opinion is to inform and help anticipate the deployment and uses, irrespective of the terminology that could be used in the future to designate metaverses. The second part of this opinion examines the very notion of metaverses. What are they exactly? Where do they source their pre-existing knowledge? What could they be used for? These are just some of the questions that need to be addressed before the ethical issues can be examined in part three.

In November 2022, France's Minister of Education asked the CEDE (Ethics Committee for Educational Data) to consider the ethical issues in the specific field of education and thereby contribute to the broader debate being conducted by the CNPEN. The CEDE's opinion has been appended to this document.

INSET

TERMINOLOGY

In this opinion, the term **virtual** is rarely used. In French[14], it describes what is potential or possible (cf. Larousse and Robert dictionaries, etc.), whereas it is often used in English to refer to, and sometimes confuse, either the digital world or the imaginary world (*cf. Section 2.2.2 Terminology*), like the expression "virtual reality", which surprisingly combines reality and imagination[15]. The rest of this opinion highlights the very real and observable consequences of an immersive experience, whether in terms of the environmental repercussions or the effects on users, which illustrates the risk of the misunderstandings associated with the use of the term "virtual".

Furthermore, *metaverse* is a contraction of meta and *universe*. In French, it has been translated as **métavers**, which is often used in the plural form in this opinion. The technical conditions to qualify the metaverse as a single space are currently not fulfilled. Most systems will not be interoperable in the short or medium term, meaning that experiences and data cannot be shared between competing systems using proprietary standards (*cf. Section 2.1.5 The future of metaverses*). An analogy can be drawn with the web, whose emergence was only possible after the standards shared by all interested parties were adopted several years after the Internet first appeared.

14. As is often the case in IT, the literal translation of an English expression into French results in misinterpretations and even errors. The word "digital" is a prime example (which does not exist in French in this particular sense).
15. Some authors (like M. Krueger from the 1970s) prefer to use the expression "artificial reality", while others opt for "simulated reality". The term "virtual reality" is used in this opinion, because it has long been used by nearly all the stakeholders in this field.

1.2. ETHICAL ISSUES

1.2.1 HOW SHOULD WE THINK ABOUT METAVERSES?

Metaverses raise similar ethical issues to other technologies, such as virtual reality, social media[16] and online gaming, but they also lead to new questions due to their specific characteristics, especially the need to take account of real time, immersion and first-person embodiment. For example, questions might be raised about the effects that could be observed in the so-called real world following an immersive experience in a metaverse[17]. It should be emphasised that these effects, and therefore the ethical issues arising from them, will vary significantly in the short, medium and long term depending on the individual, the hardware and the adopted uses. However, they must be fully taken into consideration from now on, even though their harmfulness has yet to be fully proven[18].

1.2.2 WHAT ARE THE ETHICAL TENSIONS?

Before we can provide a detailed description of the main issues that metaverses pose for individuals, society and the environment (Part 3), it is important to clearly understand how they have evolved, how they work and how useful they are (Part 2). However, this section already addresses some of the general ethical tensions, since they do not require any detailed knowledge of the metaverse.

The first of these tensions concerns the underlying **raison d'être** of a metaverse. Many projects aimed at developing such systems were launched shortly after the Facebook Group announced at the end of 2021 that it would focus on developing the metaverse and change its name to Meta[19], mainly out of fear of missing out on an important step in the technology's development. It was more of a "defensive" move (to avoid losing out on a development opportunity) than an offensive one (using a metaverse to meet a need). This "follow the herd" mechanism has been amplified by the availability of the underlying technologies, which are now mature enough to be scaled up. In other words, since innovation exists, it should be implemented without any other form of motivation. This reflex of equating innovation to progress is implicit for some and explicit for others, and warrants careful consideration[20].

A second tension arises when considering the **justification** for developing a metaverse (in the sense of demonstrating its usefulness). On 15 February 2023, a Colombian court inaugurated a virtual hearing using *Horizon Workrooms* in Meta's metaverse[21]. On 30 March of the same year, the Dubai International Arbitration Centre (DIAC) announced that it was launching a metaverse for its dispute resolution services, while underlining its commitment to promoting sustainability and respect for the environment[22]. SWhile the parties promoting these initiatives offer various justifications for their use (relieving congestion in the courts, limiting physical travel, etc.), the reasons given may sometimes lack coherence and conceal motives that are less than virtuous. How can we be sure that holding a hearing in a metaverse would be a more effective solution than organising a videoconference to ease pressure on the physical infrastructure? How can we measure whether the deployment of a metaverse is justified on environmental grounds, given the resources needed to manufacture the necessary hardware and the energy to power it?

A third tension arises when arguments based on a user's **freedom** to act in a metaverse are confronted with arguments relating to the **consequences** of that user's behaviour for other users. Some of the parties advocating these systems argue that it is vitally important to provide a space of almost total freedom in a digital world. Others even claim that if certain users are going to carry out malicious and even objectionable acts, then it is preferable for them do so through their avatars in an imaginary world than in real life. On the other hand, it is essential to consider what effects those acts will have on other metaverse users who could potentially end up being the victims. La section 3.2.2 "Psychological issues" describes the very real and sometimes enduring consequences caused by certain types of avatar-based behaviour, such as harassment or assaults.

Despite the trials, tribulations and uncertainties, discussions on the ethical issues are essential for ensuring that innovation gives greater consideration to the environment and also to humans and their organisations[23]. While some of the risks outlined in this opinion have already been documented (the risks associated with online gaming, social media and virtual reality), it is important to examine them in relation to metaverses which, due to their specific characteristics, may amplify or accentuate the risks. Other risks appear to be specific to these immersive worlds, even though it is not always easy to define them, insofar as these are emerging technologies and there is not yet sufficient hindsight to know the medium or long-term effects. Instead of getting mired in conjecture, this opinion aims to set out the fundamental ethical dilemmas underlying the metaverse as clearly as possible (cf. Partie 3 "Ethical considerations and issues").

16. S. Broadbent, F. Forestier, M. Khamassi, C. Zolynski (2024), Pour une nouvelle culture de l'attention. Que faire de ces réseaux sociaux qui nous épuisent ? *Odile Jacob*.
17. A. Lécuyer (2023), *U*nderstanding the metaverse: the effects of immersive technologies on your brain, published by *Alpha / Humensis*.
18. An analogy can be drawn with the introduction of new drugs, which are subject to a preventive mechanism before they are placed on the market. In both cases, the risks of side-effects for users have been proven.
19. https://about.fb.com/news/2021/10/facebook-company-is-now-meta/
20. The danger lies in losing sight of the difference between innovation and progress, P. Lecomte, :*Le Monde,* 01/09/23 : https://www.lemonde.fr/idees/article/2023/09/01/nouvelles-technologies-le-danger-est-de-ne-plus-pouvoir-differencier-innovation-et-progres_6187375_3232.html
21. https://www.youtube.com/watch?v=LXi2TX9OBmQ&t=7530s
22. https://www.zawya.com/en/press-release/government-news/dubai-international-arbitration-centre-launches-its-metaverse-for-next-generation-dispute-resolution-gtl665he
23. R. Chatila (2022), "Bioethics and digital ethics: a paradoxical hybridisation", in "For ethics in digital technology", CNPEN, coordinated by E. Germain, C. Kirchner, C. Tessier, *PUF,* Paris, pp. 27-39. 27-39.

2. TECHNICAL DESCRIPTIONS

2.1 METAVERSES

2.1.1 WHAT ARE THEY EXACTLY?

Nowadays, there are many different definitions for the metaverse. Development projects are driven by a very mixed range of stakeholders, all with their own vision of what a metaverse means, which leads to what can only be described as a cacophony. For example, content producers, headset / graphics card manufacturers and metaverse system designers will tend to differ in their interests and understanding of the metaverse.

Since it may seem pointless criticising the various existing definitions, this opinion proposes **a description** of the metaverse that will serve as a basis for the analyses and recommendations in the rest of this document. This description covers most of the meanings currently encountered.

A metaverse has a number of characteristics that can be grouped into four main categories: **the 3D digital world** that supports the metaverse, its perception by users, **the interactions** that it enables, and the ways in which it can be **accessed.**

- It is a digital world (sometimes called an environment) that is modelled in three spatial dimensions (3D) and which represents a part or extension of a real or fictional world; as such, it responds to the laws of physics, whether real (such as gravity) or imaginary (such as teleportation). In all cases, it offers temporal persistence (*cf. Real time management*). A metaverse contains settings (natural landscapes, urban environments, objects, etc.) in which avatars (featuring realistic or unrealistic appearances and behaviour) move around, most often representing users and controlled by them, but some of which can be controlled by pure software systems (including algorithm-powered artificial intelligence systems) *(cf. Section 2.4 Avatars)*. These environments are initially developed by the metaverse manufacturer, but may subsequently be enhanced by users.
- These worlds can be perceived through images (always), sound (often) and touch (sometimes) using conventional devices (screens, loudspeakers, etc.) or specialised hardware (headsets[24], and haptic devices[25]). Users perceive these worlds either in virtual reality (VR), where all the visible elements are computer-generated, or in augmented reality (AR), where computer-generated elements are superimposed on the user's natural vision (*see Sections 2.2 and 2.3*).
- Through their avatars, users can wander around these worlds and carry out a variety of activities, such as meetings, conversations, purchases or sales, tourism, sport, entertainment and information. To do so, they interact with the 3D environment or other avatars using conventional devices (keyboard, mouse, microphone, etc.) or specialised hardware (controllers, position and/or movement sensors, etc.).
- These 3D worlds and their perceptions can be accessed over a computer network by a very large number of users who are basically unknown to the system administrators.

Pexels, Photo Eren Li

A person interacting with a digital world using a headset and controllers

24. Some believe that immersion is a prerequisite for the metaverse, while others consider that it is merely an option. Immersion is clearly a fundamental aspect (because it induces presence and therefore adhesion), but not all users will necessarily own a VR headset. Therefore, some metaverses providing an immersive experience also offer simplified versions for computer screens and smartphones.
25. Related to the sense of touch; haptic feedback refers to the production of sensory information, such as the vibration of a telephone or the force exerted by certain video game joysticks.

INSET

REAL TIME MANAGEMENT

In metaverses, time can elapse in two different ways:

- **Real:** time passes as in everyday life and can even be aligned with a specific time zone.
- **Artificial:** time may be slowed down or accelerated, and night-time might never come[26] or instead be shortened.

In all cases, time is constantly evolving, because the metaverse is always accessible. As a result, when users return to a metaverse after disconnecting, they find that the 3D world has changed. For example, other users have performed actions (their avatars have moved, started conversations, changed clothes, etc.), a new store has opened in a shopping centre, or a show has taken place. This is known as **temporal persistence.**

In addition, a metaverse offers two types of communication between users:

- **Synchronous:** this type of communication is carried out in real time, which allows for simultaneous two-way conversations as in everyday life, where people can see and hear each other. This is the most common type of conversation in metaverses.
- **Asynchronous:** this type of communication comes with a delay (ranging from virtually zero to infinity) between the time when a person sends a message using a specialised service and the time when it is seen "later" by the recipient. The message can be static (such as an SMS, email or letter) or dynamic (like a video or voice memo).

Metaverses can be divided into two main families:

- Metaverses focusing on a specific subject, such as a brand selling its products or services (to the exclusion of all other retailers) or a tourist site offering immersive tours. In this case, the metaverse operator will have total technical autonomy in developing the 3D environment, will register users and will directly receive the profits generated by user spending.
- Metaverses offering general-purpose content and hosting a wide variety of [sub-]metaverses, such as a shopping centre with different stores, cultural or sports venues for spectators, or meeting places. In this second case, the operator of a hosted [sub-]metaverse will need to use the technical features provided by the platform operator to develop its environment, comply with the specified rules and pay part of its profits to the operator.

INSET

WHAT ARE METAVERSES NOT ABOUT?

The terms metaverse and **web 3**[27] are often associated and sometimes even confused with each other, so a distinction needs to be drawn. Web3 is an initiative aimed at "giving power back" to users, particularly in terms of content creation and control, by setting up decentralised infrastructures, unlike the current situation. Some analysts believe that this initiative will become the norm and that the metaverse will simply act as an entry point. This prediction cannot be shared, mainly because it will be a long time before there is a single metaverse. There will be many different systems instead, and clearly not all of them will be interoperables[28] (*cf. Section 2.1.5.1 Interoperability*). In addition, the wide range of hardware on the market means that immersive access is not available to all users. Although users create some of the metaverse content (parts of 3D digital worlds, such as stores, meeting places and buildings), the core of a metaverse is certainly too complex to be built by users. Consequently, companies take responsibility for building the metaverse and opt for either a centralised or decentralised architecture.

Finally, **blockchains**[29], **crypto-currencies** and **non-fungible tokens** (NFT), which are often used to justify the confusion between Web3 and metaverses, are not of the same breed as metaverses, which do not use all of them, especially since some operators want to retain total control over their data streams. Similarly, the concepts of dynamic 3D and real time, which underlie metaverses, are not prerequisites for Web3. Some metaverses will be accessible *via* Web3, while others will be accessible through today's web architecture. These are two different technologies, but they could potentially be complementary in certain contexts.

26. As in games rooms where the only light perceived is artificial (no windows opening onto the outside), so that gamers are disconnected from reality and encouraged to play for longer. Another advantage is that it reaches out to a wider group of users, whatever their time zone.
27. This should not be confused with the semantic web, which is sometimes called Web 3.0, where data are enriched with semantic metadata for the purpose of sharing data and reasoning, and facilitating global updates.
28. In the same way that the concept of the Internet (short for internetworking) did not see the light of day until several years after the first networks had appeared, all of which were proprietary.
29. Technology designed for securely sharing information between users (without a centralising mechanism). https://www.economie.gouv.fr/entreprises/blockchain-definition-avantage-utilisation-application).

2.1.2 HISTORY

2.1.2.1 THE DAY BEFORE YESTERDAY

From the 1960s onwards, science fiction was a breeding ground for descriptions of imaginary worlds that large numbers of users could access through technological devices, such as headsets. The term metaverse first appeared in 1992 in Snow Crash[30], a novel written by N. Stephenson in which the author describes a futuristic universe with a digital world, an evolution of the web, that users can access with a headset.

It was also during this period that the first deployed systems (which could be described as metaverses) started emerging. These systems offered services that are found in current development projects:

- Active Worlds (1995-) comprises around 100 3D digital worlds that users can explore with their avatars and upgrade with their own creations.
- Le Deuxième Monde (The Second World) was developed by the Canal Plus studio between 1997-2002, in which "second worlders" could wander around a recreation of Paris to meet up or shop in stores.
- Second Life (2003-) is based on user-generated content and features a specific currency, the Linden Dollar, which can be converted into real currency.

2.1.2.2 YESTERDAY

By the end of October 2021, Mr Zuckerberg announced that the Facebook Group (Instagram, WhatsApp, etc.) would henceforth be called Meta, explaining that the main objective was "to help bring the metaverse to life", a digital world where users could find friends and purchase products and services. Almost at the same time, Chinese Internet giant Baidu announced a few weeks later that it was launching its own metaverse, called XiRang[31]. The months that followed saw a spate of similar announcements from companies operating in a wide variety of fields, including retail (mass market, luxury goods, etc.), art, sport and education. These were accompanied by a large number of comments, both enthusiastic and hostile, meaning that it is hard to provide a balanced analysis.

A year later, Meta released an internal document that gave a mixed assessment of the development of its Horizon Worlds metaverse and subsequently sacked several developers assigned to the project, while Microsoft announced that it was closing AltSpace VR, its own metaverse. These announcements triggered a new avalanche of articles claiming that the death knell had been sounded for metaverses[32], with some articles explaining that these metaverses would amount to nothing. This trend was reinforced shortly afterwards by the media storm surrounding generative artificial intelligence systems, particularly ChatGPT. A number of "experts" explained that many companies would immediately shelve their metaverse plans and instead invest their money into developing AI systems.

It cannot be denied that metaverse manufacturers ran into a number of difficulties, but it is important to analyse the current situation with a certain degree of objectivity, without succumbing to the unbridled enthusiasm or excessive pessimism that we have just described. We have been witness to the hype that is often seen in other fields. Many articles have confused (and continue to confuse) a phenomenon with comments on that very phenomenon. The fact that fewer articles are being published about metaverses in no way proves that they are heading into oblivion.

We will go back to Meta's internal memo, which spelt out Mr Zuckerberg's target in October 2021 of achieving 500,000 active users of Horizon Worlds. However, they were 300,000 active users early 2022, and only 200,000 by October 2022. So not only had the target not been reached, but also 100,000 people abandoned the application after using it. The main reasons given were the lack of realistic avatars (represented only by the upper part of the body), the lack of activities and services and, above all, the low population density, which made for uninteresting experiences. This observation raises questions about the rationale for developing metaverses. What is their purpose? To meet what user needs or expectations? These are just some of the questions that have been ignored by certain metaverse developers, who sometimes appear to have embarked on this commercial gamble for fear of seeing an opportunity slip by. This period seems to be over, and these questions about the meaning of the metaverse are now central to most development projects.

In addition, there does not appear to be any justification for the opposition between metaverses and generative AI. A digital world's success hinges on its ability to create a sizeable population, either by attracting a large number of users or introducing digitally-controlled avatars that are capable of interacting credibly with human users. Yet this is exactly one of the areas where generative AI systems continue to excel, which leads us to predict that the development of these technologies will encourage the development of metaverses. Since it is hard to be certain about what future lies in store for metaverses, *Section 2.1.3 "The future of metaverses"* presents several prospective scenarios, ranging from their widespread adoption through to their disappearance.

2.1.2.3 TODAY

There are a large number of systems in use today. There is no value in listing them all in this opinion, so just a few will be mentioned by grouping them under different keywords:

Pioneers

- FortNite, was originally developed to provide users with a venue for taking part in multiplayer battle games and sharing their own creations. Fortnite is evolving into a platform that also offers social areas, marketplaces and concerts.

30. The book's title was translated into French as *The Virtual Samurai* in reference to the pseudonym used by one of the novel's heroes in the metaverse.
31. https://www.lefigaro.fr/secteur/high-tech/le-geant-chinois-baidu-fait-ses-premiers-pas-dans-le-metavers-20211227
32. https://usbeketrica.com/fr/article/adieu-metavers-petit-ange-parti-trop-tot

- Roblox, allows users to develop their own games and then offer them to other gamers, often for a fee. Gamers are represented by their avatars, whose appearance can be enhanced by purchasing accessories with Robux, which can be converted into US dollars. The platform also stages events (concerts, ceremonies, etc.).
- Sandbox, is a French initiative that adopts the same principle of developing and sharing its games by supporting them with the Ethereum blockchain, while offering its own tokens (Sands) for purchases on the platform.

Metaverse publishers (sometimes called design studios)

- For building digital spaces for brands to share content, access retail spaces, take part in "exclusive" events, or host meetings, recruitment interviews, training courses and so on.
- Horizon Workrooms (Meta), Mesh (integrated in Microsoft Teams), Spatial.io, Virbela, etc.

Immersive social media

- For developing relationships with users who are often strangers, and sometimes hosting events.
- Sansar, VR Chat, etc.

2.1.3 WHERE DO METAVERSES DERIVE THEIR KNOWLEDGE?

Science fiction, which came up with the ideas and scenarios that inspired many metaverse projects.

Virtual reality (VR) and **augmented reality** (AR) (*cf. Sections 2.2 and 2.3*), which for several decades have led to the development of software and hardware for immersing users in digital worlds.

Online games[33], which were pioneers in developing massively multiplayer online game platforms, have recently expanded beyond their core business to host such events as concerts.

Social media, which have long enabled people to discuss and chat, and whose metaverses could represent a form of evolution[34].

While the development of metaverses is powered by pre-existing knowledge and technologies, it is important to draw a distinction between the properties inherited from these original fields and their own specific properties. In the rest of this opinion, these distinctions will help differentiate between the ethical issues that are similar to those in the above-mentioned fields and those that are specific to metaverses.

2.1.3.1 SIMILARITIES

It is worth noting the similarities that exist between metaverses on the one hand and virtual reality applications and online games on the other, while distinguishing between those that are always present and those that are optional.

Virtual reality applications

First of all, attention should be drawn to the **evocative and persuasive power** of a 3D environment, whether seen in a virtual reality application or a metaverse. In both situations, users view the 3D world interactively, i.e. performing an action (moving, grabbing an object, etc.) causes the system to display a new computer-generated image of the 3D scene, which gives a sense of movement[35].

In addition, users do not see the 3D scene globally "from above", but from a position and viewing direction that correspond to the avatar's eyes, which are slaved to their movement. This **interactive first-person view** significantly reinforces the impression of belonging to an imaginary world.

Then there is the capacity for immersion, which causes users to **feel as though they are present**[36] in the imaginary world (*cf. Section 2.2.2 Terminology*). This feeling is the very basis of how virtual reality works. If users do not feel as though they are present, then they do not engage and they fail to transfer the skills and emotions experienced in the immersive environment into the real world (e.g. during a training course where the skills acquired in the virtual reality world are then used in a real-life situation)[37].

This feeling of presence can be reinforced by several other characteristics of an immersive experience, such as reproducing coherent sensory information other than sight (sound and touch) or displaying a user-controlled avatar, which allows users to better identify with the experience.

Online games

In addition to the evocative and persuasive power of a 3D environment described in the previous section, there are several points in common between [massively multiplayer] online games and metaverses. The first is the very **large number of users** connecting online[38]. There is no way of knowing exactly who the users are (such as the number of users and their age, abilities and motivations), since there are so many of them and also because online gaming most often requires anonymity.

33. This document deals with so-called massively multiplayer online games (involving tens or even hundreds of millions of users). This term is often abbreviated as MMOG or MMO.
34. Rappelons que l'annonce de Meta est apparue au moment où Facebook devait faire face à des critiques de la part de ses utilisateurs et subissait pour la première fois des pertes financières considérables.
35. In the same way as watching a film with a frame rate of 24 still images per second..
36. It is important to make a clear distinction between immersion, which is a means, and presence, which is the end. The first case concerns the technological elements, such as the screen definition, 3D view and realistic computer-generated images, whereas the second case relates to the psychological context of experience.
37. A.Grinbaum et L. Adomaitis (2022), "Moral Equivalence in the Metaverse", *Nanoethics 16*, 257–270.
38. Although it is hard to obtain accurate figures, it is estimated that Fortnite had hundreds of millions of registered users and tens of millions of active gamers by the end of 2023.

The second point in common is **temporal persistence.** In other words, when a user leaves the system, time carries on ticking in the metaverse. So when users reconnect, the environment has very probably changed (avatars have moved, etc.) (*cf. Section 2.1.1 What are they exactly?*).

The third point in common is the **permanently displayed avatars,** both in online games and in metaverses, so that users constantly perceive the location of their avatar in the 3D digital world, as well as the presence and behaviour of other avatars.

Finally, many online games, just like metaverses, allow users to modify the 3D digital world as part of a collaborative **development** process.

2.1.3.2 SPECIFIC FEATURES

It is important to highlight the key differences between metaverses and pre-existing technologies and applications. Firstly, it should be noted that users accessing the metaverse with a virtual reality headset cannot share the images with any people in their vicinity. This specific design feature of the technology has the effect of isolating users by preventing them from interacting and talking with those people (such as discussions between parents and children about an online game or video).

Virtual reality applications

Virtual reality applications, which were confined to the professional world (mainly research and industry) for several decades, have gradually been opened up to the general public, especially with the development over the last 10 or so years of hardware (headsets[39], and sensors) retailed at a much lower cost[40] than older hardware. The specific features mentioned in the rest of this section relate mainly to professional virtual reality applications, for which there are many studies based on decades of experience.

A professional reality application usually brings together a limited number of users - often just one, sometimes a group of people using headsets, or people located in one (or more[41]) immersive rooms[42]. Most of the time, these users are adults who have been trained to do a job and are motivated by the idea of accomplishing a set of defined tasks, all of which are perfectly identifiable. When users are not trained professionals, they are supervised by experts, such as for field studies carried out in virtual reality with participants to test scenarios, particularly design scenarios. Participants are then accompanied: 1) before: by describing the experience to be carried out and informing them of any risks, 2) during: by monitoring their reactions and providing assistance in the event of a problem and 3) afterwards: by commenting on the experience and encouraging them to take a moment's rest before resuming their normal activities.

In addition, the duration of most virtual reality experiences in a professional context are limited, since the objectives are accurately described and also because users tend to exhibit a certain amount of weariness when using this technology for "an extended period of time".

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Therefore, the specific features of metaverses are beginning to come into clearer focus, such as the potentially **very high number of users,** and especially the fact that users are basically **unknown** (possibly minors or vulnerable people) and sometimes **left to their own devices** for what can be a **long** time, with **temporal persistence** and always **with avatars.**

These features can be illustrated with a few examples that compare metaverses with virtual reality applications in different fields[43] :

- Training:
  - A VR-based vehicle driving simulator[44].
  - A practical work session in a metaverse where learners can move around and act in a 3D room, carry out digital actions, chat with fellow students that they do not know, and ask the trainer questions.
- Tourism:
  - An *in-situ* visit to a tourist or archaeological site, enhanced by the use of virtual reality tools[45].
  - Visit a site anywhere via its representation in a digital world, with the possibility of talking to other visitors, a tourist guide or an archaeological expert via their avatars.
- Sport:
  - Individual physical exercise with a virtual reality application[46].
  - A sports competition bringing together competitors from different geographical areas, but competing in the same digital world through their respective performances.

Online games

39. In 2014, Facebook acquired Oculus, which was one of the first companies to offer virtual reality headsets at a price that was below the market average at the time, while still offering good performance.
40. The order of magnitude varies from tens of thousands of euros to a few thousand, and then a few hundred. This trend is continuing in the same direction and can be seen, for example, in the promotional campaign organised late 2023 by a French ISP offering VR headsets for around €300 in return for signing up to its fibre broadband plan.
41. Before the term "metaverse" emerged, specialists used the expression "Collaborative Virtual Environment" (CVE) to designate digital worlds that could be accessed for professional use (design, maintenance, etc.) by many users spread over several geographical sites.
42. Users do not wear a headset, but are surrounded by large screen walls (several metres high and several metres wide), forming a cubic, parallelepiped or cylindrical room that isolates them from the outside world.
43. Section 2.2.3 "Applications" lists the main areas of application that use virtual reality.
44. https://www.youtube.com/watch?v=V0I-2uaweuI
45. https://www.youtube.com/watch?v=So_4UzvyPO4
46. https://www.youtube.com/watch?v=H9VHUeSK0w0&t=44s

When looking at the primary function of an online game, it can be seen that all users are focused on achieving a common set of objectives, with all participants playing by the same rules. Even though some metaverses have initially specialised in a specific subject, developing interoperability will gradually improve interconnectivity and therefore lead those metaverses to cover a wide range of themes. Consequently, there will be different reasons for using and engaging with immersive experiences.

Social media

If metaverses and social media are compared by distinguishing between different categories, several specific features can be observed, the first of which relates to the **real-time** nature of the experience: a user's immersive experience is synchronous (live with no perceptible lag between the user's (inter)actions and those of other users), whereas participation in social media is generally asynchronous.

The second specific characteristic relates to the **instantaneous nature of exchanges** in a metaverse and on certain social media platforms (Instagram and TikTok), whereas they can be viewed at a later date on other sites (X, Facebook and WhatsApp), meaning that histories can be compiled and exploited, such as to provide evidence of malicious behaviour.

All these observations can be summarised in the table below. A blue circle means that the characteristic is always present, whereas a white circle relates to cases where the characteristic is optional:

	VR[47]	OG	SM	MV
Modification of the environment by users		●		●
Real-time 3D visualisation	●	●		●
Immersion (headset)	●			●
Haptic information	○	○		○
Avatars	○	●		●
Temporal persistence		●	○	●
User knowledge	●	○	○	○
Single theme	●	●		○

Note that these properties can be observed in most cases, but a few counter-examples can obviously be shown. For example, some online games are in 2D, while others have no temporal persistence.

Finally, it should be emphasised that this type of analysis (especially in the last two rows of the table) is subject to change, due to the fact that these technologies and particularly their uses are constantly changing.

2.1.4 WHAT CAN METAVERSES BE USED FOR?

Since metaverses can potentially affect all sectors of activity, it appears to be illusory to draw up an exhaustive list of existing or expected applications, while raising questions about their real added value (*cf. Section 1.2.2 What are the ethical tensions?*). However, a few examples can be described, starting with **commerce,** which is undoubtedly the most widespread motivation among metaverse developers. Although the web established the concept of online commerce, metaverses have the potential to amplify the level of trade in goods and services. Users can wander through 3D streets and shopping centres, where they will come across familiar names. They can view the products, ask a sales assistant for help, invite a friend or parent, and chat with other consumers, all of which with their avatars. Companies offer an array of services covering many different dimensions, from goods (a table) and services (travel) in the real world to goods (clothing for an avatar) and services (access to a concert) that can be used in the 3D digital world.

Metaverses provide companies with improved user profiling[48] compared to the performance of current online commerce (*cf. Section 2.5 Deep user profiling*). Virtual reality technologies consistently capture the user's position and viewing direction to produce a computer-generated image based on the user's movements. By combining that data with other analysed information (interactions with other people, purchasing decisions, etc.), retailers can gain a detailed insight into customers' interests and subsequently modify the digital environments that avatars are currently using, such as by highlighting given stores in shopping centres or (over)populating the streets with vehicles of a certain brand, thereby profoundly changing **advertising** practices (*cf. Section 3.2.2 Influencing and manipulating people*).

Education and **training** are favourite areas for metaverse operators. Metaverses can be used to combine the potential benefits of online courses (such as MOOCs[49], where learners follow a distance learning course comprising videos from a tutor, course materials and assessments) with those provided by the presence and interactivity of immersive experiences. For example, they allow for a hands-on session where learners simulate handling chemical products on a lab bench with 3D-modelled test tubes, while consulting the course content and discussing with fellow students and the tutor via their avatars.

47. VR: virtual reality, OG: online gaming, SM: social media, MV: metaverse.
48. A study carried out early 2023 showed that it was possible to identify one person out of 50,000 after analysing 100 seconds of motion in virtual reality with close to 95% accuracy (73% after 10 seconds); this is no longer a case of profiling, but establishing an individual signature. https://arxiv.org/abs/2302.08927
49. Massive Open Online Courses

Healthcare is already making extensive use of virtual and augmented reality technologies, which is destined to usher in a renewal of the sector's medical practices. Metaverses bring an additional dimension, such as by allowing users to remotely consult with a doctor or surgeon through their respective avatars and view a 3D anatomical reconstruction so that practitioners can better explain the patient's condition or planned surgery. In the mental health field, metaverses will enable addiction support groups to organise immersive meetings that combine the credibility of oral discussions between avatars with anonymity (partial or total) for participants wishing to withhold their identity. Chatbots associated with avatars could also be set up to offer assistance at any time of the day, provided that appropriate supervision is provided by practitioners and that patients give their free and informed consent.

The **cultural** sector, especially the performing arts, is taking a keen interest in the possibility of reaching out to a wider audience (overcoming the constraints of location or time) as well as fostering dialogue between artists and spectators to create more interactive performances. The **film** industry should allow for the prospect of interactive storytelling, leading to different experiences depending on the choices made by spectators, who could become partial actors (in the sense of decision-makers).

It is also worth mentioning the level of attraction shown by the world of **sport,** whether for creating an enhanced spectator experience (choosing their seat in the stands or sitting as close as possible to the athletes to see different aspects of their performance), or for individual practices or competitions with other athletes located in different parts of the world, but whose avatars are competing in the same race, for example[50].

Companies in the **online gaming** sector will naturally continue to build on the efforts that they have already poured into their platforms, such as Fortnite, Minecraft and Roblox, in a bid to expand their core business by incorporating retail services, artistic events and obviously eSport competitions. The **gambling** sector (casinos, betting, etc.) will not fail to take advantage of immersive experiences as an incentive to entice ever more gamblers.

A growing proportion of companies are planning to deliver digital **tourism** services offering enhanced tours and visits, including videos, 3D reconstructions of destroyed buildings and environments, and dialogue with guides or other participants. The lower costs, health-related constraints, the limitation on the number of visitors to preserve certain sites, and the desire to reduce the travel industry's environmental impact could lead to more consumers flocking to these services (*cf. Section 3.3.2 Combining environmental benefits with social equity*).

Networking services, whether professional, friendly, family or romantic[51], are rapidly gaining traction. They offer criteria-based selection mechanisms (information, photos, etc.) and chat features using avatars in 3D worlds. Some people will predictably engage in sexual practices in metaverses, whether as spectators (pornographic sites extending their content to incorporate dynamic 3D scenes) or actors, potentially through smart devices (physiological sensors placed on the body, sex toys, etc.), with their avatars associated with amateur or professional partners (new forms of prostitution) (*cf. Section 3.3.2 Psychological issues*).

Collaborative approaches involving the general public are a prime target for metaverses. Whether organising public consultations, testing scenarios on a large scale or synchronising a very high number of participants to perform a complex task, metaverses have the potential to be a useful technology, provided that measures are taken to control the number of users and prevent any abuses from occurring.

Last but not least, metaverses can help tackle certain types of isolation. The first is geographical isolation, which restricts and sometimes even prevents people from developing a rich and diverse social circle. Isolation can also affect people suffering from reduced mobility, visual impairment or agoraphobia, which prevents or limits their freedom of movement. The web[52] and social media are already playing a part in helping isolated people develop their social relationships, but metaverses should enrich these experiences by bringing a sense of presence to these digital worlds, which adds to their appeal and sometimes their effectiveness (*cf. Section 2.2 Virtual reality*).

2.1.5 THE FUTURE OF METAVERSES

The plural form "metaverses" is used in this opinion due to the wide range of developments and changes that they are expected to undergo in the future (*cf. Terminology, Section 1.1 Motivations*). This section discusses their future by addressing the key issue of interoperability and the standardisation mechanisms that may lead to such interoperable systems, before presenting several prospective scenarios.

2.1.5.1 INTEROPERABILITY

One of the criteria for choosing to use a metaverse is its ability to **interoperate** with other metaverses. In the short to medium term, different systems could be deployed, some of which would be specialised (retail, work, tourism, social exchanges, meetings, etc.). The decision to use several of these metaverses will essentially be influenced by their ability to support a **varied range of hardware.** If each metaverse only works with a specific set of hardware, users are unlikely to own all the devices required and will therefore be limited to a choice dictated by their hardware supplier.

Another contributing factor is the technical capacity for users to **transfer** identities, avatars, objects, services and experiences between different metaverses. For example, imagine the case of a person who wants to use a single avatar in several different systems or a person who visits a geographical site in a metaverse dedicated to tourism; that person would certainly be highly interested in being

50. International "digital triathlon" competitions are already being held (Arena Games Triathlon), where professional athletes compete by swimming in a "conventional" pool, but pedal on indoor bike trainers and run on treadmills connected via a network. These events are experiencing a surge in popularity, with spectators watching live in the arena, on TV or remotely through online access.
51. Already available on the web through such sites as LinkedIn, Facebook or Tinder.
52. For example, massive open online courses (MOOCs) provide people who have been excluded from the education system with access to resources that would normally only be available in a classroom or lecture theatre. The hope is obviously to help them reintegrate into the regular system whenever possible.

able to show some of their experiences (videos and photos) in a metaverse where they chat with friends and family. If a system is "impermeable" and does not allow for any interfacing with other systems, users will choose another metaverse offering that possibility. These transfers involve technical considerations (data structure formats, particularly scene graphs, interaction processing, rendering engines, etc.), but they are primarily strategic decisions taken by metaverse manufacturers, either on their own initiative to broaden their user base or, conversely, capture users, or to comply with the regulations imposed by the public authorities[53].

Most stakeholders have taken the need for interoperability on board, and **several initiatives** are already being spearheaded to develop the process, such as the OpenXR consortium which has been promoting open standards for virtual reality and augmented reality since 2017, as opposed to proprietary solutions where one company retains exclusive rights to one type of operation. Also deserving of a mention are the Metaverse Interoperability Community Group, launched in April 2021 by the World Wide Web Consortium (W3C), and the Metaverse Standards Forum, which has attracted a large number of companies since June 2022 (including Alibaba, Meta, Microsoft and W3C). Finally, France's standardisation association (AFNOR) set up a metaverse commission in February 2023[54].

It is also worth pointing out another W3C group, called Inclusive Design for the Immersive Web Community Group[55], which has been working for several years to make immersive worlds **digitally accessible** to people with disabilities[56] (*cf. Section 3.2.1 Access and equity - Digital accessibility*). This is an extremely important issue for reducing and even eliminating restrictions on access that lead directly to discrimination against people who are unable to use metaverses for work, tourism or developing social relationships in the same way as the general population. W3C has already issued recommendations (WCAG - Web Content Accessibility Guidelines)[57], which have been incorporated in France as the RGAA (General Accessibility Guidelines)[58]. These guidelines are highly appropriate for improving access to the web for all users, but they are unfortunately still not widely known or put into practice.

2.1.5.2 STANDARDISATION

It does not take any stretch of the imagination to realise that metaverses will raise major challenges in terms of standardisation. This is due to the mixed bag of standards that are likely to apply and the many stakeholders involved in building and overseeing these immersive worlds (metaverse designers and operators, user communities, national and supranational legislators, and various organisations).

53. *cf.* CERRE report.
54. https://www.afnor.org/actualites/afnor-filiere-metavers-en-quete-de-reperes
55. https://www.w3.org/community/idiw/
56. https://www.w3.org/2019/08/inclusive-xr-workshop/report.html
57. https://www.w3.org/Translations/WCAG21-fr/
58. https://accessibilite.numerique.gouv.fr/

INSET

NORMS OR TECHNICAL STANDARDS?

A distinction should be made between norms and standards, even though confusion often arises in practice when the norms imposed unilaterally by an operator may be incorporated into the technical standards developed by independent bodies. The confusion between norms and standards is reinforced in French due to a poor translation of the English term "norm" as *standard*, which sometimes results in the erroneous use of the French expression for "standardisation organisation". A standard is a set of rules and conventions governing a product, service or practice, issued by a standardisation body that is independent of any one company, such as ISO (part of the UN), ETSI in Europe and AFNOR in France. International examples include ISO 9000 (quality management systems), ISO 13216 (ISOFIX child seats for cars) and ISO 9899 (programming languages - C)[59], and French examples (through AFNOR) include NF C15-100 (low-voltage electrical installations), NF S 31-080 (acoustics - offices and associated areas)[60] and the recent creation of a working group to develop a common language for interoperability[61].

In the field of digital technology and especially the Internet, W3C[62] plays a fundamental unifying role. This consortium brings together several hundred participants (software publishers, research bodies, network operators, etc.). Ever since its creation in 1994, it has defined the basic principles that should be respected by the web. For example, W3C is credited with developing the standards that govern HTML and XML.

Before standards are adopted, work is carried out by groups that generally include representatives of manufacturers, users and sometimes governments, who work together in developing documents that are subsequently put to the vote by the bodies concerned. This is a long and complex process, not least because it involves "negotiations" between companies that have often already developed solutions. It is understandable why each company has an interest in ensuring that the future standard closely mirrors its own products in order to maintain its technological lead and minimise the cost of aligning its products with the new standard.

"Market" or "de facto" standards are products that are generally developed by a single company or occasionally by several companies working together in a consortium, and which are widely embraced by users. These standards are considered to be open or closed, depending on whether their technical specifications are public, such as Adobe's pdf or Microsoft's doc text file formats.

In comparison, it can be said that standards encourage the spread of products, services or practices for which there is a choice between different suppliers, but at the cost of a long and complex negotiations process that sometimes results in sub-optimal technology choices, whereas norms correspond to existing products or services, some of which have been extensively adopted.

As far as the technical aspects of metaverses are concerned, as in virtually all areas of technology, norms will emerge before standards. The first stakeholders offering access to high-performance metaverses will be the first to contribute to market standards, which will influence subsequent systems. However, such early involvement in developing market standards is by no means a guarantee of ensuring exclusivity or even locking out other innovations[63].

More specifically, we can think of the first interaction conventions for moving around in a 3D digital world, or rendering engines that produce computer-generated images (such as Unity and UnReal), the most powerful of which will initially be widely adopted. However, it will be several years before interoperability protocols are deployed on a large scale, probably through standards issued by consortia converging on the development of common file formats, application programming interfaces (APIs) and even, in the long term, through standards governing certain aspects of how metaverses function. In addition, closed proprietary systems imposing their own hardware and software standards may be able to coexist.

2.1.5.3 FORESEEABLE CHANGES FOR METAVERSES

There are four potential scenarios for how metaverses could evolve in the future:

1. A single metaverse emerges (similar to today's web) to which a large part of the world's population (several billion people) will be connected.
2. Several dominant metaverses (several tens or hundreds of millions of people) take hold, particularly through platforms originating from the online gaming world, which continue to independently develop other types of services, especially retail services.
3. A relatively wide range of systems are available, which combine gaming platforms and metaverses, initially on a smaller scale and developed around different themes (retail, entertainment, tourism, social relationships, etc.), some of which comply with interfacing standards that support a form of interoperability and which enable users to share data (avatars, experiences, etc.), ultimately leading to a platform offering multiple themes.
4. Metaverses disappear.

59. https://en.wikipedia.org/wiki/List_of_ISO_standards
60. https://fr.wikipedia.org/wiki/Liste_de_normes_NF
61. AFNOR mobilizes the metaverse industry to find direction, https://www.afnor.org/actualites/afnor-filiere-metavers-en-quete-de-reperes/
62. https://en.wikipedia.org/wiki/World_Wide_Web_Consortium
63. Although it was not the first company to offer a smartphone, Apple's first iPhones featured a touchscreen using gestures (click, zoom and move) that revolutionised how people interact with mobile phones. Although such gestures had long been used in laboratories, it was only when this product was launched that they entered the mainstream. Today, this market standard has since been adopted by all smartphone manufacturers.

In the short or medium term, it seems unlikely that scenarios 1 and 4 will transpire, firstly (scenario 1) because both interoperability (*cf. Section 2.1.3.1*) and social acceptance (particularly the environmental cost) would not be deemed sufficient to build such a "second parallel world" and, secondly (scenario 4) because there are no substantiated reasons to lend credence to the idea that the (many) existing platforms would simply disappear, especially those relating to online gaming.

Scenario 2 could potentially happen, since it is merely a continuation of the current situation and should last for at least several years. It should eventually be replaced by scenario 3, firstly because it reflects what already exists and includes the fact that projects are maturing or under development, and secondly because developing interoperability between systems will provide economic stakeholders with the hope of sharing users and customers, and therefore of increasing their impact and profits[64].

2.1.5.4 FORESEEABLE CHANGES FOR HARDWARE

These changes will affect both "invisible" hardware (computing and network infrastructures) and end users' devices (headsets and interactors)[65].

In the first case, ramping up computing capacity will support increasingly complex worlds and interactions, thereby raising the number of interacting entities and improving their appearance and behaviour. Scaling up mobile network performance will make it easier for people to use metaverses on the move through augmented reality.

In the second case, it is foreseeable that several forms of hardware will coexist for accessing and using metaverses:

1. Virtual reality headsets will continue to grow in absolute terms if prices are kept under control, but they will not be the only solution as a result of their cost, the fact that they cannot currently be used on the move, and the adverse effects experienced by some users.

2. Augmented reality headsets will play an increasingly important role, firstly because they can be used in most environments, but they will not become the norm just yet due to their social acceptance, which may lead to questions[66] in the minds of many users, and also due to the safety issues that they continue to raise[67] when used in public spaces, such as a change in how real distances are perceived, which can cause falls or collisions with obstacles[68].

3. Hybrid headsets[69] offering both virtual reality and augmented reality capabilities are appearing on the market and are likely to gain traction, but with the same question marks surrounding their acceptance.

4. In the longer term, technologies that are currently being studied in research laboratories could ultimately be implemented, such as contact lenses integrating display devices (which already exist, but whose main challenge lies in energy management, i.e. battery life, power consumption and dissipation) or cerebral electrical stimulation, which is even further down the line and therefore shrouded in greater uncertainty.

As for other types of perception, the haptic technology seems destined for the greatest development, with the spread of "embedded" equipment, i.e. worn by the user, and which can take the form of a bracelet, belt or jacket, or even a full-body suit. When it comes to auditory perception, the mechanisms for spatially locating sound sources are set to become widespread.

Although the future of metaverses is wide open, it is important to bear in mind these **different variants** when considering the ethical issues, since their type and scope will vary according to the number of users (millions or billions), the variety of hardware used (from smartphones to virtual reality headsets) and therefore the immersive environment, or even the nature of the virtual experience (gaming, work, retail, health, etc.).

64. Just like the development of networks, which were initially proprietary (IBM's SNS and Bull's DSA) but were subsequently opened up through the implementation of international standards (ISO's OSI open systems interconnection model), which paved the way to interconnected networks and ultimately the Internet..
65. Réalité virtuelle et réalité augmentée : mythes et réalités, edited by B. Arnaldi, P. Guitton & G. Moreau, *ISTE éditions*, 2018. Written by some thirty authors (researchers, engineers), this book describes the state of progress of these technologies at the end of the 2010s and envisages developments for the coming decade.
66. By way of example, take the commercial failure of the augmented reality glasses (Google Glasses) sold between 2013 and 2015, which never managed to catch on with the public, particularly due to aesthetic reasons and their "lack of discretion" in public spaces, where users reported feeling stigmatised.
67. Until such time as solutions have been developed that could improve safety.
68. It is currently against the law to wear these devices while driving a vehicle.
69. Some experts are wagering that smartphones will be replaced by hybrid devices incorporating their existing features, but enhanced with visual and perhaps haptic perception functionality. User-smartphone interactions would then be shifted from a physical keyboard to other input methods combining voice control and gestures.

2.1.6 TYPE OF COMPONENTS AND STAKEHOLDERS IN A METAVERSE

Several entities are involved in the operation of a metaverse, and they need to be identified to gain a clearer understanding of the major complexity surrounding the different interactions and responsibilities (*cf. Section 3.2.3 Responsibilities*). A metaverse is a digital system built on **software** developed by **manufacturers,** run by **operators** on **hardware,** and processing **data** according to interactions with users connected *via* a **network.** Each of the components in a metaverse can be listed alongside their main tasks:

- **Hardware**
  - For users: a computer (CPU, keyboard and screen) and specific devices if applicable (headset, controllers and cameras)
  - For the network: computing and transmission equipment
  - For hosting the system: computing and storage resources
- **Software**
  - User management: registration, configuration (profiles and avatars) and login
  - Management of user interactions, computing the modifications made to the digital world, generating (locally and remotely) the images resulting from these actions, streaming the information over the network.
- **Networks**
  - For connecting users to the system, either "directly" over the Internet with a "standard" URL or over a streaming or gaming platform
  - For connecting the different system components
- **Data**
  - Description (modelling) of the static (objects and scenery) and dynamic (behaviour of certain entities) aspects of the digital world
  - Produced by manufacturers and users
  - User description: profile, experience and avatars
  - Derived from collecting the users' actions (movements, dialogue and purchases).

A distinction can also be made between different stakeholder categories:

- **Researchers and engineers**
  - Work in a public or private scientific or technological research environment, including researchers in human and social sciences, such as sociology, philosophy, economics and law
  - Create concepts and methods, and develop prototypes.
- **Component manufacturers (hardware, software and networks)**
  - Employ researchers and engineers (designers, developers and testers).
- **Manufacturers of metaverses [metaverse publishing systems]**
  - Employ researchers and engineers (designers, developers and testers)
  - Develop and maintain the software systems designed to host metaverses (in the sense of the 3D digital world) by integrating components (hardware, software and networks)
  - Sell licences to operators to use their software (or they are operators themselves).
- **Metaverse operators**
  - Main contractors of a metaverse
  - Buy metaverses [or publishing systems] and then configure them, model the content, monitor operation and finally offer access to a metaverse
  - in two forms: a "specific" metaverse or platforms offering a choice between several specific metaverses
  - After defining:
    - Login policies
    - Policies for managing the data collected (including personal data)
    - The "ground rules" in the metaverse (retail, advertising, monetisation, recruitment, violence, etc.) ;
  - Supervise how the metaverse operates by applying the terms of service and even the community rules that they have defined
  - Receive the profits (subscription fees, advertising, hosting and commission on sales).
- **Users**
  - Any person, including "known" people, represented by an avatar and interacting with the system
  - Any entity (companies, organisations [scientific, cultural, political, etc.]) that uses the metaverse to develop its business activities.

2.2 VIRTUAL REALITY

2.2.1 DESCRIPTION

Virtual reality (VR) is based on giving users the impression that they are being transported to an imaginary world, by replacing information about the real environment that they perceive through their senses with computer-generated data[70]. Images (always), sound (often) and touch[71] (sometimes) data are calculated from a 3D description of the components (scenery, objects, behaviour, etc.) in the environment making up the imaginary world, as well as the user's position and viewing direction in that environment. The computer-generated data are delivered to the user over hardware devices (headset, earphones, force-feedback arm, etc.).

If performed correctly, **substituting** information creates a sense of **presence** in the imaginary world that is first built up through the user's engagement, which depends on their culture, imagination, experiences and motivations, and subsequently through the **immersion** achieved using the technological resources available for the experience.

Immersion is the result of three main concepts:

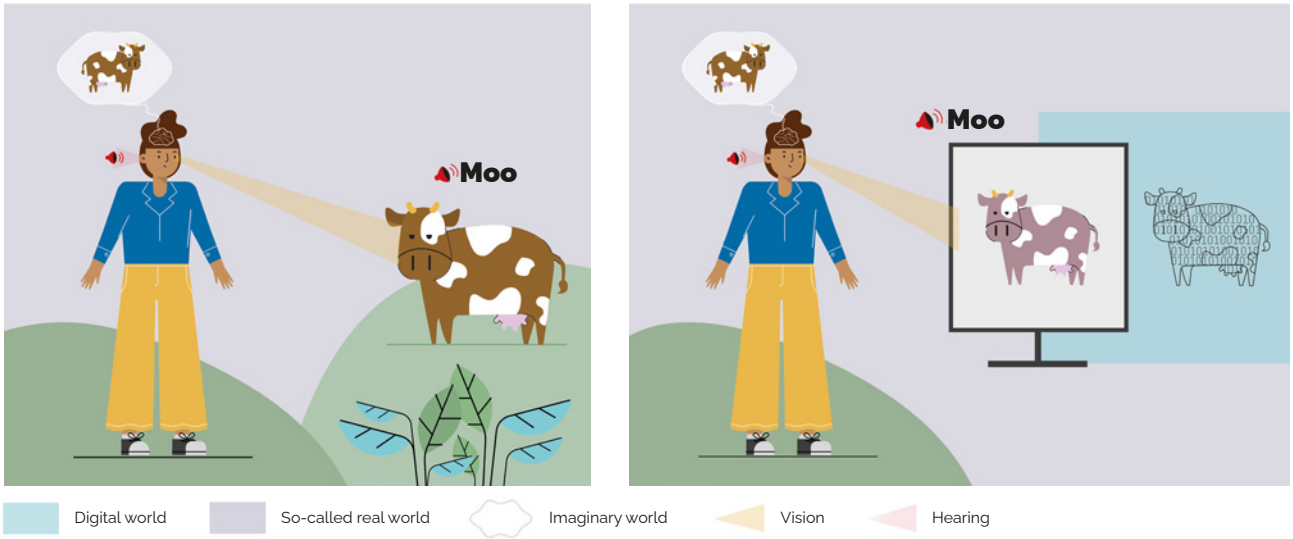
- The capacity for **isolation** from the real world: ideally, the substituted information should be total; with a headset (display and audio), users only perceive the computer-generated data, whereas with a conventional screen, they perceive the surrounding context (images, movements and sounds "around" the screen), even if only to a limited extent, which reduces the feeling of presence ;
- The **sensory richness** of the computer-generated data, which is defined by the data's quality (frequency and resolution of the images and sounds, perception of their depth, size of the field of vision, etc.), interactivity (users must not perceive the computation time) and extent (number of senses of perception[72] sinvolved, provided that the perceived data are all consistent).
- The range of user **interactions** with the environment (navigating, manipulating, grasping, communicating with other users, etc.), which encourages the user's engagement and therefore adhesion to the imaginary world suggested by the virtual reality application, by giving actors a leading role in the experience rather than being mere spectators[73].

2.2.2 TERMINOLOGY

A distinction must be made between several separate areas where virtual reality is developing:

- The **digital world,** comprising hardware (computers equipped with devices for collecting and displaying data) that is increasingly interconnected through networks, software (for receiving and processing the data collected, and then computing and displaying the data) and finally data (mainly descriptions of the 3D environments).
- The **so-called real world** (sometimes also called the physical world) that human beings perceive through their senses, either directly or through equipment (microscopes, telescopes, thermometers, Geiger counters, etc.).
- The **imaginary world** that the human brain constructs by exploiting the information that it has captured, such as while listening to a storyteller, reading a book, watching a film or experiencing virtual reality. This world is also a receptacle for theoretical or conceptual constructs, or personal inventions.

70. Le traité de la réalité virtuelle, edited by P. Fuchs, 2006, Presses des Mines, https://guillaumemoreau.github.io/news/announcement_6/ This 5-volume encyclopedia (2,000 pages) was written by over a hundred authors (researchers and engineers).
71. The term haptics tends to be used in this context.
72. As well as the senses that immediately come to mind (vision, hearing, touch, and so on), other types of senses should be remembered, such as proprioception, i.e. our capacity for implicitly sensing the position of our body parts (limbs, head and torso), which is often used in virtual reality.
73. It is worth noting that the term "virtual reality" is misused when describing immersive applications that do not provide any enhanced form of interaction, such as 360° videos where users can only change the viewing direction, or 3D views where they can only move around. Virtual reality is necessarily defined by immersion and rich interaction.



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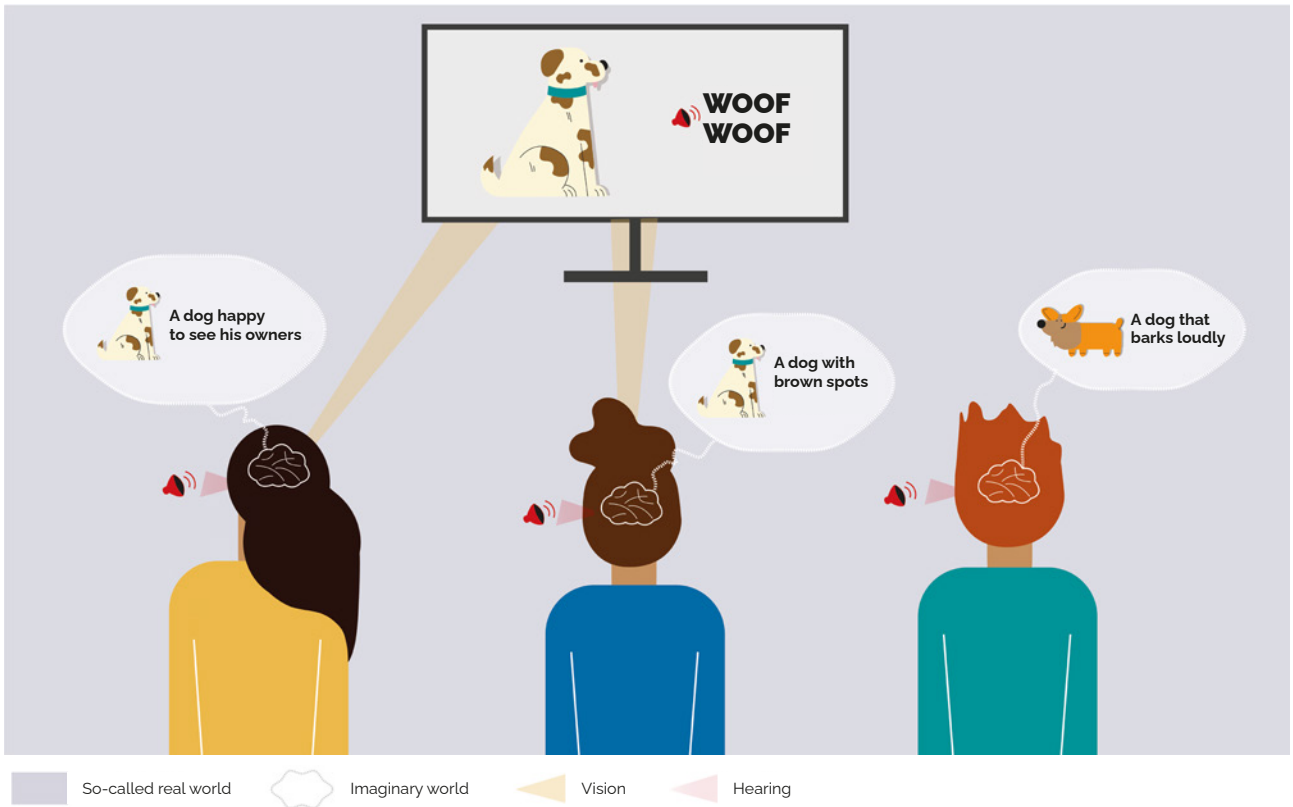
These two illustrations show the differences in perception and representation as well as the three worlds mentioned:

- On the left in the real world, a person perceives the presence of a "real" cow using their senses (sight and hearing).
- On the right in the real world, the same person can perceive, using exactly the same senses, the representation of a cow (by means of a screen and a loudspeaker) whose appearance and sounds have been digitally modelled and generated.
- Irrespective of whether the cow is real or digital, the person constructs a mental image of the animal in their imagination based on their perception and their past experience.

It should be noted that the most important boundary lies between the imaginary world (constructed by our brain) and the real world, which includes the digital world, whose reality we can perceive by measuring electrical potentials in a computer or by observing its environmental impact, for example.

Furthermore, it is important to emphasise the individualised nature of perceiving the same reality, which leads to the construction of different mental images from the same 3D digital world. For instance, the visual perceptions of the two people on the left and in the middle lead to different levels of detail, while the visual perception of the person on the right, who is visually impaired, builds a mental image based on their auditory perception.



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2.2.3 APPLICATIONS

Researchers have pioneered digital **simulation** methods and algorithms to understand and/or predict a wide range of mechanisms, phenomena and objects. However, these simulations have their limitations, especially when it comes to taking account of the interactions with human operators, which are still too complex to model. Virtual reality can be used to integrate the human behaviour captured by specific devices into these simulations.

Virtual reality's main applications can be grouped according to a few major objectives.

Building **design** was the first example where virtual reality was used several decades ago. Researchers at the University of North Carolina (USA) translated an architect's plans for their future laboratory into 3D descriptions before developing a system for walking around the building. This simulation enabled the researchers to pinpoint a number of errors and improve the plans. This example has since spread beyond the confines of architecture and urban planning to reach just about every industry that manufactures "complex objects", such as air, space, sea or land vehicles. The power of virtual reality is also harnessed to design complex industrial, medical or artistic actions.

These different applications have a number of factors in common:

- This approach is frequently (much) less expensive than the traditional trial-and-error approach, even when physical models are used.
- It improves performance due to a first-person exploration that can be shared, which fosters greater collaboration within a team that sometimes features people with a variety of skills.
- It unifies the various business functions (from design through to manufacturing, marketing and maintenance) by sharing the same model, which is occasionally called a digital twin.

Learning is another one of the core applications for virtual reality technologies, with aircraft simulators now a must for all pilots, whether for their initial or ongoing training. As with design, all vehicles are concerned (aircraft, ships, cars, F1 racing cars, etc.) and so is the performance of complex tasks, and simulators are currently being used for learning and training (industrial, medical, artistic, sports, etc.), and even for physical rehabilitation purposes after an accident, for example. More generally, training tools are now available in practically every field, such as immersion in the centre of a molecule or a planetary system to study them in greater detail, or preparing for job interviews with avatars for the candidate and the recruiter.

© Inria / Photo Gilles Scagnelli

Simulator for learning to drive an electric wheelchair. The learner sits in an wheelchair facing a large screen showing an inner-city environment (Inria-IRISA Rennes[74].

74. Gaffary, L. Devigne, V. Gouranton, B. Arnaldi, *et al.* (2020), *Wheelchair Driving Simulator with Vestibular Feedback: A pilot study.* Handicap 2020 - 11th Conference on Technical Aids for People with Disabilities, Paris, France, pp. 1-8 hal-02735943

These applications have several points in common:

- Learning takes place without any risk to humans or property, in defined environmental conditions[75] and with total control over all the parameters (even by adding disruptive elements to the scenario, such as a storm in a flight simulator).
- It can be reproduced without any limitations, which is essential for turning the skills acquired into "automatic reflexes" or carrying out a longitudinal evaluation.
- It costs less than learning under real conditions.

Analysing data that are extremely voluminous (all the components of a space launcher), complex (how the brain works), inaccessible (the bottom of the oceans or the cosmos), lost (remains of destroyed buildings) or imperceptible to the human senses (radioactivity or financial flows) is now one of the major driving forces behind the development of virtual reality applications, with two overriding objectives, namely **understanding,** which is often followed by **decision-making.** The oil industry, for example, has long used virtual reality to examine the intel provided by various types of underground or underwater exploration activities with the aim of accurately determining the type and location of the required boreholes. Another case in point is the number of surgeons who prepare complex operations (known as planning) by simulating them beforehand in virtual reality using a 3D model built from the patient's anatomical and even functional data.

In addition to the sectors already mentioned (architecture, urban planning, manufacturing and medicine), many other fields are stepping up their use of virtual reality.

One of the first on that list is the **culture** and **entertainment** industry, especially under the impetus of the video games sector, which has long invested in virtual reality, to the extent that immersive headsets have been made available to the general public in recent years, which until then had been reserved exclusively for professionals. More generally, it is also one of the forerunners that shaped the development of metaverse systems. The artistic world has also explored virtual reality since the early days by developing innovative experiences and new ways of disseminating them, particularly interactive live events.

Virtual reality has long been used for **retailing** complex products (aircraft and ships) designed for professionals, but it is now being extended to encompass everyday goods for all consumers, such as cars, real estate and fitted kitchen designs. In most of these applications, consumers use the technology to configure the good (choosing the car interior, their home's interior design or the appliances and fittings for their kitchen).

2.3 AUGMENTED REALITY

2.3.1 DESCRIPTION

Augmented reality (AR) aims to give users an improved understanding of a real environment, either by **enriching** it with information that does not exist naturally or by **extending** the limited performance of the human perception system. Examples include the inability to see objects that are too small or too far away, and which emit infrared or ultraviolet light, the inability to hear sounds that are too far away or whose frequency is too low or too high, or the inability to perceive signals that are imperceptible to human senses (radioactivity). To obtain this type of information, devices are used that can extend human perception, such as microscopes or telescopes, or which enhance our knowledge of the environment, such as satellite navigation systems (e.g. GPS) that calculate routes or display street names.

Augmented reality is based on **superimposing** this information on our natural perception of the environment using digital images. These images are generated by a computer from the measurements taken by sensors that extend the performance of our own perceptive system (microscopes and telescopes), from calculated information (such as a path between two points) or from information that has already been digitised (such as the map of a town). These images need to be calculated in real time, particularly when users are on the move, to take account of their position and viewing direction, so that the real elements and the computer-generated data are seamlessly superimposed.

There are three main types of hardware that are capable of performing this task.

The first hardware to be designed included **devices worn** on the user's head in the form of a headset (or mask). They provide either direct vision if the computer-generated data are projected onto a translucent surface, or indirect vision if they are displayed on a screen after being mixed with images of the environment taken using cameras. Researchers are studying and developing devices based on ocular lenses, which are still in the experimental stages.

The second type of hardware, which is much less well known, but increasingly implemented for industrial applications, is based on the use of **projectors** that display images on a surface, such as a windscreen or wall.

Finally, the third type of hardware involves **mobile devices** (smartphones and tablets) on which users can view the computer-generated data mixed with images of the environment taken by a camera. This type of visualisation is easier to put into practice, but offers less accuracy than the other solutions, since it does not use the position of the user's gaze via sensors, as in a headset, to regenerate a new image.

75. Similar to those in the real world.

Wikimedia, Photo Kippelboy.

An augmented reality application on a tablet at Mataro Museum (Catalonia).

2.3.2 APPLICATIONS

Although the term "augmented reality" can be traced back to 1990, the actual principle is much older. It first appeared in fighter aircraft in the 1950s, when useful information for piloting was displayed on the pilots' helmet visors. Since then, this technology has been applied to many other applications, both for professionals and consumers.

It was first extended to other forms of transport, especially **in driver-assistance systems** for people using GPS devices in their cars, and also navigation support systems for airline pilots and ship captains using satellite, radar or sonar data. Enrichment is visual and often audible (instructions and warnings). The main goal is to increase safety by preventing users from losing sight of the external environment when they consult this additional information[76].

Design activities rely on augmented reality to superimpose the computer-generated images of a project onto a real environment with the aim of studying its insertion before proceeding with construction (buildings, plane design or garden layout).

In case of industrial **maintenance** applications, the information required by technicians is displayed directly in their work environment. In the aviation industry, for instance, wiring diagrams and hole drilling locations are displayed on the inside of the aircraft, which makes it easier for technicians to do their job. Another simpler example involves displaying the documentation needed to repair a photocopier.

Leveraging this same principle, more and more applications are being used in **medicine** and surgery to project reconstructions of the anatomical parts onto a patient's body, such as the venous system in their arm for practitioners who need to insert a drip, or their cerebral structures for neurosurgeons who need to perform brain surgery. These 3D reconstructions are generated from examinations using sensors (CT scans and MRIs) and must be perfectly aligned with the patient's body to guarantee accurate medical procedures.

Augmented reality is also gaining ground in the **retail** sector by allowing customers to visualise the plans for their future home, determine whether new furniture will match their home interior or see what their new shoes will look like. It can also be used to check out a product's instructions for use or visit the manufacturer's website, typically by scanning the QR codes on the packaging.

This technology also allows consumers to **visit** museums, exhibitions and historic sites. It provides additional information, such as by creating a 3D reconstruction of buildings that have since fallen into ruin or disappeared, or a diagram describing the process for building part of a monument. These applications are available through headsets, smartphones or tablets that visitors can hire at reception, and they are starting to replace or supplement audio guides.

Augmented reality has also made inroads into the world of **education** as a way of inserting certain digital elements into a real environment to provide learners with a clearer understanding. For example, a "virtual" laboratory has been

76. This is known as a head-up display.

set up where students can consult resources on the web to develop their experiment.

Gaming has been a major influence in spreading the concept of augmented reality, especially with the tremendously successful Pokémon Go app that lets players move around in real environments that are enhanced by displaying game components on their smartphones.

2.3.3 TERMINOLOGY

The term "augmented reality" is widely accepted by all industry professionals. It should not be misused, such as by using it to describe the video enhancement techniques for inserting special effects into films. The special effects are generated by one-time calculations, meaning that all spectators see the same image. In other words, there is no interaction with the user[77].

There are other expressions that have something in common with augmented reality and virtual reality. The concept of **mixed reality** was initially put forward in 1994 and describes the so-called "continuous" spectrum ranging from (but excluding) the real world to virtual reality, and encompassing technologies that combine real elements with computer-generated elements (augmented reality is one of them). Other meanings of this concept have emerged in recent times that take into account, in addition to visual perception, the degree of realism and immersiveness of 3D digital environments.

Finally, there is the concept of **eXtended Reality** (XR), which is becoming increasingly widespread and includes the real world, mixed reality (including augmented reality) and virtual reality.

2.4 AVATARS

2.4.1 DESCRIPTION

In Hinduism, the word avatar signifies the protean incarnation of a divinity on Earth. This term was used for the first time in the 1980s to designate the **visual representation** associated with a user for the purpose of better involving them in a game's narrative. In the context of metaverses, avatars can appear in a huge number of forms, from a simple representation (a few coloured pixels) to a complex avatar (a textured and animated 3D form of the entire human body), including all the intermediate stages (face and hands). They are said to be [photo-]realistic when their visual appearance and behaviour (eye tracking, lip movement consistent with what they are saying, etc.) are close to the perception of reality (similar to a video stream). While the added value of these so-called [photo-]realistic avatars is often claimed to be a way of improving user uptake and ownership, their scope needs to be put into perspective. Favouring subjective measures instead, such as presence, perceived realism and credibility, studies reveal that it is not so much the realistic anthropomorphic aspect of the avatar alone that elicits the best evaluation from users, but the consistency in terms of the realism between the elements in a series of computer-generated images.

Avatars were initially designed to give visual substance to players using predefined images, often anonymously (using pseudonyms), and they have since evolved towards the notion of **characters** or even doubles or **digital twins,** which include much more information than a simple visual appearance, i.e. personalised representation (users choose their gender, morphology, tone of voice, accent, clothes and accessories, such as a white cane, wheelchair or magic wand), accumulated experience (e.g. dance steps), assets acquired, action history and even identity (sometimes certified).

Avatars play several roles. Firstly, they provide users with visual feedback on their actions. In other words, if users command a movement, then their avatar must perform the same movement, thereby confirming that the system has acknowledged the command. Secondly, they are useful for interacting with other users, whether to perceive their location (like a game piece that shows a player's position on a board) or their actions (e.g. manipulating an accessory), or to chat (animated lip movement).

There are several categories of avatars, depending on whether they are:

- Used for **private** or **professional** purposes. In the first case, users can choose a pseudonym and a completely imaginary visual representation (not necessarily featuring human traits), or they can choose several (such as for different contexts, whether family, gaming or meetings). In the second case, they will most often be encouraged to use their real identity and instead choose a representation close to their real appearance (using photographic data), which leads to a unique avatar.

77. For example, in the film *Terminator,* the fight scene in the bar depicts a form of augmented reality where the terminator sees information superimposed on its "natural" vision in real time, but that information was not generated by an interactive augmented reality process (the data were superimposed during post-production).

- Controlled by a **human** or **digital system.** In the first case, an avatar's behaviour (movements, actions and speech) is determined by the user, who has almost complete control[78] over the parameters using various input interfaces (cameras, motion sensors, keyboard, microphone, etc.). In the second case, the avatar is said to be "autonomous", since it is controlled by a digital system (often involving machine learning components or generative AI systems[79]) whose objectives vary according to the application, such as 3D extensions of chatbots appearing on websites to "help" users with administrative or retail procedures ("Can I help you?") or in video games where non-player characters are designed to adapt the difficulty in real time by adding opponents or partners. Note that there are two types of digitally controlled avatars, depending on whether they are designed and controlled by the platform, or introduced by third parties and controlled by a digital system that is external to the platform. In the first case, the platform is responsible for these digital avatars, which can be used to populate certain parts of its space. In the second case, avatars are introduced and controlled by an external third party to attack the metaverse, such as to saturate it and make it unusable, or influence (massively or subtly) the other avatars present by spreading disinformation, especially produced by generative AI systems.

INSET

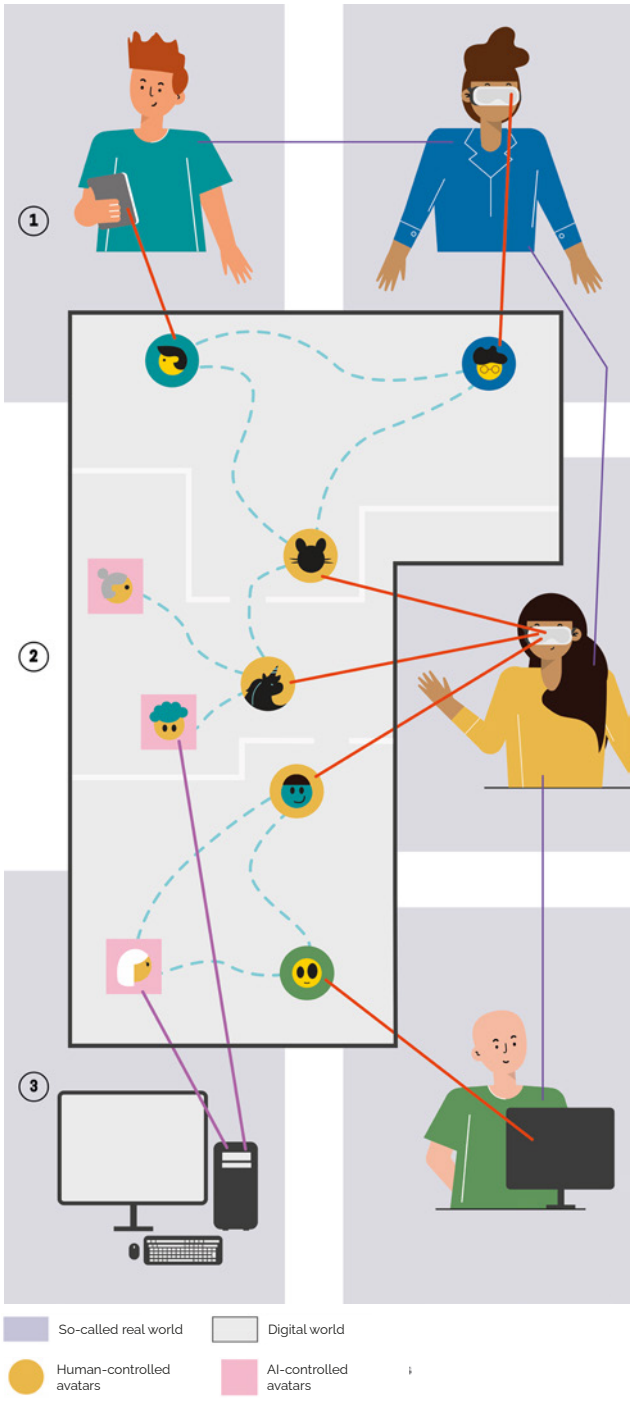
INFLUENCERS IN METAVERSES

We have recently been witness to the emergence of digital influencers on social media, such as Lu do Magalu, a spokesperson for a Brazilian distribution group with some 24 million subscribers and whose videos have notched up more than 300 million views, mainly in her home country[80]. Companies using digital avatars appreciate exerting total control over their image and behaviour (no slip-ups), their ability to adapt to different cultural contexts and also the sense of disruption (spontaneously associated with a "young and modern" image) that they create. For the time being, they are locked into a predetermined and uniquely computer-generated type of behaviour, but there is every reason to think that they will evolve into entities capable of interacting with users in metaverses.

It is also to be feared that digital influences play a role in the spread of false information (deepfakes).

2.4.2 INTERMEDIATION

The **intermediation** link between users and their avatar is especially important, both in terms of the type of link (*cf. Section 3.1.2 Avatar-related issues*) and the type of control exercised by the human user, depending on the hardware used (keyboard, mouse, joystick, capturing a person's gestures, etc.). It should be added that this control can be altered either accidentally (software bug or network disruption) or deliberately (cyberattack).



@studioluciole - Hall Lucille.

78. There may still be parameters that users cannot (yet) control, such as the way in which an avatar walks (stride frequency and size) or the intonation or accent used to express themselves.
79. The growing performance of generative AI systems, which have recently come to the general public's attention through such software as ChatGPT, should not thwart efforts to develop metaverses ("the key stakeholders would fund AI systems to the detriment of metaverses"), but instead be leveraged to improve their ability to generate even more "credible" avatars.
80. https://theconversation.com/les-influenceurs-virtuels-sont-ils-plus-puissants-que-les-influenceurs-humains-178056

This illustration shows different types of relationships between humans and avatars. First of all, in the upper section **(1)**, each of the two avatars is controlled by a human who, despite being in two different places, can communicate (purple links) *via* their respective avatars (dotted green links). The red links are two-way, i.e. from the human to the avatar to control it and in the opposite direction to make the human perceive what the avatar is seeing and doing.

In the central section **(2),** a person (dressed in yellow) controls three avatars for which she has chosen three different representations, some human-like, others not (e.g. a unicorn). Through her avatars, she can interact with other people in the metaverse.

Sections **2** and **3** contain three avatars represented by squares, which are controlled by digital systems. They look like the other avatars and they can interact with user-controlled avatars. Most of these systems are internal to the metaverse, and their main function is to populate it with "artificial" avatars. Other avatars may be the result of cyberattacks and used with malicious intent.

These different possibilities lead creators to take ownership of their avatar, which can go as far as a very strong form of identification, sometimes stemming from a need for recognition and a search for self-esteem (referred to as **embodiment**). It can be defined by three components relating to the user's subjective experience: 1. the feeling of self-location, i.e. the spatial experience of being in a body; 2. the feeling of agency, i.e. the sensation of being in control of one's actions; and 3. the feeling of body ownership, i.e. the feeling that the imaginary body is the source of sensations. This feeling is illustrated by two examples of immersive experiences. In the first, an avatar wanders down a pedestrian street and comes across avatars heading in the opposite direction. Most users modify their own avatar's trajectory to avoid being "crossed" by a purely imaginary entity. In the second, the user has to walk along a very narrow path (e.g. a plank) spanning a large gap. Once again, most users feel a sense of danger or are even unable to take a step forward, even though there is no real risk.

This opinion has already mentioned the visual feedback mechanism allowing users to know where they are and what they are doing. Scientists have highlighted another type of feedback known as the **Proteus effect**[81] which refers to how an avatar's appearance and behaviour influence a user's behaviour in both the digital world and real life[82]. Studies have measured how the choice of representation (gender, height, build and skin colour) and attitude (friendly, neutral or aggressive) can influence social interactions during and after the immersive experience[83]. One hope is to help combat discrimination (sexism, racism, body-shaming, bullying, etc.) by putting users "in the other person's shoes". One example of the Proteus effect is demonstrated in the "Live my life" experiment, where changing users' perspective by placing them in the imaginary shoes of another human can trigger empathy and lead to a change in behaviour. This experiment put men who had been convicted of domestic violence in the shoes of these assaulted women, who were embodied in a female avatar. At the end of the experiment, participants showed an improved ability to recognise fear in female faces[84]. These results may not constitute a total response to the problem of gender-based violence, but they at least represent an interesting avenue warranting further investigation.

Research[85] has shown that avatars can be used to convincingly simulate social scenarios and guide conversations in an adaptive way, while also eliciting high levels of social influence. Avatars can also draw similar emotional responses from a conversation partner compared to an interaction with a human being in real life. More recently, the use of personalised 3D avatars in 2D videoconferences has resulted in a higher level of social presence perceived by participants compared to traditional video. All these elements play a key role in understanding how emotions are modelled, expressed and used in these virtual worlds to elicit empathic responses from users (on the ethical issues associated with these mechanisms, *cf. Section 3.1.1.2 Avatar-related issues*).

81. Greek god with the power to change shape.
82. R. Ratan, D. Beyea, B. J. Li, et L. Graciano (2020), « Avatar Characteristics Induce Users' Behavioral Conformity with Small-to-Medium Effect Sizes: A Meta-Analysis of the Proteus Effect ». *Media Psychology* 23 (5): 651-75. https://doi.org/10.1080/15213269.2019.1623698.
83. https://www.cairn.info/revue-bulletin-de-psychologie-2017-1-page-3.htm
84. S. Seinflef *et al.* (2028), Offenders become the victim in virtual reality: impact of changing perspective in domestic violence, *Sci Rep* 8, 2692, https://www.nature.com/articles/s41598-018-19987-7
85. A. Lécuyer (2023), Understanding the metaverse: the effects of immersive technologies on your brain, published by *Alpha / Humensis.* 166&s.

2.5 DEEP USER PROFILING

This section describes the type of data collected when a metaverse is used and the information that can be generated. The volume and accuracy of this information, which far exceeds the data collected by applications such as the web or social media, means that the resulting user profiling process can be described as deep.

2.5.1 NEW DATA COLLECTED

A defining feature of metaverses is the sharp rise in the volume of data collected in real time to ensure that the interfaces function properly. For example, to generate the CGI images representing the digital environment, the system needs to capture the users' location and viewing direction. To make sure that the display is as seamless as possible, a frame rate of more than 20 FPS must be generated, which means that the user's location and viewing direction must be captured just as many times. Furthermore, the engaging nature of an immersive 3D experience could prompt users to stay connected for a longer period than simply browsing on the Internet, thereby further increasing the volume of data collected.

In addition to the personal data typically collected when using digital services (identity and location), the use of metaverses involves the collection of physiological data so that users can evolve in 3D digital worlds. In some contexts, the user's viewing direction can be collected with eye tracking sensors. Data can also be collected on the user's heart rate or electrodermal activity with specific devices (such as smart watches).

By combining the history of how users evolve in the 3D digital world (places visited, type and duration of their movements, avatars with which they have interacted, etc.) with their heart rate and the attentional focus deduced from the movement of their pupils, metaverse operators can ascertain some of the users' centres of interest and piece together a much more accurate profile than based on their browsing history.

The capture and analysis of electroencephalograms through brain-computer interfaces[86] which is still under development in research laboratories, can be used to determine certain elements of a person's cerebral functioning and subsequently control a digital system (a wheelchair or navigation interface). There is still a long way to go[87] to improve the technology's reliability and extend its scope, but it is conceivable that this technology will be truly available to the general public in the not-too-distant future. When that day arrives, more precise information can be obtained about users, such as their level of attention, fatigue or motivation in relation to a task.

This list is neither monolithic nor exhaustive, firstly because users will not necessarily own all the collection devices available (from smartphones to virtual reality headsets and the associated sensors), and secondly because a metaverse will not necessarily capture all the data.

2.5.2 NEW CALCULATED INFORMATION

Based on the data collected, **information can be calculated about certain aspects of a user's behaviour, even emotions.** In addition, the very choice of avatar can reveal certain aspects of our imagination[88]. However, it is important to emphasise the need to take an objective look at the reality and accuracy of this information, which is calculated using computational models that are by no means perfect. Therefore, it would be more correct to talk about **estimated** behaviour or emotions. Nevertheless, it should be pointed out that although "real" emotions cannot be reconstructed, these calculations may lead to the risk of manipulating users and violating their privacy. This information provides insights into people's internal emotional state, such as their subjective reaction to an object, person or situation. It is calculated from quantitative and qualitative data, such as physiological measurements (heart rate and electrodermal activity), facial expressions, words and explicitly stated feelings.

86. Brain-Computer Interface (BCI). Brain–Computer Interfaces 1: Foundations and Methods, Editors: Maureen Clerc, Laurent Bougrain, Fabien Lotte. 2016. *ISTE*.
87. Contrary to what some say about "mind-reading" or "transferring a person's memory", which still belong to the realm of science fiction.
88. S. Tisseron., F. Tordo (2021), Understanding and caring for online connected persons, *Dunod*, p. 158.

INSET

EMOTIONAL DATA

Several techniques for collecting and processing emotional data have been proposed in the literature in recent years[89]. They have a very wide range of applications in research into human behaviour and detecting emotions. Examples include taking account of heart rate variability correlated with changes in the state of a vehicle driver's alertness when detecting critical points along a route, electrodermal activity to measure the level of stress caused by the cognitive workload in the workplace, electroencephalograms to assess engagement with audiovisual content, and functional magnetic resonance imaging to record the brain activity of participants involved in social tasks compared to mechanical or analytical tasks. Furthermore, infrared-based functional spectroscopy is used to directly measure brain activity relating to decision-making processes in approach-avoidance theories, eye-tracking to measure subconscious brain processes that show correlations with information processing in high-risk decisions, facial expression analysis to detect emotional responses in online learning environments[90] and speech emotion recognition to identify stress and anxiety in telephone interactions in emergency call centres or detect depressive disorders.

The problem of recognising emotions from facial images currently relies[91] on so-called conventional methods or neural network approaches. Conventional methods (e.g. traditional image processing, pattern recognition and various classifiers) are based on a feature design process. Neural network approaches enable systems to learn features from the data. In particular, convolutional neural networks extract features from the processed facial image inputs and are then classified by another neural network[92].

Currently, the most effective approaches, whether in vision, speech or multimodal approaches, use transformers[93] which are neural networks with attention mechanisms, such as this multimodal approach for recognising emotions from voice and speech in emergency call centres[94].

Combining VR with traditional self-reporting methodologies has improved the level of understanding into emotions in simulated real-world scenarios[95]. Integrating biometric data, such as electroencephalograms and electrocardiograms, into VR frameworks provides an enhanced, multi-dimensional view of emotional responses[96]. In addition, recent efforts aimed at merging eye-tracking technology with VR herald new avenues for research into emotions, although several challenges lie in the way[97].

2.5.3 EMOTIONAL TRANSFERENCE

An important question relating to emotional data and their use in a metaverse concerns the emotional transference that happens when users associate emotions with entities (e.g. avatars) in the metaverse[98]. This emotional transference is a specific characteristic of virtual reality systems in which users are completely immersed in a reality where they are prompted to associate empathetic reactions as in real life. Emotional transference occurs in two ways, firstly with the aim of lending greater credibility to the avatar acting in virtual reality and interacting with the user in this reality, and secondly with the goal of influencing users' behaviour in their "real life" according to different contexts, such as the therapeutic treatment of mental disorders, or manipulation intended at influencing their decisions. In the first case, emotional transference can be used to memorise and exploit the emotions felt in behavioural therapy applications for people suffering from anxiety or phobias[99] by gradually exposing them to the object of their fears in a controlled environment (animals, heights, altitude, potential attackers, etc.). From an IT point of view, emotional transference is

89. J. Marín-Morales, C. Llinares, J. Guixeres, M. Alcañiz (2020), Emotion Recognition in Immersive Virtual Reality: From Statistics to Affective Computing. *Sensors,* 20(18):5163.
90. L. Devillers, L. Vidracsu, L. Lamel (2005), Challenges in real-life emotion annotation and machine learning based detection, *Journal of Neural Networks,* 18 (4), 407-422.
91. F. Z. Canal, T. Rossi Müller, J. C. Matias, G. G. Scotton, A. Reis de Sa Junior, E. Pozzebon, A. C. Sobieranski. (2022), Survey on facial emotion recognition techniques: A state-of-the-art literature review, *Information Sciences*, Volume 582, , pp. 593-617.
92. P. Tzirakis, G. Trigeorgis, M. A. Nicolaou, B. W. Schuller, S. Zafeiriou (2017), End-to-end multimodal emotion recognition using deep neural networks. IEEE J. Sel. *Top. Signal Process.* 11.
93. Vaswani, N. Shazeer, N. Parmar, et al. (2017), "Attention is All you Need", *Advances in Neural Inform.* Process. Systems.
94. T. Deschamps-Berger, L. Lamel, L. Devillers (2023), Exploring Attention Mechanisms for Multimodal Emotion Recognition in an Emergency Call Center corpus, *ICASSP* 2023, IEEE International Conference on Acoustics, Speech and Speech and Signal Processing.
95. Felnhofer, O. D. Kothgassner, M. Schmidt, A. K. Heinzle, L. Beutl, H. Hlavacs, *et al.* (2015), Is virtual reality emotionally arousing? investigating five emotion inducing virtual park scenarios. Int. J. Hum. *Comput. Stud.* 82, 4856
96. K. Ito, S. Usuda, K. Yasunaga, M. Ohkura (2017), Evaluation of "feelings of excitement" caused by a VR interactive system with unknown experience using ECG. *Adv. Intell. Syst. Comput.* 585, 292302.
J.P. Tauscher, F. W. Schottky, S. Grogorick, P. M. Bittner, M. Mustafa, M. Magnor (2019), Immersive EEG: Evaluating Electroencephalography in Virtual Reality. Osaka, Japan: *IEEE,* 17941800.
97. M. Gori, L. Schiatti, M. B. Amadeo (2021), Masking emotions: face masks impair how we read emotions. *Front. Psychol.* 12:669432.
L. Tabbaa, R. Searle, S. M. Bafti, M. M. Hossain, J. Intarasisrisawat, M. Glancy, et al.. (2021), Vreed: Virtual reality emotion recognition dataset using eye tracking & physiological measures. Proc. ACM Interact. Mob. *Wearable Ubiquitous Technol.* 5, 2. 10.1145/3495002.
98. A. Grinbaum et L. Adomaitis (2022), "Moral Equivalence in the Metaverse", *Nanoethics* 16, 257–270.
99. A. Gorini, F. Pallavicini, D. Algeri, C. Repetto, A. Gaggioli, G. Riva (2010), Virtual reality in the treatment of generalized anxiety disorders. Stud. *Health Technol. Inform.* 154, 3943.

achieved by automatically identifying and classifying the emotions felt by the user. These emotions are then used to create mutual coordination between the user's emotional states and the digital entities populating the metaverse in order to generate empathy in the user.

INSET

EXAMPLES OF EMOTIONAL TRANSFERENCE DURING IMMERSION

Filmmakers Chris Milk and Gabo Arora co-created Clouds Over Sidra, a UN-sponsored short film produced in 360° VR video format that tells the story of Sidra, a 12-year-old Syrian girl in a refugee camp in Jordan. It aims to shine the spotlight on the humanitarian crisis sparked by the war in Syria. The United Nations High Commissioner for Refugees has also resorted to virtual reality in a number of fundraising and awareness-raising campaigns. Other civil society organisations have also pursued the idea of using virtual reality as an "empathy machine". For example, international animal rights NGOs, such as Animal Equality (which has set up the iAnimal project using virtual reality to take people inside real slaughterhouses and intensive livestock farms to witness the lives of many animals in the meat and dairy industry from a first-person perspective) and People for the Ethical Treatment of Animals (with the I, Chicken, I, Orca, and Eye to Eye VR projects) illustrate virtual reality's power for fostering empathy (in these cases, for non-human beings).

3. ETHICAL ISSUES

Some of the ethical issues associated with video games, digital social media and virtual reality applications concern metaverses, which could potentially amplify those issues since, for example, they collect other types of data. However, metaverses raise specific ethical issues that need to be identified, while taking account of the uncertainties surrounding their deployment. After all, these are emerging technologies, and it is hard at the present moment in time to gauge the scale of their development, their uses, the methods for accessing them and the various costs involved, particularly in the long term.

A fundamental issue relates to the potential change in the human condition. How is frequent immersion in a digital universe, accompanied by possible total sensory isolation from the physical environment (sight, sound and touch), likely to transform human life into a type of "ongoing digital game"? How could relationships with others (school, work, services, culture, love and friendship, etc.) be transformed when there is a greater incentive to make these encounters through avatars? Could our perception of reality be altered? Could reality even be rejected? In a metaverse, users could satisfy their impulses and desires in complete disregard of the consequences for other people or their own responsibilities, especially their legal responsibilities. Users would not experience frustration or failure, their personality and appearance would be an incarnation of their innermost desires, and they could interact with especially realistic avatars of dead people. In addition, a new divide can already be anticipated between people who can use metaverses (financially, physically or cognitively) and those who cannot or do not wish to, who will automatically be excluded from these worlds and everything that happens within them[100]. This aspect illustrates the fact that metaverses will not only affect their users, but also those people who do not use them (sometimes referred to as non-users).

Another fundamental issue is the condition of the "Polis" in the sense of the City, the State and, more broadly, the world, which is likely to be changed by these immersive worlds, bearing in mind that some designers nurture quasi-political ambitions. It is perfectly conceivable that some metaverses will be presented as partial substitutes for the political and legal organisations that we know today. New communities could spring up with a potentially autarkic set of rules governing their life and operation, as well as new cultural codes, like sects (some of which will be active in metaverses). From a more speculative point of view, it could be feared that the integrative force and seductive powers of the immersive universe could rival with States' sovereign functions (creation of their own currency, regulatory system, police and courts, taxes, etc.)[101]. Therefore, we need to think about the potential impact that these worlds could have on communities and society as a whole, and whether they are compatible with the liberal democratic model in France and Europe, especially in terms of principles and values. In addition, it is important to ensure that the democratic values enshrined by the European Union (liberalism, protection of fundamental rights, respect for minorities, etc.) are not undermined by these new types of communities[102].

A third major issue with metaverses is their environmental impact, which is currently unsustainable if open-access metaverses are used on a massive scale (*cf. Section 3.3 Environmental issues*). This clearly raises the question of limits which, in the language of virtue ethics, can be compared to temperance or sobriety, and fairness in terms of access to the metaverse. This aspect of a metaverse's environmental issues has a clearly collective dimension by linking social acceptance, global solidarity and responsibility for the future of humanity and the biosphere.

In addition, tensions exist between the principles and also between the resulting requirements. The following are prime examples:

- Environmental sustainability may hamstring the freedom to innovate. The race for innovation that metaverse operators and manufacturers are likely to engage in, sometimes with public incentives, could have a major repercussions for the environmentt[103] .
- Environmental sustainability may conflict with the principle of justice, which could have the result of promoting access to metaverses for the widest possible audience[104].
- The freedom to innovate, leading to the development of all kinds of immersive devices and experiences, may conflict with the protection of people's physical and mental well-being.
- Respect for human autonomy[105], which represents the freedom for individuals to use all the functions available to them as they see fit, may conflict with the principle of non-malevolence, such as in cases where the metaverse manufacturer or operator does not withhold certain features to prevent malicious behaviour or implements manipulative interfaces.
- The wish among users to protect their personal data, especially their sensitive data (physiological data), while having access to all the functions of a metaverse, may conflict with the metaverse's access policy in exchange for consent to use their personal data.

100. A. Gorini, F. Pallavicini, D. Algeri, C. Repetto, A. Gaggioli, G. Riva (2010), Virtual reality in the treatment of generalized anxiety disorders. Stud. *Health Technol. Inform.* 154, 3943.
101. D. Boulier & G. Guinard (2022), Metaverses: heading towards virtual exploitation, https://aoc.media/analyse/2022/10/18/metavers-vers-lexploitation-virtuelle/
102. Sectarian, communitarian and conspiracy-based metaverses could promote certain illegal practices (incitement to hatred and terrorism) or disseminate fake news in an attempt to undermine democracies (widespread disinformation from conspiracy movements, which already exist on the Internet and certain platforms, could be amplified in an immersive universe). "Secessionist" metaverses could also emerge that fail to recognise any form of state authority.
103. The High Level Expert Group on Artificial Intelligence set up by the European Commission in 2019 has expressly identified "environmental and societal well-being" as a requirement in its guidelines.
104. Ce principe a été retenu dans le rapport du Conseil d'État au Premier ministre sur l'intelligence artificielle et l'action publique. https://www.conseil-etat.fr/publications-colloques/etudes/intelligence-artificielle-et-action-publique-construire-la-confiance-servir-la-performance
105. Also known as the principle of autonomy, namely the ability of human beings to act on tools and data. Refer to the ethics guidelines of the High-Level Expert Group set up by the European Union at https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

- A requirement for a clear distinction between a human-controlled avatar and a digitally-controlled avatar may conflict with the entrepreneurial freedom of a metaverse operator who, in its own interests, allows that 3D world to be populated with entities whose controllers cannot be identified.

INSET

AUTONOMY

As revealed by its etymology (from the Greek word "auto" meaning "self" and "nomos" meaning "law"), the word autonomy implies the ability of an entity to set its own laws. When applied to individuals, autonomy refers to a person's ability to make decisions about their own rules of behaviour. Therefore, it is closely related to the exercise of their fundamental rights, as well as certain values and principles (such as individual sovereignty in the digital age), which both ethics and law are striving to safeguard.

However, autonomy is somewhat of an ambivalent word, since it is used in philosophical, ethical, legal and technological contexts, and refers to both machines (e.g. autonomous robots and vehicles) and individuals, whether natural or legal persons. It should be pointed out that the "autonomy" of machines — with everything that can be criticised about this term — is often perceived as a risk, whereas the autonomy of individuals is seen in an obviously positive light, especially in relation to digital ethics. In case of machines, talking about autonomy is a misuse of language, because technological devices described as autonomous tend to be automated[106].

As suggested by some philosophers, it is worth noting that the autonomy of the will cannot be established as a norm, because it is a regulatory ideal that can never be achieved, however desirable. In other words, it is a "horizon that we must strive towards and not a possession of the person"[107].

Finally, it should be noted that autonomy, in the context of digital technology in general and metaverses in particular, does not confer total freedom of action on the individual, since the individual cannot be considered to be an isolated moral subject, alone with his or her conscience, and cut off from the world and others. As a result, autonomy is limited by respect for the freedom of others.

106. CCNPEN (2021), Opinion no. 2, Ethical issues regarding "autonomous" vehicles. https://www.ccne-ethique.fr/fr/publications/cnpen-le-vehicule-autonome-enjeux-dethique

107. J-G. Ganascia (2022), Servitudes virtuelles, *Seuil*.

3.1 ISSUES CONCERNING THE INDIVIDUAL

An immersive experience in a metaverse is anything but neutral for the person involved[108], so an in-depth look should be taken at the physiological and psychological consequences for certain users. Since metaverses are still being rolled out, there are currently no studies that address all these effects and especially their impact over time. However, some risks can already be identified based on existing studies into the pre-existing technologies and applications, mainly virtual reality. These effects are likely to be exacerbated in situations where users carry out an immersive experience in **isolation** (e.g. alone at home), which denies them the benefit of help from a third party as in cases where virtual reality is used in a professional setting. Although scientific evidence still contains gaps, the physiological and psychological issues are such that the onus is already on the public authorities to adopt a **precautionary principle** and impose appropriate protective measures as metaverses continue to be rolled out.

3.1.1 PHYSIOLOGICAL AND PSYCHOLOGICAL ISSUES

3.1.1.1 PHYSIOLOGICAL AND PSYCHOLOGICAL ISSUES

This section takes a closer look at the physiological issues involved, by consulting existing studies on the use of virtual reality and, to a lesser extent, digital tools, particularly smartphones. The values that need to be identified in relation to the physiological issues include transparency, physical well-being, health and respect for personal integrity. The following recommendations are designed to protect them.

We can start by mentioning the consequences caused by high levels of exposure to digital tools, which have soared with the widespread uptake of mobile phones, particularly among the younger generation. Other factors, such as blue light[109], lack of exposure to natural light, greater strain on near vision, and a sedentary lifestyle, have led to a sharp rise in myopia worldwide[110].

The issues should especially be considered for children and teenagers, whose psycho-visual system is still developing. In a report published in 2021[111], ANSES (Agency for Food, Environmental and Occupational Health & Safety) highlighted how exposure to virtual reality and augmented reality technologies could affect their development.

More generally, human vision may be disrupted by the use of a headset due to a conflict between convergence and accommodation. To perceive an object correctly, our visual system relies on two mechanisms that are naturally interconnected:

- Convergence: the eyes turn towards the nose (or ears) if the object is close (or far)
- Accommodation: the lens of our eye deforms to adjust its focus according to the object's distance

With a stereoscopic headset, users focus on the required object, but they adjust to the focal distance of the screen to obtain a sharp image. To give users the impression that the screen is far from their eyes (when in fact it is only a few centimetres away), the optical systems focus at a constant distance (often a few metres). The difference between these two distances breaks the coordination between both mechanisms, which can cause discomfort, fatigue and even headaches in some cases.

In addition, a poorly adjusted or incorrectly fitted headset can amplify these problems by causing additional shifts in perception:

- Horizontally, if the distance between the two screens is not similar to the distance between the eyes (interpupillary distance)
- Vertically, if the headset is not perfectly horizontal

These effects, and particularly those of stereoscopic vision, are examined in an ANSES report published in 2014[112]. Another issue is the poor perception of distances in the in the 3D digital world, which can alter the perception of relief.

In addition, **cybersickness**[113] causes discomfort in some users, ranging from discomfort to malaise in the most severe cases, which is sometimes combined with fatigue after a virtual reality experience. Our balance and spatial orientation are managed by our vestibular system, which comprises a set of sensory organs located in the inner ear. Inconsistencies between the visual and vestibular systems are the main culprits for cybersickness, particularly when the user's brain perceives movements in virtual reality despite standing still.

This dissonance can be increased when using virtual reality systems. For example, if users turn their head by 90° and they see an image that is shifted by an angle that is significantly different to 90° or which is displayed with a perceptible lag, the sensory conflict will be amplified. The same observation applies if users are subjected to a major movement in the imaginary scene (such as on a rollercoaster). A low frame rate is one of the primary causes of cybersickness. Researchers have shown that a minimum FPS of around 100 greatly

108. This is one of the main reasons why the term "virtual" is hardly ever used in this opinion, since the impacts on the environment and people are real, not imaginary (cf. Terminology inset, Section 1.1.4 Chosen approach). (*cf. encart Terminologie Section 1.1.4 Approche retenue*).

109. ANSES (2019), Effets sur la santé humaine et sur l'environnement (faune et flore) des diodes électroluminescentes (LED). https://www.anses.fr/fr/content/led-les-recommandations-de-l%E2%80%99anses-pour-limiter-l%E2%80%99exposition-%C3%A0-la-lumi%C3%A8re-bleue.

110. E. Dolgin (2015), The myopia boom, *Nature*, 519, 276-278, https://www.nature.com/articles/519276a.

111. ANSES (2021), What are the risks of virtual reality and augmented reality, and what good practices does ANSES recommend? https://www.anses.fr/en/content/what-are-risks-virtual-reality-and-augmented-reality-and-what-good-practices-does-anses

112. ANSES (2014), Potential health effects of audiovisual technologies in stereoscopic 3D vision, https://www.anses.fr/fr/content/avis-et-rapport-de-l%E2%80%99anses-relatif-aux-%C2%AB-effets-sanitaires-potentiels-des-technologies.

113. Sometimes referred to as "space sickness" by analogy with motion sickness.

minimises the risk of cybersickness[114]. However, it should be noted that such a high frame rate can currently only be achieved in a configuration where a computer is connected directly to the headset. In the case of metaverses, the configuration is different, since the images pass between the metaverse site and the headset through a network (such as the Internet), which limits the available frame rate. Furthermore, increasing the frame rate also requires more power to transfer the images (*cf. 3.3 Environmental issues*).

Professionals using virtual reality have long been aware of these symptoms, so they keep a close watch for the tell-tale signs of cybersickness and immediately stop the experience to allow the user to rest. Even if these events do not occur, users are advised against performing certain activities immediately after their immersive session, such as driving a vehicle (headset manufacturers often include these recommendations in their instructions for use).

Finally, there is a risk of users falling over when wearing a VR headset. Firstly, if users move during the experience, their vision is obscured and they cannot see any obstacles in their environment. Secondly, some conditions (e.g. a rollercoaster)[115] can cause a loss of balance leading to a fall, even when seated.

It is worth pointing out that while most of these symptoms may increase in proportion to the time of exposure, the same effects may tend to diminish as immersive experiences are repeated[116]. This phenomenon, known as habituation, refers to a little-known learning process.

The use of virtual reality entails other health risks whose effects have already been proven and which may persist after exposure. As noted by ANSES in its 2021 report[117], on a sensory-motor level, users may experience an impairment in their manual dexterity or ability to orientate their body (loss of motor skills), as well as a disruption to their circadian rhythm (difficulty in falling asleep). There are potentially other health effects that have not been sufficiently documented and which would therefore benefit from further studies, such as musculoskeletal disorders (MSDs), neurological effects and an increased risk of accidents[118].

Without waiting for the results of these studies to be published, consideration should be given to the experience gained by professionals (researchers and engineers) who have spent decades working on virtual reality. In this respect and given the potential widespread use of metaverses, the best practices that exist in professional circles deserve to be widely disseminated to the general public.

3.1.1.2 PSYCHOLOGICAL ISSUES

Dependency

The first issue that often arises when talking about metaverses is the risk of "addiction" for certain users, who would no longer be capable of disconnecting from these digital worlds and would therefore lose their sense of reality. Since there are currently no specific studies on this subject, it is worth referring to the field of online gaming, which bears a number of similarities to metaverses (*cf. Section 2.1.3.1 Similarities*), although it differs in terms of the range of applications and the type of audience concerned. A frequently mentioned example is the case of a compulsive gamer who allowed his child to starve to death for fear of "missing out" on important moments in the game[119]. These extreme cases are admittedly very rare, but it is important to approach this subject with a great deal of caution. The addiction phenomenon is described in painstaking detail by the psychiatric community in a reference document, called the DSM[120], which currently does not make any mention of digital technology in general as a source of addiction, due to the absence of any epidemiological studies that clearly demonstrate a link. However, experts estimate that between 1 and 5% of users suffer from serious disorders, with almost half experiencing harmful effects on their health and social relationships. According to some studies, the intensive use of games or digital social media[121] is likely to lead to a loss of control, disinterest in other activities, lying (including to oneself), concealment of the length of time spent on gaming platforms or social media, loss of important relationships or opportunities, a deterioration in sleep quality, and so on[122]. In 2019[123], the WHO added "video game disorder" to its International Classification of Diseases (ICD 11), which serves as an international reference document[124].

Therefore, it would appear that the issue of dependency on immersive digital worlds requires a thorough examination outside the media spotlight to obtain a better understanding of the underlying causes[125] and then define the relevant prevention and treatment policies in the event of a proven risk of dependency.

114. J. Wang, R. Shi, W. Zheng, W. Xie, D. Kao and H. -N. Liang (2023), "Effect of Frame Rate on User Experience, Performance, and Simulator Sickness in Virtual Reality," *in IEEE Transactions on Visualization and Computer Graphics,* vol. 29, no. 5, pp. 2478-2488, doi: 10.1109/TVCG.2023.3247057.
115. https://www.youtube.com/watch?v=r7-hmtO1Moo et http://www.youtube.com/watch?v=0Ignn19Ajvs#t=79
116. https://www.anses.fr/fr/system/files/AP2017SA0076Ra.pdf
117. ANSES (2021), Opinion on the "Health effects associated with exposure to virtual and/or augmented reality technologies". Expert group report.
118. *Ibid.*
119. https://www.liberation.fr/planete/2014/04/15/un-sud-coreen-accro-aux-jeux-video-laisse-son-fils-mourir-de-faim_997828/
120. Diagnostic and Statistical Manual of Mental Disorders, https://en.wikipedia.org/wiki/DSM-5
121. A Senate report on the use of TikTok describes it as a "public health issue given the concerns about the psychological effects of TikTok". https://www.senat.fr/notice-rapport/2022/r22-831-1-notice.html.
122. Screen addiction: myth or reality? https://www.u-bordeaux.fr/actualites/Addiction-aux-%C3%A9crans-mythe-ou-r%C3%A9alit%C3%A9 - Adde, M. Boudard, Item Response Theory Analyses of Diagnostic and Statistical Manual of Mental Disorders, *Fifth Edition (DSM-5)* Criteria Adapted to Screen Use Disorder: *Exploratory Survey, 27.7.2022 in* Vol 24 , No 7 (2022) : July
123. https://www.drogues.gouv.fr/loms-reconnait-officiellement-le-trouble-du-jeu-video-gaming-disorder
124. https://www.who.int/fr/news-room/questions-and-answers/item/gaming-disorder
125. Addiction is not hardwired in the brain, L. Ganalopoulo & S. Ahmed (2023), *CNRS Journal,* https://lejournal.cnrs.fr/articles/laddiction-nest-pas-gravee-dans-notre-cerveau

At the same time, metaverse manufacturers are responsible for incorporating design principles that avoid encouraging or even reinforcing dependency. A closer look at similar systems, such as online gaming, reveals dark patterns (rewards, loyalty competitions, targeted advertising, reminders for inactivity, etc.) that encourage gamers to stay connected for long periods of time. In March 2023, Fortnite developer Epic Games was hit with a major fine from the US Federal Trade Commission for using dark patterns to influence gamers to make unwanted purchases and let children spend money without any parental involvement[126]. Captology is also considered when designing digital services[127]. The European Parliament is spearheading an initiative targeting the addictive design of online services. It is based on the observation that in today's attention-based economy, certain technology companies use design and system functionalities to capture users' attention and increase the amount of time that they spend on their services. These include notifications, endless scrolling, personalisation and interaction mechanisms, and the use of A/B testing[128]. The European Parliament goes on to point out that this can result in a "risk of social media addiction" that is harmful to all people, meaning that further research is needed to "better understand the underlying issues, the impact of online services and potential solutions". Therefore, it encourages the European Commission to close existing regulatory gaps with regard to the exploitation of psychological vulnerabilities in the design of digital interfaces. In this respect, there could be plans to ban the most harmful practices, reduce the information asymmetry affecting users or call on digital services to design interfaces and features that comply with specific ethical requirements by drawing up a list of best practices[129]. Several groups are already putting forward proposals along these lines[130]. In light of their inherent risks, it is important to include metaverses in these studies, which could prompt changes in European Union law to offer better protection for the people using these services.

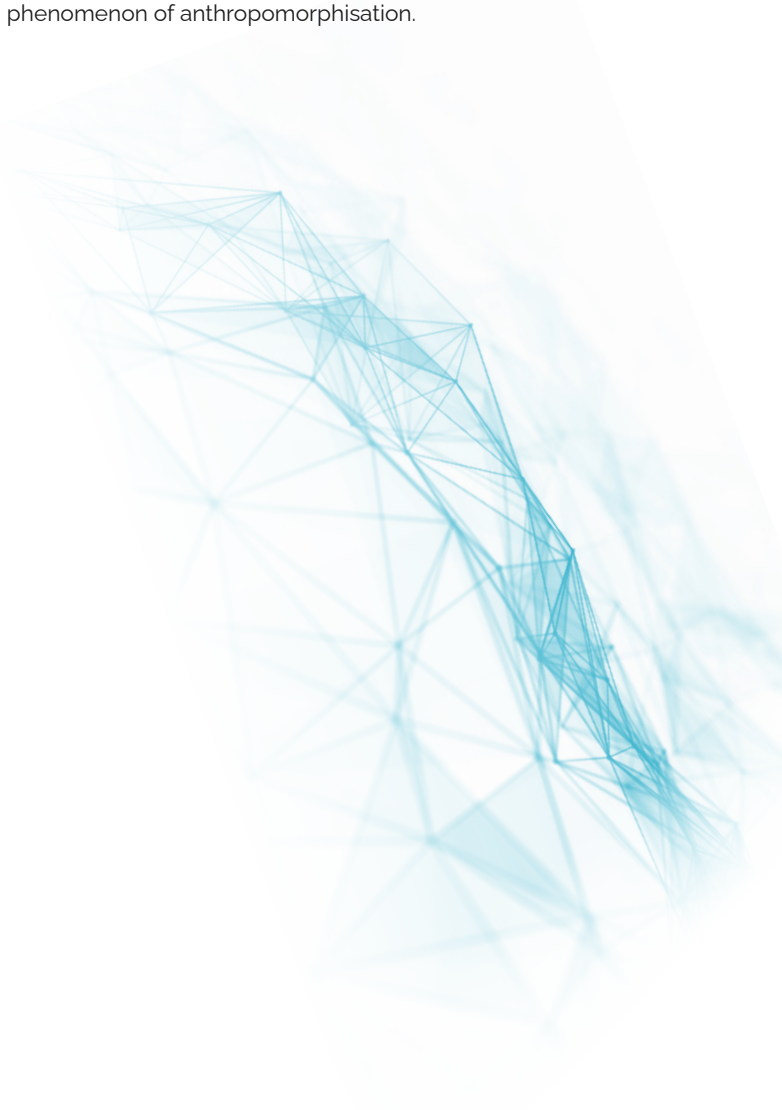
Gamer communities also have a responsibility, since they can sometimes exert psychological pressure on group members to remain active, especially during long combat sessions, and even kick out members who refuse.

These phenomena can cause people to change the order of their intrinsic priorities under the influence of an external party, which contradicts the fundamental principles of autonomy.

Unpleasant or traumatic experiences

This section starts by looking at unpleasant and even painful situations, such as conflicts or separations, whether between friends or lovers, bearing in mind that long-distance relationships (without any physical proximity) between two people can also generate strong feelings, such as happiness or sadness[131]. Favoured by the emergence of such tools as social media, messaging systems and videoconferencing, the emotional impact of conflicts or separations linked to relationships without any physical proximity could be amplified in metaverses for the reasons already mentioned, mainly immersion, which encourages users to create avatars in their image and develop a sense of attachment to another avatar.

This observation can also be applied to the relationship between a physical person and a digitally-controlled avatar. Chatbots, which have made great strides through advances in generative AI, have given rise to similar situations (*cf. Inset Samantha's story*). The combination of this capacity for "credible" dialogue with the evocative power of an avatar in a metaverse (its visual appearance, its behaviour, its body language, the way it moves, the sound of its voice, etc.) reinforces the phenomenon of projection, compared with simply reading a chatbot's words, and can lead to a phenomenon of anthropomorphisation.



126. https://www.ftc.gov/news-events/news/press-releases/2023/03/ftc-finalizes-order-requiring-fortnite-maker-epic-games-pay-245-million-tricking-users-making - also S. Tisseron, F. Tordo (2021), Understanding and caring of online connected persons, *Dunod,* p. 89.
127. The term "captology", or the science of persuasive technologies, refers to "the study of computing and digital technologies as tools for influencing or persuading individuals" (CNNum, "Can we have your attention please! What action can be taken against the attention-based economy?" 2022, p.53) - Adde, CNIL, IP Report no. 6, Shaping choices in the digital world, Personal data, design and desirable frictions, 2019.
128. A technique that involves offering several variants of the same product or service, that differ according to a single criterion, to a panel of consumers for the purpose of determining which variant produces the best results.
129. European Parliament, European Parliament resolution of 12 December 2023 on addictive design of online services and consumer protection in the EU single market (2023/2043(INI)).
130. See especially Panoptykon Fondation: https://twitter.com/PeopleVsBigTech/status/1733954797991031250
Designers Ethiques: https://beta.designersethiques.org/thematique-design-persuasif/concevoir-sans-dark-patterns
131. Metaverses in particular and digital technology in general did not invent this type of relationship, which has existed for a very long time, such as in the form of letters.

INSET

SAMANTHA'S STORY

During the Covid pandemic, US games designer Jason Roher developed Samantha, a chatbot[132]) fbased on what would subsequently become ChatGPT. To follow up on this tool, he launched Project December in September 2020, a website enabling users to create their own personalised chatbot. The site attracted several thousand visitors following an article published in July 2023 about a man whose fiancée had died and who had fed extracts from their Facebook conversations into the site in order to "maintain conversations" with her that were as credible as possible.

In response to the sudden inrush of users, J. Roher contacted OpenAI, the company that develops ChatGPT, to adapt the resources needed to enable these new data processing activities. After several email exchanges, the response was negative, and in September 2023 the company decided to cut off access to these resources, citing safety issues and behaviour with sexual connotations.

Therefore, the author decided to close the website, which triggered a backlash on social media, especially from users who were upset at losing the relationship with their chatbot.

Then there are situations where some metaverse users feel the consequences more acutely, such as "**theft**", which may involve their avatar and its attributes (clothing, experience, etc.) as well as objects, places or services acquired by the avatar. Although no phenomenon of this type has yet been documented in relation to metaverses, there could conceivably be cases where users are victims of an "**abduction**", i.e. a malicious party takes control of their avatar, either to perform malicious actions with that avatar or return it to its owner against payment of a ransom. It is also important to consider the possibility of experiencing the feeling of a "**murder**" if an avatar is deliberately eliminated by a malicious third party, which is something that certain gamers can relate to (this does not mean a character that disappears after losing a fight, but rather the case where a third party gains control of an avatar and purposely deletes it along with its attributes, such as its appearance, experience and purchases).

Mechanisms can also be considered for metaverse operators to **expel** avatars. For example, if a user is deliberately violating their established terms of service, they could decide to temporarily or permanently remove all or part of the avatar's capabilities. An analogy can be drawn with imprisonment, where a person is deprived of some of their rights, starting with their freedom of movement and even going as far as capital punishment if the avatar is permanently removed. Once again, not all users will share these feelings, but they cannot be ignored for users who do experience them.

Harassment and attacks take various forms depending on whether the case relates to the well-known context of social media (reading messages, viewing images or videos) or metaverses (experiences that are sometimes felt to be real). Secondly, and this is specific to metaverses, users may experience situations where their avatar becomes a target for inappropriate or even aggressive words or gestures. For instance, the user's avatar may be brutally surrounded by several avatars who shout out insults and use speech containing bodily, racist, religious, sexist or sexual components[133]. If a user's avatar is "touched", it would be appropriate to speak of a feeling of sexual assault, as has already been reported by users of the first metaverses[134]. In this respect, it should be emphasised that perpetrators would not be charged with rape as French law currently stands. Article 222-23 of the French Criminal Code states that "an act of sexual penetration of any kind whatsoever, or any oral-genital act committed on another person or on the perpetrator through violence, coercion, threat or surprise, is rape." Sexual assault gives rise to more debate. Although it is defined by Article 222-22-2 of the French Criminal Code as "the act of forcing a person, through violence, coercion, threat or surprise, to undergo sexual abuse by a third party or carry out such abuse on that person", there is now some discussion as to whether any physical contact is required to characterise it[135].

In addition, new hardware devices are being developed to capture motion, potentially the whole human body, and generate haptic feedback (force, vibration and heat), which can lead to "real" physical attacks[136] if they are not equipped with effective mechanisms to prevent misuse by malicious people. These devices are used for gaming, education, art and sex (connected sex toys). In the last case, misuse can lead to situations that are similar to the definition of rape under French law.

Although such attacks are well known on social media, it is important to draw attention to a specific **aggravating factor** in metaverses that results from first-person perception, real-time interaction with the attacker and the feeling of being embodied in the avatar (the Proteus effect described in *Section 2.4 Avatars*), all of which accentuates the negative feeling. Furthermore, it is likely that the more time and money users invest in maintaining their avatar, the greater the level of distress that they will feel following certain malicious acts committed in the metaverse.

132. CNPEN (2021), Opinion no. 3, Ethical issues of conversational agents. https://www.ccne-ethique.fr/publications/cnpen-agents-conversationnels-enjeux-dethique?taxo=56

133. Societies 2023, 13(2), 36; https://doi.org/10.3390/soc13020036

134. https://www.sudouest.fr/sciences-et-technologie/metavers-un-avatar-peut-il-etre-agresse-sexuellement-dans-un-univers-virtuel-10411336.php, https://mailchi.mp/numerama/peur-de-marcher-seule-dans-le-metaverse?e=693cd93859, https://medium.com/athena-talks/my-first-virtual-reality-sexual-assault-2330410b62ee#.8lcy2o2bh https://www.theguardian.com/technology/2016/oct/26/virtual-reality-sexual-harassment-online-groping-quivr

135. see in particular J. Rochfeld, "The body of the avatar. Thoughts about the legal treatment of incorporation and proprioception", Mélanges Dany Cohen, *Dalloz*, 2023.

136. The New York Times mentions the case of gamer Mari DeGrazia, who claimed that she was sexually assaulted in this way while she was playing Population: ONE (Meta Quest). https://www.eko.org/images/Metaverse_report_May_2022.pdf ; S. Frenkel and K. Browning (2021), The Metaverse's Dark Side: Here Come Harassment and Assaults. *New York Times*, https://www.nytimes.com/2021/12/30/technology/metaverse-harassment-assaults.html

These malicious acts are most often perpetrated using the basic functions of the metaverse system (e.g. verbal attacks or inappropriate gestures) or in so-called sandboxes, where users are invited to develop their own features. They can also result from cyberattacks that exploit a flaw in the system, which leads to actions that the metaverse manufacturer did not foresee, such as third parties taking control of an avatar. This highlights the need to promptly implement and regularly update effective **cybersecurity** measures for metaverses.

Finally, some authors have raised the issue of **derealisation** (where users feel detached from real life) and **depersonalisation** (a feeling of alienation from oneself), where some users are no longer capable of telling the difference between imaginary life in the metaverse and real life. Without wishing to downplay the importance of these issues, it should be noted that there is currently a lack of scientific literature on the matter, which can mainly be explained by the insufficient number of studies on these subjects.[137] Since nothing is known about their prevalence rate or the extent or duration of their occurrence, this knowledge gap must be filled by developing new research programmes.

In conclusion, it should be remembered that an action, which is often described as virtual because it is carried out in a digital world, has very real physiological or psychological consequences. Therefore, the impacts on certain users, which may vary in terms of their intensity and duration, should not be overlooked or minimised, and they could even lead to **trauma**[138], which will need to be considered as such, both from a medical point of view to determine their treatment, and from a legal perspective to punish offenders after new types of offences have been established..

RECOMMENDATIONS

In light of the risks to people's physical and mental health, this opinion recommends implementing a number of mechanisms:

Prior to development and implementation

P1 (For researchers) Develop multidisciplinary research programmes on a French, European and international level to examine both the physiological and psychological effects of metaverses in the short, medium and long term, with a view to formulating recommendations. Research will need to consider the situations where users are isolated during the immersive experience, since the absence of a third party can amplify some of these impacts and create new effects. Incorporate ethical issues into all these research programmes in liaison with the ethics committees of the associated research institutions.

These projects should especially address the effects on the individual's psychological integrity, such as dependence, harassment, aggression and extortion experienced in an immersive context, or manipulation based on emotional transference and the use of captology techniques when designing virtual worlds.

P2 (For public authorities) Refer the matter to the relevant authorities, particularly ANSES (French Agency for Food, Environmental and Occupational Health & Safety), to follow up on the opinion that it published in 2021 on virtual reality and augmented reality, by extending it to encompass the specific context of metaverses and the new devices available.

P3 (For public authorities) Prevent metaverse manufacturers from developing interfaces that force users to remain online, and when users sign out, prevent manufacturers from depriving them of certain features when they log back in at a later date.

P4 (For manufacturers and operators) To take account of the possibility that cybersickness may occur and cause uncomfortable situations while users are isolated during their immersive experience, implement a procedure enabling users to assess the main risk factors that specifically concern them, especially before their first full immersive experience; for example, investigate the idea of implementing questionnaires or a step-based immersive experience with stopping points and questions.

P5 For manufacturers and operators) To reduce cyberattacks and, where applicable, their effects, continually implement the necessary cybersecurity mechanisms..

137. https://metavers-tribune.com/la-realite-virtuelle-peut-induire-des-symptomes-legers-et-transitoires-de-depersonnalisation-et-de-derealisation/

138. The effects of these events can be amplified if they awaken memories of previous traumatic experiences.

Before and during the immersive experience

P6 (For public authorities) Bind metaverse operators with an obligation to provide clear and understandable information on the physiological effects due to cybersickness that may occur during or after immersion. These warnings must be displayed before users sign in and must be available when offline. In particular, warn users to take a break after an immersive experience before resuming an activity that requires their concentration and attention, such as driving a vehicle.

P7 (For public authorities) Impose mechanisms to make users aware of the amount of time that they have spent connected to a metaverse, such as displaying the time or the daily, weekly or monthly total.

P8 (For manufacturers) Develop protection mechanisms (exclusion zones, immediate disconnection, etc.) that are clearly identified, always available and thoroughly described in the documentation.

Regulatory and legal aspects

P9 (For public authorities) Draw up legislation to classify new types of offences if users suffer a traumatic experience in the metaverse, whether psychological (even where there is no physical aggression) or physical.

3.1.1.3 SITUATIONS DE VULNÉRABILITÉS ACCRUES

As already mentioned, experiences in metaverses will differ tremendously depending on the type of hardware used and the subscription and consent mechanisms implemented, which will also lead to varying consequences.

It is important to describe another form of variability, i.e. people. In other words, every user is different, and several people may come away from the same immersive situation with a very different experience. The same remark applies to a single person who, depending on their state (tiredness, interest, etc.) and the context (existence of external pressure), may experience variable effects.

It should be emphasised that the risk of individual vulnerability is exacerbated when users are on their own. More often than not, these isolated users are not informed or trained how to use metaverses properly. In addition, some users may be unaware of their own vulnerabilities, such as undiagnosed disorders or suppressed memories of old traumatic experiences that may be awoken by an immersive experience[139]. Anticiper l'intégralité des effets des environnements immersifs, quel que soit leur degré de gravité ou de probabilité, pour l'ensemble de la population, est une tâche difficile, si ce n'est impossible.

Anticipating all the effects of immersive environments, irrespective of their degree of severity or probability, for the entire population is a difficult, not to say impossible, task.

However, the emphasis should be firmly placed on situations where the potential vulnerabilities are already well known, such as the elderly or people with disabilities, including cognitive disabilities. There are particularly serious health risks, such as epileptic seizures, for users with epilepsy. It should be pointed out that for people who do not have a history of epilepsy, exposure to these environments is no more likely to trigger seizures than video games. Although, as ANSES points out, there is "insufficient research to conclude" that virtual reality can induce paranoia or dissociative disorders, it is recommended that people suffering from psychotic disorders should avoid exposure to these technologies. Conversely, some studies tend to show that immersive environments can actually be beneficial for certain people with an autism spectrum disorder (ASD)[140]. Nevertheless, it is important to distinguish between experiences carried out in a therapeutic setting and the use of a metaverse without any control and supervision by a professional. In the latter case, there is a very high risk of discomfort, since some people with ASD can be very sensitive to light and noise, and are stressed by unfamiliar environments.

In all these cases, these vulnerabilities are only potential and do not affect all these populations.

RECOMMENDATIONS

P10 (For researchers) In accordance with the preamble to recommendation P1, develop research programmes aimed at understanding the specific physiological and psychological effects on vulnerable people when using metaverses.

P11 (For public authorities) Bind metaverse operators with an obligation to provide clear and understandable information on the potential risks, particularly for people suffering from certain conditions or behavioural disorders.

P12 (For public authorities, manufacturers, operators and users) Recommend that people suffering from certain conditions or behavioural disorders should either avoid using the metaverse or be accompanied before, during and after using the metaverse at these different stages, and provide advice for carers on the potential risks of using metaverses.

139. S. Tisseron, speech during the conference entitled "One year after the publication of the report on metaverses by the interministerial exploratory mission", 7 November 2023, Ministry of Finance (INRIA, CNNUm and Directorate General for Business).
140. A. Dechsling, S. Orm., T. Kalandadze et al. (2022), Virtual and Augmented Reality in Social Skills Interventions for Individuals with Autism Spectrum Disorder: A Scoping Review. *J Autism Dev Disord* 52, 4692–4707. https://doi.org/10.1007/s10803-021-05338-5.

3.1.1.4 CHILDREN AND TEENAGERS

Social interaction plays a crucial role in the cognitive and emotional development of children and teenagers. It would appear to be essential to take account of the particular situation when minors, who are an especially vulnerable group, are exposed to immersive technologies from both a physiological and psychological point of view[141].

Therefore, questions must be raised about parental supervision and even the prospect of a ban on such experiences for the very young, in the same way as restrictions exist for video games and films. It should be remembered that the use of immersive devices, including headsets, incurs risks for the **development of the psychological and visual system** in the very young (*cf. Section 3.1.1.1 Physiological issues*). Secondly, since metaverses are used as spaces for social encounters, these new types of immersive interaction have effects on a natural person's behaviour, whether within immersive environments through their avatars or in the real world.

As the Ethics Committee for Educational Data points out (*cf. Appendix 1 - Opinion of the Ethics Committee for Educational Data*): "The impact that the use of avatars in virtual worlds has on self-construction and self-representation must be taken into account, particularly in the case of children and teenagers who are in the process of building and developing their identity." Some quarters are encouraging the French education system to use metaverses and more generally virtual reality devices to "enrich" the education process for students. However, the anticipated educational and cultural virtues of using such immersive worlds should not overshadow the important role that physical interaction plays in the psychological and cognitive development of children and teenagers, especially the very young. The experience of the health crisis and the ensuing lockdowns revealed the limitations and inadequacy of digital tools for ensuring the psychological well-being of schoolchildren and students.

Consideration should also be given to the cases of rape, grooming, and **sexual** harassment and assault[142], such as described in the report[143] by a British child protection charity. Based on a scientific literature review, interviews with stakeholders (developers, victims, support groups, etc.) and observations of how digital platforms operate, the report was presented to and discussed by the British and European parliaments. The authors explain how they thought that they were working "ahead of the curve" to try to anticipate and give policy-makers, lawyers, regulators and developers ample time to implement safeguards but, in carrying out their work, they realised that the risks already existed [144]. They report that half of the children abused in a digital world remain silent about their experience, either due to fears of retaliation from their VR community or being banned from using VR by their parents, or because of a feeling of shock; it should be noted that some of these children end up committing suicide. They also mention the phenomenon of derealisation (dissociation between imaginary and real life, *cf. Section 3.1.1 Psychological issues*), which has been observed in victims and also in perpetrators who, without the usual inhibitions, act with a greater sense of impunity.

There are two main types of scenario. The first, which is similar to what has been seen on social media, begins with an encounter between a minor and a malicious individual through their avatars. The perpetrator will tend to choose an appearance and type of behaviour (particularly language) that are likely to gain the young person's trust. Discussions can lead to meetings, whether remotely (telephone or videoconference) or in the real world. If meetings take place in the digital world, the aim is to obtain messages, photos and videos of certain situations (nudity, "explicit dances", etc.). If they take place in the real world, they may lead to inappropriate actions (words or gestures), assault or rape.

The second type of scenario also begins with an initial encounter through avatars, but can lead — and this is a specific feature of immersive experiences — to actions carried out in the metaverse. Firstly, a child is exposed, through their own avatar, to words and/or practices of a sexual nature (touching and simulated sexual acts, which are sometimes collective). Secondly, a child is allowed or encouraged to view sexual practices that may be non-consensual, degrading or violent, involving third-party avatars, some of which may look like children or acquaintances[145]. Once again, immersive first-person viewing reinforces the feeling of presence, such as in relation to watching a pornographic video whose harmful effects are well known, particularly on the development of sexuality, by "standardising" practices that are degrading, violent or non-consensual.

These practices may spawn new forms of prostitution involving minors who, through their avatar, perform acts that are requested and paid for by a client.

In both types of scenario, there are several ways for perpetrators to exploit the recordings that they have made of these interactions (digital or real) other than for their personal use. Firstly, services specialising in tackling crime against children have seen an upsurge in blackmail attempts where the perpetrator threatens to show the recordings to the victim's family and friends unless the victim pays a sum of money or sends a new recording of a real or simulated explicit sexual activity, either directly or through their avatar[146]. These recordings can then be sold or swapped, both on the clearnet using peer-to-peer networks or generic applications (social

141. UNICEF (2023), The Metaverse, Extended Reality and Children

142. The scenarios described in the rest of this section do not only concern minors. Adults, especially public figures (e.g. politicians), are also potential targets for these acts. However, children and teenagers are considered to be easier prey on account of the potential vulnerability associated with their age, the possible naivety caused by their lack of experience or their possible social isolation.

143. C. Allen and V. McIntosh (2023), Child safeguarding and immersive technologies: an outline of the risks. National Society for the Prevention of Cruelty to Children, London.

144. According to estimates, around a quarter of the 8 to 18-year-old population in the United States have already had an immersive experience.

145. Which may include people who have never connected to a metaverse.

146. According to Article 227-22-2 of the French Criminal Code: "Except in cases of rape or sexual assault, any incitement by an adult for a minor, by means of electronic communication, to commit any act of a sexual nature, either on that person, or on or with a third party, even if such incitement is not acted upon, carries a prison sentence of seven years and a fine of €100,000.
The penalties are increased to a 10-year prison sentence and a fine of €150,000 when the offence is committed against a minor under the age of 15. The penalties are increased to a 10-year prison sentence and a fine of €1 million if the offences were committed as part of an organised gang."

media and websites), and the darkverse (*see inset*) between members of paedo-criminal networks.

INSET

DARKVERSE

Just like the Internet and the dark net (or dark web), metaverses harbour "areas" known as darkverses that are rife with illegal and even criminal activities. These activities can obviously be carried out in any other part of a metaverse, but a darkverse offers anonymity, which explains why they attract organised criminals as well as individuals looking to commit crimes against children. Darkverses may include "service packages", such as the sale of disinformation tools (featuring an army of AI-controlled avatars, services for manipulating animated 3D sequences, etc.) or the organisation of "open meetings" or "private chatrooms" that attract "enthusiasts" of specific criminal practices.

The above-mentioned report[147] singles out metaverse manufacturers for failing to prioritise child safeguarding. There is an attempt, in vain, for manufacturers to impose an age limit, preventive information or the need for parental control. An aggravating factor that is specific to immersive experiences is that they do not allow an "outside observer" to control a traumatic sequence that has already taken place or is taking place, unlike browsing a website or taking part in a game session where several people can view the images on a screen. This situation can be amplified by the fact that generations differ in their knowledge and understanding of the technologies involved, particularly through the video games culture.

RECOMMENDATIONS

P13 (For researchers) In accordance with the preamble to recommendation P1, develop research programmes aimed at understanding the specific physiological and psychological effects on vulnerable people when using metaverses. As recommended by the French Ethics Committee for Educational Data, examine the potential effects on children's and teenagers' ability to develop their identity before considering any wider deployment of these uses, particularly in schools and extracurricular activities.

P14 (For public authorities) Without waiting to see the results of any current scientific studies, consider which measures should be taken to protect the youngest users with a view to imposing age restrictions on the use of certain devices such as headsets, and banning access to metaverses by looking into the prospect of implementing effective parental controls or access restrictions.

P15 (For public authorities) Draw up legislation to classify new types of offences if children or teenagers are exploited while using metaverses

P16 (For public authorities) Bind metaverse operators with an obligation to provide clear and understandable information on the risk of exploitation concerning children or teenagers.

3.1.2 AVATAR-RELATED ISSUES

An avatar comprises a set of visual, sound and potentially behavioural representations associated with a person using an immersive environment and can take a form ranging from a few coloured pixels to a more sophisticated appearance (*cf. Section 2.4.1 Description*). Over the last few years, avatars have evolved considerably as users have started personalising and fleshing them out to the point of attaching experiences, goods, their image, and even facets of their own identity or representation. Since avatars can convey emotions and personal data (possibly sensitive data), it is important to give greater focus to this particular subject. The avatar can be viewed in its own right or through its interactions.

There are two categories of avatars within metaverses, namely those that are controlled by human users and those that are controlled solely by a digital system (*cf. Section 2.4.1 Description)*. These two categories of avatars raise specific ethical questions, which will be examined in turn.

Choice of avatar

The first series of questions touches upon the **choice of avatar**. Except for the specific case of avatars used for professional purposes where the employer may impose certain restrictions (*cf. Section 2.4 Avatars*), it is important to draw attention to the **considerable freedom** available to users when choosing the appearance and behaviour of their avatar, while remaining within the limits of the technical possibilities offered by a metaverse. Such freedom should benefit users by encouraging them to exercise their fundamental freedoms (freedom of expression, assembly, association and opinion), and it ties in with the issue of preserving anonymity, such as during online conversations.

Depending on the features offered by the system, users can choose to represent themselves in non-human form or as all kinds of animals and imaginary creatures. The choices that users make when creating their avatar in a metaverse may be influenced by a variety of reasons, whether to have fun, to show their creative streak, to differentiate between their real and digital appearances on aesthetic grounds, to protect their anonymity or to mislead other users for malicious or criminal purposes and avoid identification in the event of illegal conduct. As far as the last example is concerned, tensions arise between the right to freedom of expression and preservation of anonymity, and the need to ensure that perpetrators of malicious or unlawful acts can be identified. Some users might be tempted to go "incognito" in order to commit acts that are ethically or legally immoral or reprehensible under the guise of anonymity (or rather the appearance of anonymity).

147. The Metaverse, Extended Reality and Children, *op. cit.*

Wikimedia, Photo Hyacinthe Luynes

Different types of avatars in Second Life

INSET

L'ANNEAU DE GYGÈS

The presence of an avatar is always "revealed" to other users, since there is no such thing as an "invisible" avatar, barring exceptions. These considerations conjure up images of Plato's "Ring of Gyges" and the ethical questions raised by the following thought experiment: the person wearing such a ring would be invisible to all others and might therefore be tempted to commit illegal, immoral or unjust acts if such behaviour seemed beneficial to that person. Similarly, people using a metaverse with an invisible avatar could be more easily tempted to commit malicious acts against other users.

A closer look should also be taken at the possibility for each user to choose **several avatars.** The issue of multiple identities and the question of representation in the relationship with other people refer more generally to the issues of **digital identities.** These issues are central to metaverses[148]. When it comes to malicious behaviour, these very questions are already being raised by the creation of fake profiles on social media, such as for the purpose of blackmailing people by threatening to reveal intimate pictures. They are likely to be amplified in metaverses since, in addition to photos, "compromising" dynamic 3D scenes could take place and be recorded (*cf. Section 3.1.1.4 Children and teenagers*).

In all these cases, the question of **trust** arises. One viable approach would be to set up an **authentication** mechanism so that users would know who is controlling the avatar with which they are interacting, while ensuring that such a mechanism is optional. However, it is already essential to carry out campaigns to educate the general public and especially young people about the risks of misconduct by other users and provide the necessary instructions on how to exercise caution. For example, specific avatars could be put into action in a metaverse with a series of real-life scenarios to show how malicious people can exploit their interactions and behaviour in the metaverse.

Risks of anthropomorphism

As for avatars controlled by digital systems, it is worth highlighting the risks associated with the **anthropomorphic illusion,** which increases as avatars become ever more realistic. While AI systems as such are already subject to a certain degree of anthropomorphic bias, as evidenced by the discussions surrounding chatbots[149], the fact that the appearance and behaviour of avatars are increasingly close to reality accentuates the tendency for humans to attribute human characteristics to those avatars and consequently modify their own behaviour (*cf. Section 2.4.2 Intermediation - Proteus effect)*. The emergence of generative AI systems reinforces the capacity for illusion by offering wholly believable conversations between human users and avatars[150] , which thereby heightens the risk of manipulating users. To limit this illusion, thought needs to be given to the types of mechanism that should be put into practice so that users, if they so wish, do not forget during the immersive experience that they are in the process of interacting with a digital system.

Children and dead people

Another question concerns the cases where people use **representations of children, the living and dead people** (in visual, auditory and/or written form), and the means to oppose this practice. This particular problem is not inherent in immersive worlds, but arises in new terms due to the characteristics of metaverses, especially with the ability to create avatars controlled by either users or digital systems. Users can take on the appearance and behaviour (including

148. C. François, R. Ronfard, A. Basdevant (2021), Interministerial Exploratory Mission on the Metaverse, p. 61 and p. 94-96.
149. CNPEN (2022), Opinion no. 3, Ethical issues of conversational agents, p. 7 & s. https://www.ccne-ethique.fr/publications/cnpen-agents-conversationnels-enjeux-dethique?taxo=56
150. CNPEN (2023), Opinion no. 7, Ethical issues of generative artificial intelligence. https://www.ccne-ethique.fr/fr/publications/avis-7-du-cnpen-systemes-dintelligence-artificielle-generative-enjeux-dethique

dialogue) of a child, a living person other than themselves or a deceased person. Choosing such a representation would then be limited to respecting the ethical principle of non-malevolence, i.e. it must not infringe third-party rights. From a legal perspective, if the avatar's image or behaviour is likely to confuse other users, it could be construed as constituting an infringement of publicity rights (personality rights, right to protection of privacy, etc.) or digital identity theft (punishable under Article L. 226-4-1 of the French Criminal Code). In addition, it raises questions about the ethical issues involved in a society where deceased people could be transformed into avatars without having given their consent during their lifetime, by making a distinction between public bodies and private individuals. The problem of chatbots mimicking dead people (deadbots) can therefore be transposed to the specific case of the metaverse[151].

Another issue concerns the case where **adults choose to visually represent themselves as a young child.** This prompts the question of whether they could make their avatar engage in behaviour that could be considered to be criminal (sexual acts carried out by a "virtual child"). In this respect, the well-documented example of Second Life paints a revealing picture of these tensions. Although Linden Lab, the platform's creator, prohibits minors from accessing Second Life, adult users can choose avatars that look like children. Several cases of child pornography have been reported[152], where avatars were used to simulate the sexual abuse of minors[153]. Other problematic cases involve Second Life users who create child avatars wearing "provocative outfits"[154]. Linden Lab has responded by taking a number of measures to ban people engaging in ageplay on its platform[155]. In November 2007, the company published its policy on avatar representations involving (or appearing to involve) minors on its blog[156]: such behaviour is explicitly forbidden in Second Life. In addition, when the individuals concerned are detected, they are subject to penalties that may go as far as terminating their accounts, closing groups, removing content, and losing land or access to land.

Rights and legal status

In addition to the choice of visual representation, another issue concerns the **type of avatar** when it is controlled by the user within the limits imposed by the system. Assuming that the avatar bears a strong resemblance to the person by faithfully reproducing their image, this begs the question as to whether the metaverse manufacturer can, by virtue of its terms of service, claim "all rights" to the avatar, such as removing it or preventing users from disposing of their avatar as they see fit[157]. In addition, it is worth examining whether users can sell their visual representation to a third party.

151. CNPEN (2022), Opinion no. 3, Ethical issues of conversational agents, pp. 14-16. https://www.ccne-ethique.fr/publications/cnpen-agents-conversationnels-enjeux-dethique?taxo=56
152. M. Johnson, K.M. Rogers (2009), "Too far down the yellow brick road – cyber- hysteria and virtual Porn, *Journal of International Commercial Law and Technology,* 4(1).
153. Combating Child Exploitation in Second Life. DOI: https://ieeexplore.ieee.org/document/5444398
154. K. Connolly (2007), Second Life in virtual child sex scandal. *The Guardian,* UK. http://www.guardian.co.uk/technology/2007/may/09/secondlife.web20
155. T. Guest (2008), Second lives: A journey through virtual worlds, New York, *NY: Random House.*
156. K. Linden (2007), Clarification of Policy Disallowing "Ageplay". https://blogs.secondlife.com/community/features/blog/2007/11/14/clarification-of-policy-disallowing-ageplay
157. JJ. Rochfeld, (2023) "The body of the avatar. Thoughts about the legal treatment of incorporation and proprioception", Mélanges Dany Cohen, *Dalloz.*

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LEGAL STATUS OF THE AVATAR

The status of user-controlled avatars is a tricky issue, since avatars fall between two legal categories, i.e. the object[158] and the subject. There is some debate in legal circles as to whether avatars can be classified as intellectual works in light of the modern methods available for creating computer-generated characters, which allow users to be highly creative when crafting their avatar(s)[159]. These aspects can have strong economic implications when the issue of selling these avatars is addressed. Furthermore, since avatars can potentially be used to identify the people that they represent, current law begs the question about whether the GDPR applies as soon as, according to the provisions of Article 4, personal data is any information that relates to an identifiable natural person who can be identified, either directly (first name and surname) or indirectly (biometric data, identifiers, etc.). Considering an avatar to be personal data also suggests the notion of digital identity. Since users leave an extremely strong imprint on their avatar, whether in terms of their personality or identity, their avatar could legally be considered to be subject to publicity rights. If metaverse users decide to represent themselves with avatars that mirror their likeness, then questions will inevitably arise about privacy and image protection.

RECOMMENDATIONS

P17 (For researchers) In accordance with the preamble to recommendation P1, develop research projects to identify and analyse the risks of anthropomorphism that may arise from choosing an avatar that incorporates human traits and characteristics into its behaviour.

P18 (For public authorities) Bind metaverse operators with an obligation to provide clear and understandable information on the risks of anthropomorphism.

P19 (For public authorities) Bind metaverse operators with an obligation to provide clear and comprehensible information where operators introduce avatars controlled by a digital system and mechanisms to ensure that users do not forget during the immersive experience that they can interact with these avatars and, if they so wish, identify them as such.

P20 (For public authorities and metaverse operators) Educate users, especially vulnerable people, on the risks of being manipulated or developing an attachment to fictitious entities.

P21 (For public authorities, manufacturers, operators and researchers) Carry out ethical studies into the use of avatars that look and behave (and talk) like a child or a living or deceased person, with a view to implementing a framework to govern such practices.

P22 (For public authorities, manufacturers, operators and researchers) Carry out ethical studies into the link between preserving anonymity and the obligation for users to authenticate when using digital services.

3.1.3 DATA-RELATED ISSUES

The issues relating to the protection of personal data, especially physiological data, cropped up before metaverses hit the scene. They have long existed in many other applications (e-commerce, electronic voting, social media, etc.). As with any digital system, a closer look needs to be taken at how metaverse operators will collect and use those data, and how users will be informed and capable of giving or refusing their consent. In addition, depending on the type of metaverse and its developer's purpose, highly detailed profiling could potentially be carried out for commercial purposes. Longer connection times, increasingly enriched data (compared to the data that are currently collected when users browse the web) and the introduction of new data categories raise a host of **specific ethical issues.**

INSET

POSITION DETERMINATION IN A METAVERSE

In a metaverse, manufacturers must be able to determine a user's exact position and viewing direction at all times in order to produce the corresponding computer-generated images. Therefore, this capability could easily be offered to other users, but the terms would need to be defined (systematic or on request, subject to consent, level of precision, etc.). The ability to determine a user's position sparks significant ethical issues that bear similarities to existing contexts, such as geolocating a smartphone or finding a user's location on the virtual map provided by the Snapchat app[160]. There is currently a great deal of social pressure weighing down on the decision to allow or decline this feature within a group of friends or a couple, and refusal could be interpreted as a desire to conceal behaviour. Consequently, tensions lie between the principles of transparency and trust between people and the principle of freedom for people to not disclose their movements or reveal the identity of the people that they have met in a metaverse.

158. In this case, the conventional rules of property law would apply. The avatar would then constitute an intangible object that is economic in nature.

159. V.-L. Benabou (2023), "The intellectual property issues of digital representations of individuals in the virtual world: what rights for their digital double?", *Dalloz IP/IT*, p. 220.

160. https://map.snapchat.com/

3.1.3.1 DATA PROTECTION

Several questions arise when dealing with the prospect of collecting, processing and cross-referencing physiological data, which could provide information about users' behaviour and interactions, and even their physiological and psychological state. This potentially highly precise information may reveal aspects of their personality and even their intimacy.

The first question concerns the user's control over the data resulting from their successive immersive experiences (i.e. their history), from the initial data collected (location, viewing direction, actions, etc.) through to the computer-generated information, such as behaviour or estimated emotions. Some argue that avatars can be considered to be a "virtual emanation of the person" if they can be used to single out that person, such as through their similarity to the person's appearance or behaviour. Due to the very close link that ties users to their avatar, it would have to be accepted that, as a matter of principle, avatars cannot be transferred, i.e. the principle of non-transferability would apply. If an avatar is considered to be nothing more than a visual representation of the user, then a distinction must be made between the non-transferability of this visual representation (*cf. Section 3.1.2 above*) and the non-transferability of the data collected.

In addition, the status of the physiological or behavioural data collected must be determined. The definition in the GDPR is broad enough to classify such data as personal data. However, it may be harder to categorise such physiological or behavioural data as sensitive data (these data are not allowed to be processed[161]). There will not be any difficulty in classifying the data as sensitive if they disclose the person's state of health, which may be the case if they show that the user is suffering from depression or reveal the user's sexual orientation, or if biometric data are processed that identify the person. However, given the current state of knowledge, not all physiological or behavioural data can be used to individually identify a person. Nevertheless, this situation could change if they are cross-referenced with other datasets, or if scientific advances pave the way to new identification methods[162]. The list of sensitive data could then include behavioural and physiological data.

However, given the issues involved in using these data in metaverses, the definition for sensitive data may appear to be insufficient, since prohibiting processing activities on such data under the GDPR is subject to a number of exceptions, especially the requirement to obtain the data subject's consent, which does not seem to afford much protection. That explains why some[163] suggest recognising a ban in principle on the sensitive processing of physiological and behavioural data, i.e. any processing operations that present a significant risk of infringing fundamental rights and freedoms. As far as immersive worlds are concerned, restricting these processing operations could be justified when there is a substantial risk of undermining the individual's privacy or limiting their autonomy, decision-making process and freedom of choice.

3.1.3.2 INFORMATION AND CONSENT

Another issue concerns the need to inform users and the conditions for obtaining their **consent** when this is legally required to process their data, which presupposes that choice interfaces are honest and easy to use. Therefore, metaverses could potentially offer several levels of consent (full or limited) that provide users with total or restricted access to their features, which constitutes a form of forced incitement to give their full consent. This could end up creating a conflict between the user's desire to enjoy the most immersive experience possible and their wish to protect their personal data. This conflict will be compounded by the fact that the hardware interface or metaverse manager will have a vested interest in gaining access to a larger and/or more accurate set of data. This may be achieved by offering an improved experience during immersion in return for collecting a greater volume of personal data.

This may lead to questions about whether users are actually able to provide their free consent if a quality immersive experience (particularly if it has already begun) is subject to processing especially detailed data in real time. This ties in with existing discussions about the "*privacy paradox*", namely the discrepancy between the expressed concern for protecting data and users' actual behaviour. Beyond that, we might question the very possibility for users to express such consent in the context of immersive worlds, given that their metaverses' properties may limit users' full awareness. Therefore, an in-depth review is needed to determine the effectiveness of collecting consent in this particular context. These limits could justify requiring metaverse providers and operators to take all measures to prevent substantial violations of the user's autonomy. Such a move is especially necessary, since users should be able to promote the use of virtuous systems and consequently exert pressure on metaverses that give less respect and consideration to their privacy and autonomy.

Another aspect worth mentioning is the data collected by the cameras on augmented reality devices, which is used to recreate the user's actual environment. This data could make it possible to identify people and their behavior without their consent.

An analogy can be drawn with the way in which voice assistants capture the spoken words of non-users, which are then analyzed by voice recognition processes to identify the recorded user. Even if most of this data remains confined to devices, there is a risk that needs to be taken into account.

161. Sensitive data are any information revealing racial or ethnic origin, political opinions, religious or philosophical beliefs, or trade union membership, and genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation.

162. Just like fingerprints, which did not provide a reliable means of identifying a person until the early 20th century. https://www.gendarmerie.interieur.gouv.fr/pjgn/institut-de-recherche-criminelle-de-la-gendarmerie-nationale/l-expertise-decodee/identification/les-empreintes-digitales-la-doyenne-des-preuves-scientifiques

163. J. Rochfeld, C. Zolynski (2021), " The value of emotions: what system for mental capitalism?", Entre art et technique: les dynamiques du droit. Mélanges en l'honneur de P. Sirinelli, *Dalloz*, pp. 749-770, spéc. 762&s.

RECOMMENDATIONS

P23 (For public authorities) Investigate the need to strengthen the protection of physiological and behavioural data by classing such data as sensitive within the meaning of the GDPR, and even consider the prospect of banning sensitive processing operations on such data when there is a substantial risk of undermining the individual's privacy or limiting their autonomy, decision-making process and freedom of choice.

P24 (For public authorities) Require metaverse managers to set up a mechanism that respects the principle of data protection by design in accordance with the GDPR, which specifically indicates the risks and types of personal data processing operations; in addition, require metaverse managers to take all measures to prevent a substantial violation of the user's autonomy.

3.2 SOCIETY-RELATED ISSUES

3.2.1 ACCESS AND EQUITY

Metaverses should encourage respect for a wide range of values, equality before the law and individual life choices. Manufacturers and operators should also ensure that their metaverses are not used to undermine the principles and values enshrined in European law. Consequently, respect for fairness and equity in immersive environments is vitally important when it comes to the ethical issues, over and above the formal legal aspects. This should be reflected at three different levels, namely access to all metaverses, access for all users and the possibility of not being forced to access a metaverse.

Access to all metaverses

To prevent locking users into an ecosystem imposed by a metaverse manufacturer based on its proprietary technologies, it is important to offer the most varied selection of products and services to make sure that users have a real choice. This capability especially depends on ensuring interoperability between those different systems that allow certain types of data to be shared, whether avatars, experience or digital assets (*cf. Section 2.1.5.1 Interoperability*). Interoperability is mainly reliant on metaverse manufacturers adopting conventions and then standards (*cf. Section 2.1.5.2 Standardisation*).

Therefore and whenever practicable, "all" stakeholders, from designers and operators through to users, need to be involved in the various discussions and standardisation work, so that users are not subjected to standards promoting values that are different from and sometimes far removed from national and European values. Companies, academia and governments alike should address these issues so that they can play a part, however small, in standardising products that are designed and developed by non-European companies.

Access for all users

Distributive justice appears to be a core principle of digital ethics insofar as it aims to tackle any unequal distribution in the benefits provided by new technologies, such as metaverses and immersive environments.

When transposed to metaverses, distributive justice firstly implies promoting access to the widest possible audience, regardless of the financial and technological means of those people who wish to access these environments, as emphasised by the European Parliament in its report on virtual worlds[164]. Narrowing the digital divide has two upsides in terms of equity and social justice, namely widespread access to metaverses as such, and widespread access to culture facilitated by metaverses due to the educational and informative nature of some types of metaverse[165].

To ensure that metaverses form an open and universally accessible ecosystem, a closer look must be taken at how to effectively guarantee that access, while factoring in the financial costs as well as the challenges involved in ensuring that as many people as possible are proficient in using the technologies. Rejecting bias and discrimination is another aspect of equity. In this respect, it is important to consider populations that are particularly vulnerable, such as people with disabilities. While some of the rhetoric singing the praises of metaverses emphasises the theoretical possibility of transforming them into open, inclusive and accessible worlds, it needs to be taken to its logical conclusion by ensuring that the appropriate hardware and software can actually be developed[166]. In the absence of any research in this area, the promises heralded by inclusive and open metaverses are doomed to remain nothing more than hype.

164. https://www.europarl.europa.eu/doceo/document/IMCO-PR-751902_EN.pdf
165. Metaverses can offer access to cultural activities, such as virtual visits to museums, or activities that would otherwise be too expensive or out of reach (visits to remote, closed or destroyed sites).
166. C. Parker et al, (2023), Towards an Inclusive and Accessible Metaverse, CHI EA '23: Extended Abstracts of the *2023 CHI Conference on Human Factors in Computing Systems*, Article N°370, pp. 1-5. https://doi.org/10.1145/3544549.3573811

INSET

DIGITAL ACCESSIBILITY FOR PEOPLE WITH DISABILITIES

Digital technologies have become an essential tool for enquiring, developing knowledge, communicating, learning and participating in public life, yet approximately 15% of the population[167] are potentially excluded, either partially or totally. For example, this includes people who suffer from tremors that prevent them from typing comfortably and accurately, people whose visual or hearing impairments prevent them from perceiving all the content displayed on a screen (text, images or sound), or people whose cognitive problems affect their ability to understand information. These restrictions lead to **discrimination** that results in their exclusion from the digital world..

Technological solutions are available for most of these problems, ranging from specific hardware (adapted keyboards, screen readers with text-to-speech synthesis, etc.) to software applications that incorporate the basic mechanisms found in all operating systems (keyboard shortcuts, predictive typing, speech recognition and synthesis, magnifiers, etc.), as well as the application of W3C guidelines (WCAG), especially the structure and description of non-text content (images, graphics, URLs, etc.), for building office documents or websites.

Most of these solutions have been tried and tested for decades, but unfortunately they are rarely put into practice because they are often only known to a small audience. For example, work has been conducted into sensory substitution, which enables people with visual impairments to perceive (at least partially) an image and therefore an animated scene. Therefore, it is important to apply existing solutions while continuing to develop research projects to create metaverses that minimise the exclusion caused by disabilities if the values of justice are to be truly respected.

In addition, other issues must be considered, which may appear to conflict with each other. The first is the risk that certain metaverses could end up being reserved for a small part of the population for financial reasons, due to the expensive hardware or subscriptions required to access them. The second issue can be found in the opposite assumption, where the supposed "widespread" access to culture (e.g. through the national education system) facilitated by immersive experiences[168] would lead to a situation in which only an "elite" would continue travelling and visiting physical museums, while the rest of the population would make do with the simulations offered by metaverses. When it comes to social justice, the result is a tension between the desire to promote metaverses for their ability to broaden access to culture (bearing in mind that culture is considered too elitist, particularly among the younger generation), and the need to maintain a direct relationship between the general public and works of art. Only when these issues are taken into account can immersive environments be effectively brought to a wider audience. The fact remains that these issues, which involve social and public policy choices, must not be left to metaverse operators alone. It is up to the general public and policy-makers — both national and supra-national — to address them.

However, universal access to all metaverses goes hand-in-hand with a fundamental difficulty in terms of the environmental issues involved, which may raise major question marks about the large-scale use of metaverses (cf. 3.3 Environmental issues).

Possibility of not being forced to access a metaverse

In addition, people who do not wish to use metaverses on personal grounds or who are unable to use them for various reasons (disability, limited financial resources, lack of technology skills, etc.) should not be forced to do so by any means whatsoever, and other solutions should be considered if important actions need to be carried out, such as certain administrative procedures[169].

RECOMMENDATIONS

S1 (For all stakeholders) Raise awareness and encourage participation in standardisation activities. Create a French and European strategy to drive participation, including at the international level.

S2 (For public authorities) Require metaverse manufacturers to implement technical solutions so that their products are digitally accessible to people with disabilities.

S3 (For public authorities) Prohibit the use of the metaverse as the only option for carrying out certain procedures, especially administrative formalities; maintain the option of using other solutions, particularly involving real people.

167. urcentage moyen mesuré par l'OMS, soit au moins un milliard de personnes. https://www.who.int/fr/news-room/fact-sheets/detail/disability-and-health

168. "Virtual" museum visits using software and websites are already available. V. C. Maurel (2015), L'usage du web 2.0 par les musées en relation avec leur public et ses enjeux. http://clairemaurel.com/wp-content/uploads/2015/03/Memoire-Claire-MAUREL.pdf

169. One example is the decision in France to create an online platform for completing and submitting income tax returns, which has caused many problems for those people who do not have the necessary equipment or do not know how to use the platform, which has required the authorities to reopen their walk-in tax enquiry offices.

3.2.2 INFLUENCE AND MANIPULATION

The issue of manipulating feelings and opinions and, consequently, influencing action-related decisions (purchases, voting, political commitments, religious choices, etc.) must be given priority consideration due to what is at stake for individuals and society as a whole, particularly in terms of preserving informed public debate and, more generally, democracy.

At a time when our democracies are coming under increasing threat, it is important to take account of the additional risks posed by metaverses. People must be given the means to develop their critical thinking skills and adopt the "right" habits when faced with attempted manipulation, and also protect themselves against aggressive commercial practices designed to influence their decisions (purchases, etc.) and against attempts to destabilise institutions.

3.2.2.1 ISSUES IN TERMS OF INFLUENCING AND MANIPULATING PEOPLE

The most common approach involves manipulating the emotions of metaverse users to guide and force their decisions (such as relating to purchases). This type of manipulation can be achieved by **modifying in real time the 3D digital environment** where users are moving their avatar and "adapting" it to reflect their interests and tastes, whether by adding specific objects like stores, placing a large proportion of a given brand's vehicles in the streets, or bringing users into contact with avatars giving their feedback (obviously positive) about a given product. It is easy for users to engage with goods or special offers that seem to appear "spontaneously" on a website, when in fact they have been generated according to their purchasing and browsing history. The persuasive power of this technique is amplified by the immersive nature of an experience in a metaverse.

It is clear that the extent to which user data are collected, as well as their accuracy, coupled with the possibility of experimentation and optimisation (A/B testing) which are facilitated by the use of algorithms that analyse the impact of this environment on a large scale from millions of data items (clickstream data), encourages the development of these adaptation mechanisms.

This has the effect of creating tensions between the user's desire to evolve in a 3D digital environment that closely mirrors their interests, and the risk that personalising this environment will expose them to manipulation mechanisms that are designed to influence their decisions. This can undermine people's autonomy, especially those in vulnerable situations. In fact, adapting immersive environments in real time can impair users' ability to exercise their freedom of choice and thereby reduce their self-determination. .

Note that a number of regulations now govern the use of these misleading practices, notably choice interfaces containing manipulative designs, especially when they are used by digital applications, such as social media, online marketplaces[170] or artificial intelligence systems[171]. Therefore, it is important to ensure that these various legal provisions apply effectively to 3D digital worlds and, if necessary, check whether they are sufficient for covering their specific features. Such regulations seem all the more necessary in this context, insofar as the algorithmic processing of user data could identify and exploit their vulnerabilities.

To guarantee users a degree of self-determination and real freedom of choice, a settings system can be provided so that they can determine whether or not they wish to customise the environment. In this case, the effectiveness of such a choice, which should be free and informed, would depend on a settings system that is easy to understand and accessible at all times.

In addition to real-time modifications to the environment, user manipulation may result from **interactions with avatars** controlled by digital systems and aimed at exploiting their emotional feelings (affective computing) to influence their decisions and behaviour[172].

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METAVERSE SCAMS

Metaverses may contain scam techniques that exist in the real world, but they are amplified by the persuasive power exercised by avatars. For instance, phishing attempts involve direct interaction with an avatar that looks like a family member asking for quick help in the form of money, or an "official" representative of an organisation (public or private) explaining why it needs access to the user's confidential information. One example is the technique whereby a scammer poses as a bank employee who knows a large number of details about the victim's identity and accounts and, under the pretence of protecting the victim from a live attack, obtains the user's confidential access codes. This scam is currently highly effective and uses a telephone conversation or text message from a number associated with the victim's bank to gain their trust, and this technique will undoubtedly be further "improved" in metaverses.

In light of these manipulation risks, there are currently discussions about the need to safeguard the right to respect for the metaverse user's psychological integrity[173].

170. Regulation (EU) 2022/2065 on a single market for digital services, Article 25.

171. Proposal for a Regulation on Artificial Intelligence, Article 5(1), point (a); see also Whereas 16.

172. CNPEN (2022), Opinion no. 3, Ethical issues of conversational agents, and CNPEN (2023), Opinion no. 7, Ethical issues of generative artificial intelligence.

173. C. Zolynski, J. Rochfeld (2022), La valeur des émotions : quel régime pour le « capitalisme mental » ?, in Mélanges en l'honneur de P. Sirinelli, *Dalloz*, pp. 749-770 ; C. François, R. Ronfard, A. Basdevant, Interministerial Exploratory Mission on the Metaverse.

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NEUROTECHNOLOGIES AND NEURORIGHTS

Even though metaverses do not fall directly within the field of neurotechnologies, it is worth noting that Chile's Chamber of Deputies passed a law on 29 September 2021 on cognitive rights, or "neurorights", which establishes that, while respecting "*the physical and psychological integrity*" of a person, "*no authority or individual*" may, using technologies on the human brain, "*increase, decrease or disrupt this individual integrity without the appropriate consent*[174]". UNESCO has also published a report on the ethical aspects of neurotechnologies, which emphasises the need to protect (1) cerebral and mental integrity as a matter of human dignity, (2) personal identity and psychological continuity, (3) human autonomy and (4) mental privacy. Members are currently discussing the prospect of a new normative instrument on neurorights[175]. Work is also underway within the Neuro Rights Foundation on an international level.

RECOMMENDATIONS

S4 (For public authorities) Analyse the existing legal framework to ensure that it can effectively prohibit and punish deceptive or manipulative practices resulting from a modification to the immersive environment according to how data are used and how users interact with the metaverse, while paying specific attention to the use of artificial intelligence systems for this purpose.

S5 (For public authorities) Bind metaverse operators with an obligation to provide clear and understandable information on the potential modifications to the immersive environment by the operator based on the physiological, behavioural and interaction data collected.

S6 (For metaverse manufacturers and operators) Develop a settings system that can easily be understood and accessed at all times, so that users can choose from a range of options:

- Do not adapt the immersive environment (all users who choose this option "see" the same thing).
- Adapt the immersive environment to reflect their explicitly stated interests.
- Adapt the immersive environment to include modifications based on the use of the user's data by the metaverse operator or third-party companies developing activities in the metaverse.

3.2.2.2 ISSUES IN TERMS OF INFLUENCING AND MANIPULATING SOCIETY

The issues in terms of influencing and manipulating society relate to content that may be disseminated within metaverses, such as **hate speech or discrimination** particularly based on a person's external appearance (body shaming), ethnic and social origin, religious beliefs or sexual orientation, and **disinformation** or **conspiracy** campaigns. These practices are used by conspiracy groups or sects to convince and attract new members or followers.

All these phenomena are already well known on social media[176], and can also be found in metaverses, which stokes tensions and confrontations within society. Their impact will be amplified when users are immersed in an imaginary world, since it generates a sense of presence and lends a degree of credibility to what they are experiencing (*cf. Section 2.2 Virtual reality*).

Note that propaganda relies on disseminating misleading or prejudicial information, which plays a central role in influencing and manipulating society. This information can take various forms, whether text, speech, pictures or videos. Although such practices have long existed, digital technology has played a major role in amplifying them for two main reasons. Firstly, as in the case of hate speech, the multiplier effect of disseminating information over the Internet and social media has enabled perpetrators to reach out to an increasingly wide audience. In addition, unlike pre-existing mass media platforms such as radio or television, digital technology can be used to target specific audiences and thereby create and maintain circles of people sharing similar interests and opinions. Secondly, recent developments in artificial intelligence systems, and specifically generative AI, have simplified and improved the process of manipulating photos and videos[177] for spreading fake news (deep fakes). Metaverses are an integral part of this global trend and represent a further step forward, especially in terms of their evocative and persuasive powers.

One way to achieve this, for **disinformation** purposes, is to produce and disseminate fake news in a 3D digital world by building a dynamic 3D sequence where avatars portraying public figures make false or even completely invented statements and/or perform compromising or illegal actions. This possibility has an impact on individuals (particularly blackmailing and extorting money) (*cf. Section 3.1.1.4 Children and teenagers*) and also society, such as by trying to influence the outcome of elections, even from foreign countries.

174. Loi 21383 SOLE Art. N ° 1 et 2 DO 25.10.2021 : "Scientific and technological development will be at the service of people and will be carried out with respect for life and physical and mental integrity. The law will regulate the requirements, conditions and restrictions for its use in people, and must especially protect brain activity as well as the information from it."
175. UNESCO (2021), Report of the International Bioethics Committee of UNESCO (IBC) *on the Ethical Issues of Neurotechnologies* (SHS/BIO/IBC-28/2021/3 Rev).
176. https://www.arcom.fr/nos-ressources/etudes-et-donnees/mediatheque/lutte-contre-la-diffusion-de-contenus-haineux-en-ligne-bilan-des-moyens-mis-en-oeuvre-par-les-plateformes-en-ligne-en-2022-et-perspectives
177. A clear example is the viral image of Pope Francis wearing a puffer jacket.

RECOMMENDATIONS

S7 (For all stakeholders) Be fully aware of the potential for social harm (disinformation and destabilisation) and the anthropological impact when using metaverses, resulting from changes in the relationship between individuals and the relationship between information and knowledge.

S8 (For public authorities) Bind metaverse operators with an obligation to provide clear and understandable information on the possibility of disinformation and manipulation from avatars in a metaverse.

3.2.3 RESPONSIBILITY

Using immersive environments involves a number of risks, whether environmental, individual or collective, and acts of wrongdoing in a metaverse can have significant repercussions on users. Since metaverses can lead to harmful situations, particularly when they give rise to unlawful behaviour, reminding all stakeholders that there is an "ethical responsibility" (or to paraphrase philosopher H. Jonas, an "ethic of responsibility") in the face of "technological risks[178] seems essential for making these new worlds "habitable"[179].

However, the liability issues are somewhat complex. This complexity is especially due to the fact that metaverses are in the early stages of their development and the uncertainty surrounding the existing legal framework with respect to the applicability of recently adopted EU regulations and the proposals contained in draft legislation potentially aimed at regulating these new environments or some of their aspects[180]. This is also compounded by the "deterritorialised" nature of these spaces, which raises the question of extraterritorial[181] legal rules. Another issue is the definition of a public order that is capable of preserving and enforcing values.

This can also be explained by the wide array of risks resulting from both the individual and collective use of metaverses, especially since some of those metaverses are (still) not sufficiently documented or easy to quantify. While the harmful impacts on the environment have already been proven and are hard to deny, insofar as documented studies are available (*cf. Section 3.3 Environmental issues*), the risks to society — on a societal or anthropological level — may appear to be more abstract for the time being.

Another difficulty occurs when it comes to apportioning liability, especially as a result of the many different stakeholders that are likely to be involved at one level or another in the value chain. Furthermore, it may be hard to define and assign liability within metaverses due to the very nature of these immersive environments. Whatever the case, it should be remembered that liability presupposes the ability to understand the meaning and consequences of a person's actions, which immediately rules out the assumption of attributing liability to avatars controlled by digital systems. However, metaverse operators and manufacturers could be held liable if they offer a digital world where certain representations are biased, such as relating to the gender or skin colour chosen for their avatars, including the long-term effects[182].

178. H. Jonas (1990), The Imperative of responsibility, Paris, *Le Cerf*, p. 30-31. 30-31. See also: H. Jonas (1974), Technology and responsibility: reflections on the new tasks of ethics, *Esprit*, p. 163-184.
179. To paraphrase H. Jonas again, who emphasises the obligation to ensure "the existence of a habitable world". See: T. Vaissière, (1999), "Ethics and responsibility according to Hans Jonas against international environmental law", vol. 2, pp. 135-199.
180. The European Union is in the process of voting in a number of regulations and directives in the field of digital technology, many of which are still being drafted or negotiated. As for other recently adopted regulations, questions are being raised about whether they can apply to metaverses: Regulation (EU) 2022/2065 on a single market for digital services, Regulation (EU) 2022/1925 on contestable and fair markets in the digital sector, Proposal for a Regulation on Artificial Intelligence, and Regulation (EU) 2023/2854 on harmonised rules on fair access to and use of data.
181. Whose scope exceeds territorial jurisdiction.
182. *TechEthos* D2.2: Identification and specification of potential ethical issues and impacts and analysis of ethical issues", L. Adomaitis, A.Grinbaum, D. Lenzi (2022), https://zenodo.org/record/7619852

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THE AVATAR'S LACK OF LIABILITY

As mentioned earlier, metaverses are populated by two types of avatars, namely avatars controlled by users, and avatars controlled by digital systems. In the latter case, it should be remembered that **a digital system is not considered to be a legal person** or to have the status of a legal person, irrespective of its appearance and any attributed or projected traits. Consequently, in the event of harm, avatars controlled by digital systems cannot, as such, be held liable[183]. Although some voices may have argued in favour of creating a legal personality for digital agents that are likely to incur liability[184] , the CNPEN categorically rejects the idea of holding "electronic persons" (sic) liable for "any damage caused to a third party[185]. As has been pointed out[186], this proposal raises more ethical and legal problems than it does real solutions.

This means identifying the entities that can be held liable and specifying the type of liability, as well as determining clear and transparent rules for attributing liability. To achieve this, a distinction can be made between the stakeholders who contribute to the conditions for establishing metaverses, whether through their research, work or economic activities (*cf. 3.2.3.1*), and the people using and accessing these metaverses through their avatars (*cf. 3.2.3.2*).

3.2.3.1 RESPONSIBILITIES ASSOCIATED WITH MANUFACTURERS' AND OPERATORS' ACTIVITIES

All the manufacturers and operators involved in designing and deploying metaverses, irrespective of their technical field, may contribute to the harmful effects caused to users by the development and use of metaverses — individually and/or collectively — and to our environment (use of resources and energy, waste generation at the end of the equipment's life, etc.).

Depending on the risks and context, responsibility may take on a more moral[187], ethical or legal dimension, bearing in mind the difficulty in determining the liability rules for each stakeholder concerned. It should be emphasised that legal liability and the potential sanctions are not the only means available for addressing the risks inherent in metaverses, which means that consideration should be given to more flexible mechanisms for holding these stakeholders accountable.

In terms of the individual or social risks associated with malicious behaviour from users or organisations, metaverse manufacturers and operators are ethically and, where applicable, legally liable from the moment that they are alerted to harmful acts of any kind (discrimination, hate speech, manipulated opinions, bullying, harassment, etc.) and fail to take (effective) action. In this respect, manufacturers and operators should take steps to report acts of wrongdoing, as illustrated for social media in Regulation (EU) 2022/2065 on a single market for digital services, identify the perpetrators and, if applicable, punish them or archive the technical elements required for evidence during subsequent legal proceedings.

In particular, this raises the question of how to detect and moderate harmful content and behaviour. Moderating unlawful content is a well-known part of digital platforms, especially social media (infringing content, hate speech, disinformation, etc.). Featuring the combined action of human moderators and algorithms, moderation involves either identifying harmful content and removing it if it is considered to be unlawful, or attaching a warning label to the content to indicate that there are uncertainties about its status. Moderation can be "preventive" — i.e. *ex-ante,* before the content is posted — or ex-post, by removing or reducing the visibility of the content.

In the case of metaverses, it is very hard to incorporate these mechanisms for moderating harmful dialogue and behaviour. Firstly, the sheer scale of real-time interactions means that there is no way to use a human-only form of detection or moderation. Secondly, as far as algorithm-based moderation is concerned, the difficulty lies in the fact that behaviour cannot be recorded due to the synchronous nature of metaverses. Since dialogue and actions are not recorded as standard and therefore cannot be viewed after they have been carried out, it is impossible to remove them (*cf. Real time management in Section 2.1.1*).

However, mechanisms could be introduced for recording traces of sequences performed in a metaverse (verbal or even gesture-based interactions), which could be analysed after the fact and potentially used to build up evidence of malicious or even illicit behaviour. The recording system could either be continuous or explicitly triggered by a user or the system managing the metaverse. In the first case, an analogy can be drawn with motorists who fit a dash cam in their vehicle to film the outside environment and capture footage of other drivers' behaviour in the event of a problem, whereas in the second case, the analogy is with traffic surveillance cameras installed at fixed points.

One line of research aims to design behavioural recognition algorithms that could trigger a recording upon detecting what is considered to be a high-risk type of behaviour for the user. However, this technology solution causes concerns due to the prospect of detecting false positives (the algorithm incorrectly identifies nuisance behaviour), where one consequence

183. G. Loiseau (2023), "Artificial intelligence and the law of persons", in Droit de l'Intelligence artificielle, *ed. Bensamoun,* A. and Loiseau G., Lexis *Nexis, 2*nd edition, p. 39, no. 106 &s. and G. Loiseau (2018), "The legal personality of robots: a legal monstrosity", *JCP G* 597; M. Bacache, "Artificial intelligence and the rights of responsibility and insurance", *in Droit de l'intelligence artificielle,* op. cit., p. 69. 69. Adde, A. Bensamoun and J. Farchy (2020), report for the CSPLA on the legal and economic challenges of artificial intelligence in the cultural creation sectors, p. 36.

184. A. Bensoussan (2015), Droit des robots, *Larcier,* p. 41 s. et « La personne robot », *Recueil Dalloz* 2017, p. 2044 ; M. Willick (1983), "Artificial Intelligence: Some legal approaches and applications", 4 :2 AI Mag 5 ; European Parliament Resolution of 16 Feb. 2017 with recommendations to the Commission on Civil law rules on Robotics, 2015/2103(INL).

185. Also along these lines, EESC (2017), The consequences of artificial intelligence on the (digital) single market, production, consumption, employment and society, point 1.12

186. V. notamment G. Loiseau, articles préc. ; A. Bensamoun and G. Loiseau (2017), "Integration of artificial intelligence in the legal system under ordinary law: questions of time", *Dalloz IP/IT*, p. 239.

187. For example, researchers' liability as to the use of their results for these harmful effects.

would be the potential infringement of fundamental rights and freedoms if these algorithms are used for automatic moderation or reporting cases to the competent authorities. Another problem concerns the possibility of falsifying evidence by manipulating the content of these recordings.

These difficulties play in favour of giving operators a greater sense of responsibility for anticipating and preventing such risks. Therefore, it would appear to be desirable to incorporate ethical principles into metaverses by design for the purpose of protecting users' safety, well-being and health, such as refusing to develop misleading interfaces (*cf. Section 3.2.2.1 Issues in terms of influencing and manipulating people*) or embed mechanisms designed to extend a user's connection time (*cf. Section 3.1.1.2 Psychological issues*).

This would involve implementing **protective** measures, such as creating an exclusion perimeter that prevents unauthorised avatars from entering a nearby zone, or preventing contact with certain parts of the avatar's body. To safeguard the user's autonomy, these **mechanisms could be configured** to suit the context (environments used or avatars with which the user interacts). There could also be an immediate disconnection mechanism that is available at all times and which users could trigger in the event of danger, while providing for a smooth transition to avoid a sudden disconnection from the immersive environment which could have harmful effects. To date, these measures have only been partially implemented, so they should be extended.

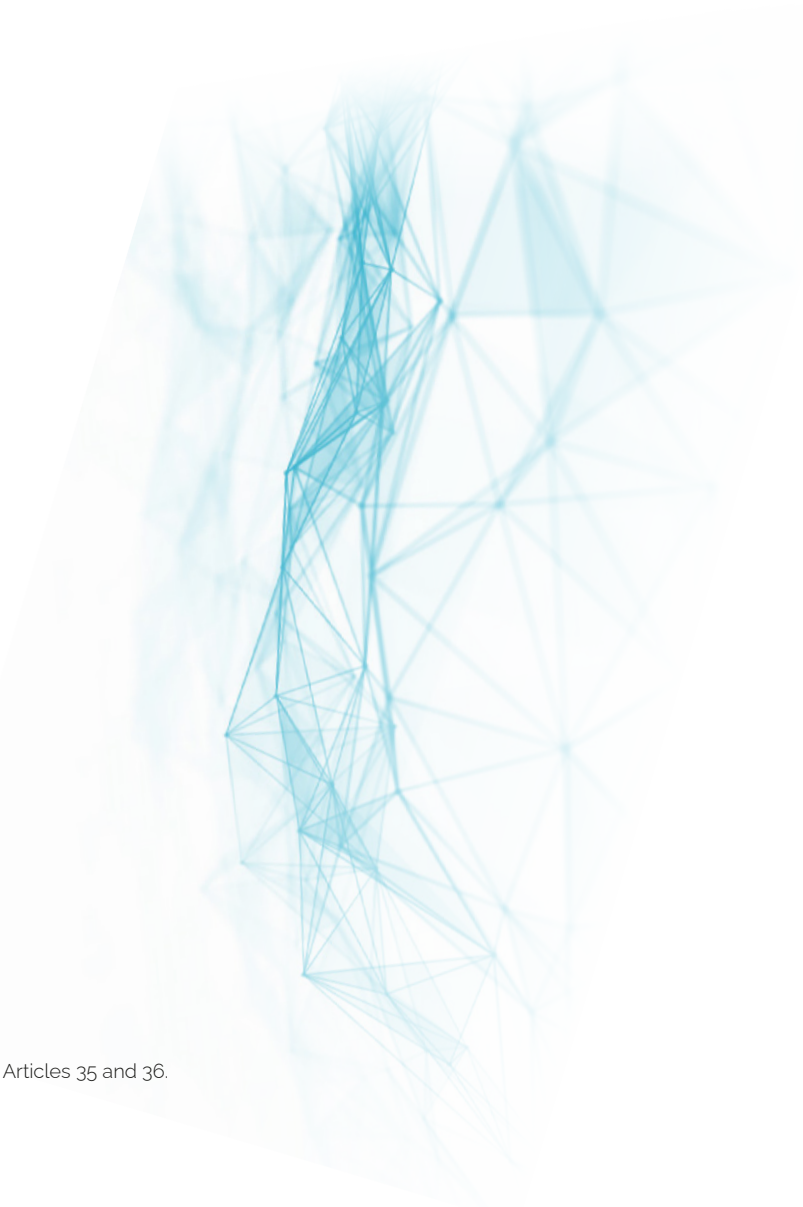
Manufacturers and operators who provide users with inadequate information or fail to implement moderation or protection systems to prevent inappropriate behaviour may therefore be held liable. More generally, metaverse operators may be held liable if they fail to inform users of the different types of risks involved in accessing immersive digital environments. In addition, hardware manufacturers could be held liable if they market haptic devices with ineffective or deficient control systems, and which could result in bodily injury (burns, forces, etc.), or if they neglect the harmful effects of blue light (*cf. see Section 3.1.1.1 Physiological issues*) either during the design stage or through the lack of settings available to users. Metaverse operators should encourage users to personally adopt responsible behaviour by alerting them to the ethical aspects, such as those relating to environmental issues or matters of fairness, inclusion and non-discrimination (*see recommendations P7, P20, S7, S12, E4, and E7*).

This means thinking long and hard about the method for identifying the various risks resulting from the deployment and use of metaverses, including the risks relating to the behaviour of certain users, while taking account of the ongoing technological development of metaverses and the innovations that lie ahead. If a manufacturer fails to implement adequate mechanisms to protect against a risk, determining its degree of liability would then involve differentiating the extent to which knowledge has advanced in terms of the risks identified: (1) not yet perceived, (2) perceived or assumed but not yet demonstrated through studies, (3) documented in scientific literature but not yet covered by standards, (4) identified and governed by standards. For example, metaverse manufacturers and operators, as well as entities developing their own environment within a metaverse, could be subject to a long-term obligation to exercise due diligence. They would then be responsible for carrying out a risk assessment, adopting risk mitigation measures and reporting on their actions to the regulator and civil society in accordance with the systemic regulation model imposed on very large platforms by Regulation (EU) 2022/2065 on a single market for digital services[188]. It is important to emphasise the need to make such a risk assessment subject to an independent audit and the regulator's control, since this is a prerequisite for giving operators a real sense of accountability, insofar as a simple self-assessment could prove to be ineffective.

RECOMMENDATIONS

S9 (For manufacturers and operators) Implement measures to detect and characterise any illegal acts committed in a metaverse, and identify the offenders. Where applicable, enable evidence to be gathered for use in legal proceedings.

S10 (For researchers) In accordance with the preamble to recommendation P1, consider developing research projects with the aim of designing behavioural recognition algorithms that are capable of triggering a recording upon detecting what is considered to be a high-risk type of behaviour for the user.



188. Regulation (EU) 2022/2065 on a single market for digital services, Articles 35 and 36.

3.2.3.2 RESPONSIBILITIES ASSOCIATED WITH USERS' ACTIONS WITHIN METAVERSES

Although most users are not involved in designing, developing[189], rolling out or operating metaverses, they are nevertheless essential stakeholders who play a key role in the smooth running of such immersive worlds by the very fact that they are present through their avatars. In particular, the actions of their avatars within these immersive worlds, and even more so their interactions, are susceptible to cause inappropriate, harmful and even illegal situations. Consequently, it is vitally important to remember that a metaverse cannot be a lawless zone, that a user's behaviour in a metaverse is not virtual (in the imaginary sense) and that it can cause real harm. Therefore, users are likely to be held morally, ethically or legally liable if they carry out acts of wrongdoing or illegal actions, meaning that they would be subject to various sanctions and penalties (removal from the platform or prosecution in the most serious cases). In case of proceedings, the aim will be to ensure that the liability rules are effective from a legal point of view, and the need to adapt certain provisions if necessary. It should be pointed out that there are currently discussions on the prospect of extending the definition of "rape" under criminal law to include sexual assaults committed in metaverses through avatars (with or without haptic devices). Another option would be to create a new category of offences that are specific to immersive environments (*cf. Section 3.1.1.2 Psychological issues*).

However, this has attracted a number of comments about how to attribute liability for offences. On the one hand, as pointed out by the TechEthos report[190], uusers in an immersive environment may commit an act of wrongdoing, but the environment itself may have been designed to enable or even encourage such acts. However, this does not mean that users are discharged from all liability simply because they have the technical capacity to commit those acts. Nonetheless, metaverse manufacturers or operators could potentially be liable for not having designed an interface that prevents users from committing such acts (see above). On the other hand, the process of attributing liability may be complicated where users lose or lack control over their avatar (e.g. if the system contains bugs or has been hacked); the difficulty will then be for users to prove that this actually happened in order to claim exemption from any liability.

A range of complementary methods should also be considered for giving **users a greater sense of responsibility.** Before embarking on an immersive experience, potential users must be able to find out about the content of a metaverse and how it works through clear and precise documentation (e.g. available on a website). During the experience, there should be a mechanism to alert users to the ethical issues, such as by organising awareness campaigns within metaverses "in real time", or by issuing and distributing documents such as "ethics policies". In this respect, it is worth pointing out that the use of pictures or videos can be more effective than text (whether online or in paper format). Other empowerment mechanisms for giving users heightened awareness of the impacts that their avatars' behaviour can have in the real world could also be considered, such as training on risks, especially for minors (e.g. in schools).

More generally, and as emphasised by the Ethics Committee for Educational Data (*cf. Appendix 1*), a key ethical issue in the development of metaverses lies in educating users about the opportunities and risks in these new forms of interaction with the aim of improving their reflexivity and generally their knowledge of digital technology.

RECOMMENDATIONS

S11 (For public authorities) Assess whether there is any need to adapt — on a national, European or international level — the liability rules to take account of the specific issues, legal problems and ethical issues raised by metaverses, while especially considering European regulations on digital technology.

S12 (For public authorities and operators) Educate users on how metaverses work and raise awareness of the ethical issues arising from their behaviour in metaverses and their effects on other users in the so-called real world. Alert users to the risks associated with their interactions in metaverses with the aim of developing their critical faculties.

189. It is also worth mentioning that some metaverses allow users to modify parts of a 3D digital world.

190. *TechEthos* D2.2: Identification and specification of potential ethical issues and impacts and analysis of ethical issues", L.Adomaitis, A. Grinbaum, D. Lenzi (2022), https://zenodo.org/record/7619852

3.2.4 SOVEREIGNTY

In October 2018, France's Advisory Commission on the Ethics of Research into Digital Sciences and Technologies (CERNA) published an opinion entitled "*Sovereignty in the Digital Age. Remaining the masters of our choices and our values*"[191], "in which it stated that ethical issues [...] were twofold:

1. In the absence of sovereignty, the choices resulting from rational reflection and the expression of free will cannot be implemented; sovereignty is therefore essential to applied ethics.

2. Furthermore, digital technology transforms, but does not eliminate, the traditional expression of the sovereignty of the people. Despite its globalising effects, the digital age does not erase the expression of cultural diversity or the need and right of human communities to govern themselves and forge their destiny according to a shared set of values, aesthetics and political choices."

In addition to national sovereignty in the traditional and historical sense of the term, new sovereignties can be defined in this particular context. This includes European sovereignty, scientific sovereignty, technological sovereignty, economic sovereignty, individual sovereignty and, of course, digital sovereignty.

As described in the CERNA opinion, this leads to considering an entity's sovereignty not only in terms of certain attributes, but above all by evaluating that entity's real and non-theoretical capacity to control the attributes over which it claims to have control. Putting such an approach into practice only makes sense if it is accompanied by the appropriate legal provisions for identifying and providing a basis for each of the elements of this definition: what is the precise definition of the entity? What attributes does it claim to control? Is this claim legitimate, and which legislative system is behind it? How does the entity exercise this control in practice?

Instead of the term *sovereignty*, which is often typically understood to mean national sovereignty, the term s*trategic autonomy*[192], would be preferable. It is now often used in the European context, but both terms describe the same capacity to have the *power to exercise power.* This opinion retains the most common meaning of sovereignty, which is often supplemented by the framework in which it is must be understood, such as individual digital sovereignty or European technological sovereignty.

When it comes to virtual / augmented reality and especially metaverses, there are many sovereignty-related issues.

Individual sovereignty. A huge amount of personal data are collected that cover physiological aspects (heart rate, viewing direction, etc.), cognitive aspects (times and types of actions and reactions, electroencephalograms, etc.) and interests (types of sites visited, etc.). Controlling what is done with these data is essential and represents a major issue for individual sovereignty, which covers a reality that is more complex than what has previously been considered in the notion of individual autonomy. The context is both technically complex for users to determine and understand the primary and secondary processing operations that are carried out on their data (whether instantaneously or deferred), and where the many systems involved are so intricate that they defy, hinder or prevent such understanding. A major ethical issue is ensuring that these personal data are kept confidential, both by making users as responsible as possible and by implementing regulations, particularly at the European level, to give users control over the information generated and inferred from the data collected.

Cultural sovereignty. At the present time, the major stakeholders in the digital world come from the United States (GAFAM) and China (BATX). Unsurprisingly, the same is true of metaverses, with France and Europe currently dominated by the US. But we will need to reckon with the ability of other actors to use the basic building blocks that are widely available for developing and implementing systems involving diverse cultural values. They may concern musical, legal, literary, historical, well-being, medical, recreational, clothing or language aspects. Values, cultures and worldviews have a direct influence on the way in which certain functions of digital systems are developed. For example, it is important that French or European users should be able to choose a metaverse based on their own cultural references and national or continental values if they so desire, and that they should be able to choose from among the systems to which they have access. Therefore, this capacity for informed choice is a matter of cultural and individual sovereignty, and represents a major challenge for ethical discussions about the applications of these technologies.

It was on the very theme of cultural sovereignty that the President of the Republic insisted during his speech in Aubervilliers on 17 March 2022: "*We will fight to build a European metaverse. This is a key issue, obviously not only for creation, but also for the ability to enable all our creators, whatever their cultural field or area of activity, to create and not depend on Anglo-Saxon or Chinese actors and aggregators, who will be able to totally circumvent the current rules on copyright and neighbouring rights*."

Behind this cultural challenge lies a political issue of the highest order, which is undoubtedly not a new one. The first issue of "Revue d'histoire culturelle" (cultural history review) in 2020 focused on the following question: "*Is culture also a tool for governing?*" Historians working across different eras were unanimous in answering "yes" to this question. What may be even newer today in the digital age is that people also need to think about whether "*culture is also about being governed?*"

Finally, cultural sovereignty also depends on the technological capacity of a given entity (company, association, State, etc.) to develop metaverses in a given cultural space (spatially but also temporally).

Technological sovereignty. The technological aspects that underlie the development of metaverses are crucial and represent a key challenge for gaining a competitive advantage and maintaining the capacity to innovate. Technological sovereignty may be attached to very different entities, whether companies, research centres, local authorities, countries or regional associations. These different entities may vie for control of the technological elements

191. http://cerna-ethics-allistene.org/digitalAssets/55/55160_AvisSouverainete-CERNA-2018-05-27.pdf
192. Strategic autonomy can be broken down into "political" (decision-making), "operational" (ability to independently plan) and "industrial" areas: https://www.defnat.com/pdf/Dumoulin%20(T%201211).pdf

needed to develop metaverses. The ethical challenges lie in the ability of these entities to control the development and implementation of metaverses based on the current state of knowledge.

National sovereignty. As has just been emphasised, the integrative aspect of metaverses concerns the technologies required for their development, but also the major attributes of nations that enact laws or rules, especially to mint coins, deliver justice, levy taxes, maintain order and ensure internal and external security, and control education and the use of the nation's language(s), to name a few of the most sovereign aspects[193]. However, these attributes also fall within the metaverses' potential sphere of competence. Some metaverses will implement their own currency, create value from intangible assets, levy specific taxes, control their trade flows, set up specific courts of justice and arbitration, create their own police force, develop their own language and produce educational material. This can lead to a conflict between the interests of the nation and those of the metaverses, as is currently the case between different nations around the world. The forums for debate, discussion and negotiation exist between States, along with their well-known limitations and difficulties, but nothing is available for helping develop tools of the same magnitude between nations and the private stakeholders governing metaverses. Such negotiations will generally involve populations from different nations and will be based on the technical and decision-making mechanisms of the physical space around the world. Once again, it should be emphasised that the various entities concerned may be part of the physical space or the digital space, but they are all in the real world. The ethical issues in this context are not new, but metaverses are ramping them up to such an extent that heightened vigilance and constant monitoring of the recommendations issued are essential.

RECOMMENDATIONS

S13 (For stakeholders) Have access to the software and hardware technologies required to develop sovereign metaverses, i.e. allowing for democratic expression that respects national and European values, particularly relating to the scientific, cultural, linguistic, legislative, financial and security aspects.

3.3 ENVIRONMENTAL ISSUES

The environmental impact of the extremely fast rise in digital technology is a major cause for concern[194]. To keep it under control, account must be taken of the entire lifecycle of all the hardware devices, as well as their energy consumption, from manufacture through to disposal[195]. The challenge is using the digital transition to support the ecological transition by reducing its own environmental footprint [196]. The impact and environmental performance of the different metaverse development scenarios and their sustainability are discussed in the inset entitled *Three Meta-Words*. The report on metaverses by the interministerial exploratory mission already pointed out that "*the deployment of metaverses raises questions in terms of their energy expenditure and the new infrastructures that must be factored into the development equation*"[197].

The environmental challenges are so fundamental that public authorities, manufacturers, operators and users are responsible **for embracing energy efficiency principles to limit the metaverses' carbon footprint**[198].

193. JJ. Achmirowicz and J. Langlois-Berthelot (2023), "Video games and metaverses: new cognitive warfare zones for terrorist groups", *in Revue Défense Nationale,* no. 865, p.52-56.

194. - ADEME & ARCEP (2023), Assessment of the environmental impact of digital technology in France - Forward-looking analysis up to 2030 and 2050 (3/3). https://www.arcep.fr/uploads/tx_gspublication/etude-prospective-2030-2050_mars2023.pdf
- The Shift Project (2021), Environmental impacts of digital technology: 2021-year trends and 5G governance, Note d'analyse. https://theshiftproject.org/article/impact-environnemental-du-numerique-5g-nouvelle-etude-du-shift/
- The Shift Project, Planning the decarbonisation of the digital system in France: specifications. https://theshiftproject.org/article/planifier-la-decarbonation-du-systeme-numerique-en-france-cahier-des-charges/
- CNIL-LINC (2023), Data, footprint and freedoms, *IP Report* no. 9. https://linc.cnil.fr/sites/linc/files/2023-07/cnil_cahier_ip9_0.pdf

195. INRIA (2023), « Le numérique est-il un progrès durable ? », *Pour la Science,* supplément réalisé en partenariat avec INRIA n° 546. https://www.inria.fr/fr/numerique-progres-durable-environnement-pour-la-science https://librairie.ademe.fr

196. J. Perrin (2022), "Integral and ethical ecology of digital technology", *in* National Digital Ethics Steering Committee - For ethics in digital technology. Coordinated by Éric Germain, Claude Kirchner, Catherine Tessier, *PUF,* ISBN 978-2-13-083348-2, pp. 127-141.

197. C. François, A. Basdevant and R. Ronfard (2022), Exploratory Mission on the Metaverse, Ministry of Culture - Ministry of Economy, Finance and Industrial and Digital Sovereignty. https://www.economie.gouv.fr/files/files/2022/Rapport-interministeriel-metavers.pdf

198. - The Shift Project, Energie, climat : quels mondes virtuels pour quels mondes réels : orienter nos choix technologiques vers la sobriété numérique + Energie, climat : des réseaux sobres pour des usages connectés résilients : des infrastructures numériques adaptées à la double contrainte carbone – rapports intermédiaires décembre 2023 - https://theshiftproject.org/mondes-virtuels-reseaux/ final report due March 28, 2004
- CEPIR "Cas d'Étude Pour un Immersif Responsable", https://www.cepir.info/ - Initiated in August 2022, CEPIR is a project to assess the environmental impact of XR (VR/AR/MR), 70% of which is supported by the French government as part of the "Supporting green alternatives in culture" initiative (France 2030), led by Caisse des Dépôts. Final report due in February 2024.

INSET

THREE META-WORLDS

The following three scenarios result from the workshop entitled "Meta-green? A debate-fiction on the sustainability of Metaverses/XR/VR", led by the Ecole Nationale Supérieure des Arts Décoratifs[199]. Other scenarios have also been developed by LINC[200].

Meta-Infinity

Thanks to major advances in nuclear fusion technology, which hit the market in 2053, electricity is an abundant, clean and renewable form of energy. Driven by this technology, our societies have adapted and have decided to stake everything on innovation. Due to state subsidies, virtually all activities are turning towards the intensive use of virtual worlds. The widespread use of extended reality has radically changed our lifestyles, with users encouraged to "live" in metaverses. Yet the atmosphere continues to warm, and by 2100 we will (probably) reach +4°C.

Meta-Transition

XR technology has changed people's mindsets and enabled this world to achieve net zero. Everyday life has radically changed. The clothes that we wear and the furniture around us only become unique (and coloured) when we wear augmented reality glasses/lenses. This is the transition to a new form of energy efficiency, where the economy is regulated in terms of carbon credits and where the metaverse has become a tool for leading social change.

Meta-Low Tech

The spate of economic, environmental and political crises has culminated in a radical change to society. A completely different social model from the one that we know today has taken hold, where everyone has learned to reduce their environmental impact, and society has been reorganised on a local level to promote reasonable consumption practices. IT tools are repaired, shared or manufactured using local resources. Technology contributions and benefits are directed towards the common good, and their use is streamlined. In the latter case, metaverses are either not developed at all or only to a limited extent.

3.3.1 CONSUMPTION OF RESOURCES AND ENERGY

Taking a more objective look at the link between ecology and metaverses involves quantifying the use of energy and mineral resources, and the emissions generated by developing and operating a metaverse.

INSET

THE COMPLEXITY IN ESTABLISHING THE FIGURES

Firstly, it is essential to remember that these figures are very hard to establish, depending on which impacts are taken into account. Therefore, experts tend to agree on the importance of carrying out life-cycle assessments (LCAs) using multi-criteria (carbon, depletion of abiotic resources, etc.), multi-stage (manufacture, consumption and end of life) and multi-component approaches.

In addition, although recent studies are beginning to seriously substantiate the environmental impact of digital technology in general and immersive worlds in particular, these figures often court controversy between those who believe that digital technology is THE solution for environmental issues and those who think that it is THE problem. The experts at the CNIL's Digital Innovation Laboratory (LINC) have clearly explained[201] the difference between the scientific community that works on these figures in a fairly consensual way by discussing successive improvements, and the circles of thought that try to derive elements from these figures (often in isolation) for the purpose of coming up with slogans to convince people of a given standpoint (whatever that may be). This sometimes leads to recommendations, such as regularly cleaning email inboxes, or moral questions about the importance of viewing videos of cats watching a fire burning in a fireplace. These messages are not without their merits, but it should be noted that they are often individual recommendations on usage instead of addressing the manufacturing process for the hardware and the costs generated by the infrastructures (network, storage, processing, etc.).

199. Paris, Thursday 27 October 2022 - see: https://www.youtube.com/watch?v=yuUAgkrnV_8

200. Le Laboratoire d'Innovation numérique de la CNIL a proposé quatre scénarios prospectifs du futur de ces mondes virtuels : https://linc.cnil.fr/metavers-ce-jeu-dont-qui-sera-le-heros.

201. CNIL (2023), Data, footprint and freedoms, *IP Report* no. 9.

The main environmental impact with digital technology in general and metaverses in particular can be tied to users' hardware[202]. Devices, such as screens, televisions, computers and smartphones, are responsible for 65% to over 90% of the impact for each environmental impact criterion studied, which puts them ahead of data centres and networks[203]. To compound the situation, the immersive nature of metaverses encourages users to purchase new types of hardware (mainly headsets[204] and sensors), which is likely to significantly increase the amount of resources consumed during their manufacture and the quantity of waste generated at the end of their life. In addition, even though the intrinsic power draw of data centres is improving in terms of PUE (power usage effectiveness), the growing demand for cloud services is inflating energy use. Consequently, attempts should be made to curb the rising amount of hardware per user and optimise sharing between data stored locally and data stored elsewhere for running metaverses. According to the report produced by the Exploratory Mission on the Metaverse, the main factors fuelling the metaverse's surging carbon footprint are as follows: i) data storage services hosted in the cloud, and the growth in energy consumption with the number of connected users, ii) training the AI models needed to run the metaverse, iii) producing powerful microprocessors to support the metaverse access equipment or manage the infrastructure, and iv) the environmental impact of NFTs and cryptocurrencies used by certain metaverses.

The existing body of French[205], European[206] and international[207] standards and regulations already provides a sound foundation for governing and guiding the development of immersive systems, but clarification is required on the design for specific types of hardware, such as virtual reality headsets, or the real-time use and persistence of immersive worlds.

ENCART

THE POWER-HUNGRY ONLINE GAMING SECTOR

Cloud-based online video games (or cloud gaming), which are the closest thing to how a metaverse technically functions, have already been extensively analysed[208]. First of all, it should be noted that gaming machines have major energy requirements due to their intrinsic computing power, and that attempts to ramp up their performance outstrip efforts to improve their energy efficiency (rebound effect). According to a 2015 study by Berkeley researchers[209], gaming PCs, which at the time represented only a small share of the global installed PC equipment base (2.5%) and of the market (7%), were responsible for 20% of the annual energy consumption by PCs, notebooks and consoles. That same study predicted that the consumption of gaming PCs would double by 2020. A more recent study in 2020[210] highlights the improved energy efficiency of new games consoles and revises their specific consumption downwards. As for the way in which video games are used, cloud gaming is singled out in comparison to downloaded games. Although gamers can potentially play without needing a specific console, it involves transferring computing power to data centres, and its intrinsic consumption per hour of play can be more than five times higher[211]. Finally, and this applies in general to video streaming, it is advisable to use a Wi-Fi connection rather than a direct connection to the mobile network, which consumes more electricity than a Wi-Fi connection for the same amount of data uploaded or downloaded. However, it has to be said that the current trend of watching HD videos on smartphones while on the move is being dangerously encouraged by the increasingly high resolutions featured on devices and the roll-out of 5G. Therefore, there is every reason to be concerned about the further deployment of metaverses with connected headsets.

202. In 2019, digital technology represented 34 billion items of equipment worldwide for 4.1 billion users, excluding small accessories, i.e. 223 million tons of hardware. See: https://www.greenit.fr/etude-empreinte-environnementale-du-numerique-mondial/
203. ADEME & ARCEP (2023), *op. cit.*
204. According to the CEPIR project, VR/AR headsets have a similar environmental footprint to top-of-the-range smartphones.
205. - RGESN : Référentiel général d'écoconception de services numériques. https://ecoresponsable.numerique.gouv.fr/publications/referentiel-general-ecoconception/
- RGESN : Référentiel général d'écoconception de services numériques. https://www.legifrance.gouv.fr/dossierlegislatif/JORFDOLE000038746653/
- REEN 2021 Law aimed at limiting the environmental footprint of digital technology.https://www.legifrance.gouv.fr/loda/id/JORFTEXT000044327272
206. ESPR : Ecodesign for sustainable products regulation. https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en
207. ITU standards: L.1410, https://www.itu.int/rec/T-REC-L.1410/en and L.1420, https://www.itu.int/rec/T-REC-L.1420/en Normes ISO : 26000 - https://www.iso.org/fr/iso-26000-social-responsibility.html ; 14040 : https://www.iso.org/obp/ui/#iso:std:iso:14040:ed-2:v1:fr ; 14064 : https://www.iso.org/obp/ui/fr/#iso:std:iso:14064:-1:ed-2:v1:fr
208. J. Meyer *et al. op. cit.* pp.90-121.
Von Yaourt (2023), "Ecology: does PC gaming pollute more than other forms of gaming?".
209. Mills, E. Mills (2016), "Taming the energy use of gaming computers". *Energy Efficiency* 9, 321–338. https://doi.org/10.1007/s12053-015-9371-1
210. J. Aslan (2020), Climate Change Implications of Gaming Products and Services, PhD dissertation. https://openresearch.surrey.ac.uk/esploro/outputs/doctoral/Climate-change-implications-of-gaming-products-and-services/99512335802346
211. J. Meyer *et al. op. cit.* Fig. 52.

3.3.2 HOW CAN ENVIRONMENTAL BENEFITS BE COMBINED WITH SOCIAL EQUITY?

Some of the ways in which metaverses are used could, however, be potentially beneficial for the environment with a view to promoting social equity.

One area that is often mentioned is shrinking the environmental footprint by replacing — at least partially — long-distance individual travel for business, cultural or tourist activities with digital conferences or immersive visits, which would then be within reach of a wider audience. However, air traffic continues to grow, despite the development of remote communication solutions[212]. For this idea of replacing activities to become a reality, we would need to rethink our models for economic development and cultural life.

Similarly, there has also been talk of reducing the amount of damage caused to tourist sites as a result of excessively high visitor numbers by replacing visits with remote immersive experiences. However, this kind of replacement is no substitute for the physical interaction with the people who live near these sites and who benefit from the economic spin-offs of tourism.

Another objective of metaverses is to improve access to sites (cultural, tourist, etc.) and services for people with disabilities, such as motor impairments that limit or prevent them from getting around. *(cf. Section 3.2.1 Access and equity)*.

Therefore, there are many challenges involved in combining environmental ethics and social ethics. On the one hand, action must be taken to scale down the amount of energy used by digital technology and also the passenger transport industry (road, sea or air) to counter the effects of the explosion in tourism caused by more affordable travel options, such as through low-cost operators, and ever longer holiday periods, while striving to achieve the objective of promoting social equity and sharing the economic benefits of tourism with local populations.

3.3.3 A TOOL FOR RAISING AWARENESS AND TRAINING ON ENVIRONMENTAL RESPONSIBILITY

While the responsibility of manufacturers and operators in relation to environmental issues was discussed in *Section 3.2.3.1*, it is also important to consider the responsibility of metaverse users. Therefore, it is essential to raise their awareness by focusing on their footprint and their motivations. Instead of providing users with a list of dos and don'ts, it is preferable to allude to their ethical responsibility by encouraging them to think about and, if necessary, amend their consumer behaviour in view of the negative effects that excessive consumerism can have on resources and the environment. Energy efficiency, which resonates with the notion of temperance in virtue ethics, encourages consumers to voluntarily practise self-restraint, such as refraining from changing their headset whenever a new model comes out or restricting their use of metaverses with a mobile connection, which increases the quantity of resources needed to deploy and use mobile networks. To respect the principle of scaling down energy use, the different stakeholders need to educate and even teach users about the best practices and how to use digital technology responsibly.

Prior to empowering users, it is worth mentioning a field that is still infrequently exploited for raising awareness, which is concerned with providing training on how to manage and adapt complex ecosystems by simulating the local or global impacts of a given human or technological activity (such as introducing materials or exogenous species, i.e. introducing a predator of a pest species that causes damage to other species) on the climate, vegetation and biodiversity, and their evolutionary dynamics. An example includes access to a large number of users, including experts in environmental issues, metaverses for training on eco-friendly building design or mobility solutions. Immersion increases participants' attention and active involvement, and allows more exercises to be carried out with immediate feedback on mistakes, without any danger to real ecosystems.[213]

3.3.4 SUSTAINABILITY

Various extreme scenarios can be entertained if we look ahead a few decades (*see the inset entitled Three Meta-Worlds*). But the only sustainable scenarios involve combining energy efficiency with the reuse, repairability and recycling of equipment as part of the responsible use of sector-level metaverses benefitting the common good. In other words, the prospect of a universal metaverse or several metaverses driven mainly by commercial and gaming activities seems to be unsustainable. According to Raja Koduri[214], Executive Vice President of Intel's graphics division, the widespread use of the metaverse on a global scale would require a 1,000-times increase in available computing power, but the question of whether a universal metaverse would be ecologically viable has clearly been raised.

Whatever direction is taken, the environmental impact of developing metaverses, digital technology and AI in general must be scrutinised as closely as possible using a multi-criteria analysis that is not restricted to greenhouse gas emissions. Such an assessment should be conducted across the entire lifecycle of the tools and also the basic query and calculation operations[215]. It is vital to continue reducing the energy consumption of the algorithms[216] needed to roll out metaverses, which includes the grey energy used to produce the devices and computing infrastructures, at the scale of the computing centre or embedded component. The

212. See: https://www.iata.org/contentassets/e00c14fd49db4c058365d9cef531184d/2023-04-04-02-fr.pdf

213. For example, see: https://design.numerique.gouv.fr/formations/ecoconception/ et https://www.polytechnique-insights.com/dossiers/digital/metavers-lespoir-les-promesses-et-les-inconnus/le-metavers-est-un-outil-pour-une-transformation-durable/

214. Quoted *in* A. Basdevant *et al, op. cit.* p.83

215. Negaoctet for ScoreLCA (2021), Environmental impacts of connected objects and services based on their use: Orders of magnitude and methodological recommendations - see: ACV France (scorelca.org). accessed on 20/06/2023

216. P. Gay, M. Hebiri, S. Lousteau, F. Valade (2023), "The utility in reducing the energy consumption of AI algorithms", *Bulletin de l'AFIA* 120, p. 47-53.

deployment of low-energy behaviour models in the use of metaverses could be considered, such as by offering users limited performance in terms of graphic resolution, along the lines of the recommendation that ARCOM has made to on-demand audiovisual media platforms[217].

RECOMMENDATIONS

E1 (For operators) Before developing a metaverse, think about its purpose and the environmental consequences arising from its implementation and use in order to promote applications that benefit the common good.

E2 (For public authorities) Develop arrangements for sharing the infrastructures and equipment used by public institutions for accessing metaverses. In addition, immersive hardware can be made available to the general public in third places that also provide support for the immersive experience.

E3 (For researchers, manufacturers and operators) Implement a metric for measuring the metaverses' impact on the environment as a system, including the manufacture, durability and recycling of the equipment and hardware on the one hand, and the energy consumption on the other, and consistently display the metric. Define appropriate labelling and certification schemes.

E4 (For public authorities) Require manufacturers to display the environmental impact of the hardware used and its energy consumption.

E5 (For manufacturers) Allow users to configure their environment so that they can reduce their energy consumption when using metaverses, such as by lowering the display resolution.

E6 (For public authorities) Prevent manufacturers from developing manipulative interfaces that encourage long connections with the aim of reducing the energy used by immersive worlds.

E7 (For users) Adopt a responsible attitude towards the environmental consequences of using metaverses, especially when acquiring new hardware or using a mobile network.

E8 (For all stakeholders) Consider developing mechanisms to preserve human interaction or compensate for the economic losses sustained by populations living near tourist sites that are reproduced in metaverses.

217. Voir : https://www.linfodurable.fr/sobriete-energetique-larcom-incite-les-plateformes-de-streaming-passer-en-mode-economie-40974

4. CONCLUSION

In conclusion, it is important to emphasise several points that emerge from the CNPEN's analysis of the ethical issues surrounding metaverses.

First of all, it is essential to stress that immersive experiences in a metaverse are not neutral, whether for the individual, society or the environment. Even though the effects, whatever they may be, are not all fully understood, their existence is undeniable and, in some cases, they continue after the experience has ended.

In addition, it is vital not to wait for metaverses to be widely deployed before addressing the associated ethical issues, firstly because metaverses are already available for use. Secondly, it is important to incorporate the results from reviews of the ethical issues when developing future systems. Above all, it is essential to carry out analyses over a long period of time, so that the interested parties can produce substantiated findings and understand the sustainable issues.

Furthermore, metaverses cannot be considered to be either good or bad as such, but must be seen as potentially having both beneficial and harmful effects, depending on the context in which they are used.

Lastly, it is important to note that, while metaverses require us to reconsider the ethical issues relating to the pre-existing technologies and applications (virtual reality, augmented reality, online gaming, social media, etc.), they also raise questions of their own that warrant a specific examination.

The CNPEN is proposing a list of recommendations for addressing these issues without further delay. This is an initial process that will need to be extended as metaverses are deployed.

In addition to the ethical issues covered by this opinion, other questions need to be asked now, especially to anticipate any risk of the market being monopolised by a few dominant players whose business model would be an extension of their advertising model, which is likely to produce harmful effects for individuals and society alike. Therefore, consideration should be given to models that preserve such fundamental values as user freedom and autonomy, shared resources and equity.

APPENDIX 1 : OPINION OF THE ETHICS COMMITTEE FOR EDUCATIONAL DATA

OPINION no. 2023-2

ETHICS COMMITTEE FOR EDUCATIONAL DATA

The ethical issues raised by the development of the metaverse within the field of education and its consequences on the use of educational data.

Contribution to the work of the CNPEN

In response to the referral from the Minister of National Education and Youth, Pap Ndiaye, dated 25 November 2022.

Chair: Nathalie Sonnac

Members: Sylvie Alayrangues, Ignacio Atal, Dominique Cardon, Jean-François Cerisier, Gilles Dowek, Christine Froidevaux, Michelle Laurissergues, Catherine Morin-Desailly, Pierre Schmitt, Bruno Studer, Françoise Tort, Célia Zolynski.

September 2023

Preamble:

For several years now, virtual reality and augmented reality have been the focus of ever growing expectations in the field of education, where they are seen as opportunities for responding to a number of challenges, such as providing solutions for people with special needs, opening up access to cultural and educational content enriched by augmented versions, and supporting vocational training on machines using virtual reality. They are seen as a driving force for creating learning environments with a higher degree of personalisation (simulators) and sometimes a greater element of fun, which would be impossible to develop in any other context due to costs, safety and the environmental impact. Furthermore, these environments can be opened up to a wide range of audiences and are conducive to fostering inclusion.

However, various ethical issues are raised by the use of metaverses and virtual, augmented and immersive reality (referred to here for convenience as *virtual worlds*) in education, with consequences on the protection of educational data.

We draw attention to the ethical issues that are specific to the field of education or which are accentuated in this particular field, while distinguishing between the issues that are associated with the fact that the practice would be carried out within the National Education system and the issues linked to the fact that users of these worlds would include young people (children and teenagers). Finally, we identify the challenges associated with personal education data and conclude with the training needs for potential users.

A - Educational background

Added value

At the present time, there is very little use of educational software based on virtual reality technologies in the classroom, but a little more in vocational education. As far as the metaverse is concerned, its use remains experimental. Therefore, it is hard to assess the added value of using these technologies in education. The question then arises as to whether there is any merit in developing new software and new virtual worlds, for the sake of innovation, to meet needs that do not yet exist but which could arise in the future.

Recommendation 1: Promote research into the benefits for learners and teaching professionals in developing virtual worlds for educational purposes, which will need to be evaluated through field trials.

Fairness and equal access

As with any new digital technology that brings its share of opportunities and potential drawbacks, one of the risks is that it will not be made available to everyone under the same conditions. It is important to ensure that the advantages of virtual technology in education are evenly distributed. The need to offer equal access covers both the technical aspects (headsets, network, etc.) and the IT aspects (sufficient digital literacy to use the technology). The various forms of the metaverse require recent, fast hardware which, in certain specific cases, can have the effect of accelerating the obsolescence

of the hardware currently in use. This is particularly problematic in the context of a responsible digital approach.

Recommendation 2: Ensure equal access to new virtual world technologies in the education sector if such technologies are developed.

Non-discrimination

The physical, neurological and psychological risks that may arise from the use of these virtual worlds, and which are not marginal, mean that some people would be unfit to use these technologies. This raises the risk of discrimination against students who would be excluded from classroom activities using these technologies.

Sovereignty and cultural bias

The leading global players in digital technologies and services (US and Asia), as well as the major players in video games, have clearly stated their intention to invest significantly in metaverses and virtual reality. In the absence of massive investments from the European Union and a structured industry, and without European players of sufficient size, there is a significant risk that these same major non-EU players will end up exercising a near-monopoly over the supply of these new technologies. In addition to the risks for technological sovereignty, which is present in all areas of application, using virtual worlds designed by non-EU actors in the specific field of education raises a cultural sovereignty issue. The risk of a cultural bias runs counter to the principle of an education system that pursues national aims while championing European values.

Recommendation 3: Invest in virtual world technologies and bring greater structure to the research and innovation sector on both a national and European level to prevent monopolies by the leading non-EU players in digital services. If the value of using virtual worlds in education is established, encourage the development of appropriate educational content.

Captology and business model

In light of the business models developed by some of the world's major digital service operators to power today's platforms, there is a tremendous risk that these new virtual worlds will be built solely on profit-driven models to the detriment of collaborative, educational and cultural uses, and the protection of users' data. It could be feared that these technologies would often be based on exploiting users' cognitive biases to increase their commitment to the game.

Video games and metaverses

Games are universally appealing and they stimulate attention, concentration, logic, memory and coordinated sensory-motor actions. They support the social and cognitive development of children who are motivated by them. Many metaverses are modelled

on virtual worlds in video games, which cover a wide variety of practices. Their positive or negative effects depend on the content and methods used: serious/educational or

entertainment games, competition or cooperation and creativity, presence of avatars and/or identifiable characters, confrontation with scenes of violence/antisocial behaviour or fair play, multi-player or solitary games.

Recommendation 4: If young people are exposed to virtual worlds in school and extracurricular activities, support them through discussions with educators or parents who are themselves aware of these practices.

Derealisation of science

In scientific disciplines, the use of virtual experience systems based on simulation and inspired by video games seems to be attractive and promising, especially when it gives access to experiences that would not otherwise be possible. However, removing students from the practical work rooms where they can personally experiment with physical phenomena could lead to a derealised vision of science, which would then be seen as purely virtual. One possible consequence would be a sense of mistrust towards scientific theories, especially if developers create virtual experiments to confirm or disprove those theories, depending on their own point of view, which would heighten the risk of conspiracy or pseudoscience. Therefore, it is critical that virtual experiences should be used sparingly and not systematically.

Recommendation 5: Strike the right balance between practical work and virtual experiments in schools for the purpose of maintaining the link with real scientific phenomena.

B - Young people's use of virtual worlds

Health effects associated with exposure to virtual and/or augmented reality technologies

ANSES has identified a significant number of health effects associated with the use of virtual reality.

(a) Psychological and psychosocial effects (emotional risks and derealisation)

(b) Interface and content dependency

(c) Content-related effects (violence, relationship to sexuality, etc.)

(d) Social isolation of young users within the group

The members of the Ethics Committee for Educational Data also point out that these effects could be accentuated by the persistent nature of metaverses.

These effects are all the more important since students are still developing (visual, emotional, cognitive and auditory system development). Therefore, special attention is required.

ANSES points out that children, teenagers and young adults, whose crystalline lenses are still clear, are the most sensitive to the light radiation emitted by these devices due to their age or state of health. These are the people who would be affected if virtual worlds were used in schools. Consequently, devices that emit light radiation should not be used.

Avatars and identity construction

The impact that the use of avatars in virtual worlds has on self-construction and self-representation must be taken into account, particularly in the case of children and teenagers who are in the process of building and developing their identity. The possibility of switching from one identity to another ultimately raises the question of self-continuity through multiple identities and, above all, the consistency of the "self". For some virtual world users, this can lead to dissociative identity disorders in relatively rare cases. As recommended by ANSES, longitudinal studies on these risks should therefore be carried out and the findings made public, before considering whether to roll out virtual experiences in schools and extracurricular activities.

Recommendation 6: Use virtual experiences in schools sparingly and responsibly in light of the potential effects on children and teenagers, especially the health risks and those relating to the construction of their identity. Carry out longitudinal studies to gain a clearer insight into the risks before considering whether to roll out virtual experiences further in schools and extracurricular activities.

Cyber-bullying

Virtual worlds (including metaverses) are a breeding ground for cyber-bullying due to the anonymity afforded to users. Their immersive nature reinforces control over victims. Furthermore, special attention should be paid to the effects arising from acts of violence during interactions between avatars, bearing in mind that these effects may be amplified by the use of haptic technologies.

If virtual worlds are developed on a massive scale, prior thought must be given to the mechanisms for shielding minors from harm. In this respect, it appears to be particularly important to require designers and operators to carry out risk assessments and adopt measures to mitigate those risks, as is already required of very large platforms according to Regulation (EU) 2022/2065 on a single market for digital services. In addition, it would be advisable to involve trusted flaggers as set out in the same regulation, and especially associations for the defence of minors, as soon as they are in a position to report any harmful behaviour on a platform or any collateral effects resulting from interactions in these virtual worlds.

Recommendation 7: Require metaverse designers and operators to produce studies that analyse the risks of cyber-bullying and implement the necessary mechanisms to protect minors.

C - Protection of privacy: collection and use of personal data in virtual worlds

Specific attention must be paid to personal data relating to education, which mainly concern minors. It should be remembered that although personal education data is not considered to be sensitive data within the meaning of the GDPR, they may be become sensitive if they are cross-referenced with other data.

Immersive uses (virtual and augmented reality) require tools such as glasses or headsets, some of which are fitted with devices for capturing and recording biometric data: (i) cameras to record eye movements, mouth movements and facial expressions; (ii) microphones for recording the user's voice.

The data collected during these immersive experiences include physiological data, interaction data and cognitive data, which can also provide details about a person's emotional state and reveal their personality and values. They are highly personal and border on intimacy, and a third party's knowledge of these data can be perceived as invasive. Therefore, they must be highly protected.

These data may be considered extremely valuable in the education system, since they can be used to fine-tune the student's profile and personalise the learning journey. However, they can be exploited for more damaging purposes. For example, they could be used to assess a learner's degree of motivation and penalise them as a result, or even manipulate them. These data are specific to the individual's physiological and psychological identity, and in the field of education, they concern young people in the throes of development, who may be easily influenced.

Health data

Health data that are relevant to the use of virtual worlds, such as data relating to cybersickness or neurological disorders like epilepsy, are sensitive data. Teachers will need to be familiar with this information before carrying out any immersive experiences in the classroom. One ethical issue involves reconciling confidential health data with the need to protect students from a harmful experience.

Identification data and security

Students and teachers will need to identify themselves to access these virtual worlds. Their identification data must be highly secure, especially due to the risk of identity theft.

In addition, virtual world technologies can be used to alter images in people's field of vision, which can have a strong impression on them. This can lead to the risk of disinformation and manipulation. To prevent these risks, all possible defences against cyberattacks must be implemented, monitored to ensure that they are up-to-date and reinforced if necessary. Measures must also be taken to anticipate how to manage and limit the impact of any cyberattacks that slip through the defences.

Personal data retention

The data and metadata produced in these virtual worlds are extremely sensitive from an ethical perspective and will quickly become highly voluminous. Care will need to be taken about the ways in which data are collected and if applicable, stored (where? for how long? by whom? etc.) and accessed (who has the right to access the data and for what purposes?). In accordance with the GDPR, the collection of such data must be kept to a minimum. Therefore, the type of educational data required for learning experiences in virtual worlds must be accurately defined.

Recommendation 8: In terms of data protection:

- *Provide the highest level of security for the login data used by students and teachers for the metaverse and other virtual worlds; in particular, all possible defences against cyberattacks must be implemented, monitored to ensure that they are up-to-date and reinforced if necessary, and measures must be taken to anticipate how to manage and limit the impact of any cyberattacks that slip through the defences.*
- *Provide a strict framework for collecting and storing data relating to their use (minimisation, etc.).*
- *Prohibit any sensitive processing operations on physiological, interaction and cognitive data, as well as the use of emotional recognition techniques in school, extracurricular and after-school environments.*
- *More generally, ensure that applicable legislation applies to metaverses in order to guarantee protection of minors' rights concerning access to these virtual worlds and the processing of their data in an educational and after-school context.*

D - Training and information for students, teachers and parents

One of the key ethical issues in developing metaverses and other virtual worlds is informing users about the opportunities and risks involved, and especially raising awareness among children and their parents. As such, information resources and approaches must be designed and developed by involving young people with the aim of harnessing and incorporating their feedback.

Recommendation 9: If metaverses and other virtual worlds are deemed to be appropriate for use in the national education system, train teachers (during their initial and ongoing training) how to properly use these tools and design learning activities that reflect the results of scientific research. More broadly, train the entire educational community on the challenges inherent in these technologies.

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APPENDIX 2: LIST OF PEOPLE INTERVIEWED AND VISITS

VIDEOCONFERENCE HEARINGS

- Philippe Coen, Sandrine Richard (Respect Zone)
- Régis Chatellier (CNIL-LINC)
- Geoffrey Delcroix and Nicolas Pouard (Ubisoft)
- Edouard Geffray (Ministry of National Education and Higher Education)
- Laura Hiel and Blandine Dusser (Ministry of Economy, Finance, and Industrial and Digital Sovereignty)
- Stan Larroque (Lynx)
- Anatole Lécuyer (Inria)
- Steve Mann (University of Toronto)
- Jean Martin (Jean Martin law firm)
- Rémi Ronfard (Inria)
- Alexandre Rudoni (Allen law firm)
- Camille Salinesi (University of Paris I Panthéon-Sorbonne)
- James Zopissa (Massive Immersive)

SITE VISITS AND DEMONSTRATIONS

- Inria-Irisa Rennes - Anatole Lécuyer/Equipe Hybrid
- Meta Paris - Martin Signoux

APPENDIX 3: COMPOSITION OF THE WORKING GROUP

CO-RAPPORTEURS

- Pascal Guitton (Emeritus Professor at the University of Bordeaux, Guest)
- Serena Villata
- Célia Zolynski

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- Anaëlle Martin

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- Laurence Devillers
- Claude Kirchner
- Jérôme Perrin
- Catherine Tessier

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- Christine Froidevaux
- Eric Germain
- Alexei Grinbaum

ALPHABETICAL INDEX

The National Pilot Committee for Digital Ethics – CNPEN – was set up in late 2019 by the French Prime Minister. It comes under the auspices of the National Consultative Ethics Committee for health and life sciences, the CCNE. The Committee comprises leading figures from academia, industry and the institutional sector. Experts in digital technology, law, economics, philosophy, language, logic and medicine all contribute to discussions on the ethical issues that have become essential as a result of the development of digital technology, while helping inform public debate. Previous opinions issued by the CNPEN include the ethical implications of "autonomous" vehicles (May 2021), chatbots (September 2021) and, alongside the CCNE, the ethical issues surrounding the use of artificial intelligence for medical diagnosis (November 2022), and health data platforms (February 2023). More recently, the CNPEN has addressed the ethical issues of retroactive name changes in digital scientific documents (June 2023), generative AI systems (June 2023) and facial, posture and behavioural recognition technologies (November 2023).

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