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Ethical Considerations for the Use of Virtual Reality: An Evaluation of Practices in Academia and Industry

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Abstract

The following article offers a set of recommendations that are considered relevant for designing and executing experiences with Virtual Reality (VR) technology. It presents a brief review of the history and evolution of VR, along with the physiological issues related to its use. Additionally, typical practices in VR, used by both academia and industry are discussed and contrasted. These were further analysed from an ethical perspective, guided by legal and Corporate Social Responsibility (CSR) frameworks, to understand their motivation and goals, and the rights and responsibilities related to the exposure of research participants and final consumers to VR. Our results showed that there is a significant disparity between practices in academia and industry, and for industry specifically, there can be breaches of user protection regulations and poor ethical practices. The differences found are mainly in regards to the type of content presented, the overall setup of VR experiences, and the amount of information provided to participants or consumers respectively. To contribute to this issue, this study highlights some ethical aspects and also offers practical considerations that aim, not only to have more appropriate practices with VR in public spaces but also to motivate a discussion and reflection to ease the adoption of this technology in the consumer market.

Keywords: Ethics, Technology, Virtual Reality, Practice, Consumers, Academia, Industry.

CCS Concepts

•Human-centered computing → Virtual reality; •Social and professional topics → Codes of ethics;

1. Introduction

Virtual Reality (VR) is a technology used to present a realistic and immersive simulation of a virtual world to an individual through the use of specialised hardware and software. A core feature of VR is that it isolates the viewer from the outside world, and has the potential of achieving a high level of immersion [WS98].

There are mainly two different approaches to isolate the viewer from the outside world. One being a Head Mounted Display (HMD) and the other a cave automatic virtual environment (CAVE) [CNSD93, Sut68]. This work is focused on the consumer market, therefore only HMDs experiences are discussed. A HMD is a headset with binocular displays that blocks the outer real world incoming light and presents one image for each eye producing stereoscopic imagery. These headsets also track, with certain precision, the head movements, and match those with the movement of the virtual camera inside the simulation.

A realistic and immersive simulation does not directly imply that VR resembles how humans see and perceive the world, but that the level of immersion is such that the viewer achieves a sense of embodiment [KGS12] in which she owns and controls another avatar.

1.1. A Brief Review of the History and Evolution of VR

To understand the motivation of this work it is essential to briefly present what has been the path of VR as a technology from inception to present day. Up until 1990, the primary applications and purpose for VR were training simulators (aviation, automobile, military and medical), although, with many technological shortcomings compared to today's systems, it was the best that could be achieved at the time [Sut65, Lip80, VPL87].

In 1993, Sega announced the Sega VR at around 200 USD, supporting stereo vision, sound, and the user's head tracking. The project did not last long in the market, suffering from poor hardware capabilities, inducing motion sickness and eye-strain and was quickly removed from the market a few years later [Ret17].

The technological advancements of the decade regarding computing and graphics capabilities, refresh rate, and tracking technology were not sufficient to fit in a portable format the immersive experience that VR was meant to provide [Bro99]. In 1999, Brooks discussed and argued that VR was "happening", "This personal assessment of the state of the VR art concludes that whereas VR al-

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most worked in 1994, it now really works..." [Bro99, p. 1], adding to the list of open problems latency, geometry complexity, resolution and haptic augmentation and concluding "...VR has crossed the high pass from 'almost works' to 'barely works'..." [Bro99, p. 27]. It is important to note that the requirements deemed acceptable in 1999 regarding latency, tracking, and resolution would not be sufficient today.

Davies [Dav97] explains that "twentieth-century technical developments have put humankind ... [into] a totally new ethical situation" and that "we have to be *stewards* of the whole creation whether we like it or not" [Dav97, p. 77]. In his argument, the author states that, besides obvious developments of destructive technologies, "there are no real effective mechanisms by which society can seriously question technological developments", posing a major challenge for ethics, and "... if ethics does not rule, then mere technical capability will, with whatever technological implications that has for society" [Dav97, p. 77].

Due to VR not reaching the mass consumer market as it seems to be doing now, many of the problems did not pose such ethical controversy for the society and consumers. These systems were being used in restricted spaces and disciplines, where there was much more control in the safety protocols, risks assessment, and content. VR was actively used for training, and research, and not as much in entertainment.

In the last two decades, different VR devices were developed, lowering the costs and improving hardware capabilities. It has not been up until recent years that the technology has experienced much interest from blue-chip companies such as Sony, Microsoft, Facebook, and Google, investing and partnering with technology developers to give a boost to VR for mass consumption. This trend continues to develop, and it could be argued that on the technological side the improvements are such that successful VR experiences can be delivered with a spending budget of under 2000 USD for all the equipment.

Due to the concerns of running poor quality VR experiences, and hurting the technology as it happened in the past, (probably as well for commercial reasons) NVIDIA as well as AMD have started branding some of their products as *VR Ready* [NVI16, AMD16]. This initiative has been quickly adopted by many manufacturers of Laptops and Desktops in the industry. A VR Ready PC is said to fulfil the minimum set of requirements needed to deliver an optimal VR experience.

The growth projections for VR headset shipments and revenue [Smi17], and the availability of affordable or free high-quality game engines [Uni17] for prototyping VR applications indicate that VR will likely reach a much wider audience in the upcoming years. This setting for VR experimentation, will not be as controlled and well designed as it has been in the past and hence will pose new unknown challenges and risks for the final consumers.

1.2. Scope

After surveying the way VR is being used today, in the private and public spheres, as well as in research, we believe that basic health and safety guidelines are not being always followed or at least communicated to users/participants by most of the stakeholders. These practices can increase the risks of accidents for members of the society and arguably violate codes of ethical conduct [Ame02].

Although there are multiple aspects that attain to ethics in VR, this work focuses on secondary physiological effects as well as health and security guidelines that need to be considered in any VR installation. Users' rights as consumers are also discussed in regards to the potential places of exposure to VR, and how in each of those situations practice and protocols diverge.

To our understanding, this particular situation where consumers and VR meet in public spaces has not been explored from a legal or even an ethical perspective, and it is of great interest if the technology is expected to grow in adoption. Psychological side effects (positive and adverse) of VR go beyond this analysis, for a comprehensive discussion on these see [MM16].

The following research questions were proposed for this work:

- What are the current industry and research practices for VR?
- What are the ethical and legal implications of these practices?
- How can these practices be improved to reduce risks associated with the exposure to VR?

1.3. Paper Overview

In Section 2, previous works about ethical aspects in VR and physiological problems linked to the technology are discussed. Section 3 describes the research methods employed to collect and classify information for this paper. In Section 4, the most relevant results are presented, and in Section 5 these are critically analysed, and proposals to improve some aspects of existing practices and regulations are presented. Section 6 summarises the main results of the paper and highlights some areas of future research.

2. Related Work

In this section some definitions of Computer Ethics relevant for this paper are discussed, as well as a brief mention of the legal and Corporate Social Responsibilities (CSR) frameworks analysed. Lastly, common physiological adverse effects of VR are presented.

2.1. Computer Ethics

It is necessary to establish a relevant framework to discuss the ethical issues that are foreseen for a successful adoption of VR. Bynum [Byn00] revises the history of Computer Ethics as a field, including its most influential definitions. The majority of these definitions are grounded in theories such as *teleological* and *deontological*. The most significant difference between them is that in *teleological* (utilitarian) theories *actions* are seen as a mean to an *end*, and it is this *end* that justifies the *actions*. On the other hand, on *deontological* theories (Kantianism), higher principles such as the dignity of human beings are used to determine if actions are right or wrong, regardless of the purpose.

The contributions to the Computer Ethics field started with the work of Norbert Wiener [Wie48] during the Second World War in the 40s. Wiener coined the term *Cybernetics* and then in the 50s with his book *The human use of human beings* [Wie54] established

some principles that are still valid today. In Bynum's [Byn00] summary of Wiener's work, the purpose of life for humans is to achieve their maximum potential as a living being, that coexists with others within a society. He established the following principles of justice, (1) freedom, or the liberty for an individual to develop to its full potential, (2) equality, as in what is just for A and B remains just when the positions of A and B are interchanged, (3) benevolence, where good will between men should have no limits (to the extents of humanity), and (4) "minimum infringement of freedom" where the role and constraints of society should not affect the freedom of its individuals. Wiener then set some fundamental questions around the implications of the introduction of modern machines into society, and presented an approach to doing this whilst preserving the core justice principles set before [Wie54].

Johnson [Joh01] and Maner [Man80] proposed similar definitions of Computer Ethics, mostly suggesting that computers did not bring new ethical problems, but transformed or exacerbated some of them. Hence traditional theories such as utilitarianism and Kantianism should be used.

A broader definition, not explicitly based on philosophical theories, was provided by Moor [Moo85] in 1985, arguing that many Computer Ethics problems arise due to an existing *policy vacuum* about how new technology should be used. Moor defines Computer Ethics as " ...the analysis of the nature and social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology". The author highlights that *computer technology* in his definition is used in a general sense, including software as well. When trying to solve the *policy vacuum* problem, a larger problem arises, which is a *conceptual vacuum* and the solution lies in analysing and "...proposing conceptual frameworks for understanding ethical problems involving computer technology..." [Moo85, p. 266].

2.2. Legal Frameworks

There is a large body of policies and legal regulations that aim to offer protection to consumers worldwide. Even with similarities in some of their directives, these policies vary in definition and implementation between countries.

Although not strictly laws, ISO standards are well-established documents that provide guidelines of good practices and high-quality standards for the industry; for this work, it was found relevant to review the ISO 26000:2010 on Social Responsibility. This ISO [ISO10] provides guidance on social responsibility issues, aimed at organisations of any size, location, and activity. They are the result of the cooperation between governments, NGOs, industry, consumer groups, and labour (unions) organisations.

2.3. Physiological Issues Related to VR

Behr [BNKH05] defines four key aspects of VR that are subject to ethical scrutiny and are described here for reference and further analysis in Section 5.

2.3.1. Simulator Sickness

It is one of the most relevant physiological adverse side effects of VR, and it can also happen in real life. Whenever a person perceives a mismatch between an expected sensory stimulus and the real input, motion sickness can occur. This manifests as the loss of balance, and is mostly (in a healthy person) due to the visual system [LE15]. *Simulator Sickness* was introduced [FKKM83] to refer more specifically to issues encountered in early simulators for aviation, military, and automotive industries. Although the area of application of VR is much broader today, this term (or Cybersickness) is still used to refer to the same group of symptoms.

In [LE15] Lewis-Evans talks about some of the symptoms of *Simulator Sickness*, including balancing issues, sweating, disorientation, vertigo, loss of colour of skin, nausea, eye-strain, and headaches. In VR, the disparity between the physical world movements and the virtual world (through the visual system) is considered to be the main source of simulator sickness, although there are other aspects such as resolution, field of view, flickering, and luminosity that can also cause this [Kol95].

In research studies, it is common to see the Simulator Sickness Questionnaire (SSQ) [KLBL93] being given to participants, before and after the experimentation. This helps the researcher identifying the possibility side effects and take actions to alleviate and warn the participant about activities that should be avoided afterwards. The SSQ is also used when trying to compare different locomotion methods within Virtual Environments. For an analysis on empirical evidence regarding induced Simulator Sickness see [NP02].

The use of screening methods (such as the SSQ) and establishing protocols for dealing with this issue are often required by local Institutional Review Boards (IRB) [BGC*10].

2.3.2. Information Overload

Studies on human information processing argue that humans face finite limits when processing and assimilating information, and when a limit is reached "behaviour becomes confused and dysfunctional" [JSK74]. It could be said that VR is no exception as to whether this situation can occur, mostly related to the content, the task, and the interaction technique provided. Possible side effects of information overload include stress, frustration, and disillusionment among others [EM04].

As mentioned in Section 2.3.1, if there is a possibility of affecting physically or psychologically a research participant, an IRB would require from a researcher to have a protocol in place if the participant experiences discomfort during or after the study [Bro99]. For other practitioners (public spaces), there are no formal requirements established. Although this could be part of the *policy vacuum* that Boor refers to in his analysis of Computer Ethics [Moo85], it is important to highlight that this is not an exclusive issue of VR.

2.3.3. Intensification of Experience

This aspect highlights the fact that VR can provide the means to intensify an experience that would not be possible in the real world. For instance, changing the physical environment, the avatar physical characteristics, etc. Researchers see this as a benefit in user studies, as there is no "real" laboratory to setup or maintain, allowing them to share spaces and time without major efforts. When immersion is achieved, some authors suggest that the possible lack

of control can have adverse effects in the participants, such as stress or aggressive behaviour, exceeding ethical limits of even utilitarian ethics research [BNKH05, Bau99].

2.3.4. Reentry into the Real World

The physical and psychological issues that participants can suffer after the VR experience have been labeled as reentry problems [BNKH05]. As the *nature* of an immersive VR experience can transcend after the activity, participants may experience changes in cognition, emotion and behaviour [Bio97]. Some of the approaches to deal with this issue are addressed in the Section 5.

3. Methodology

The methodology proposed for this analysis included an information retrieval activity from different bibliographical databases, online video sources, license agreements (EULA) from VR vendors, and legal frameworks for consumer protection. Also, a Participatory Observation during a visit to a game exposition event was done.

The reason for searching for video content was to evidence the different setups in which VR is exposed to people, along with some of the incidents that had occurred when using this technology. This search included public exhibitions, research and technology conferences or events. Information regarding domestic installations and private use of the technology was excluded from this analysis as it goes outside of the scope of this paper.

Overall, these activities provided us with enough information to analyse and compare the practices and responsibilities in research and industry spaces. The results are presented in Section 4 according to (1) Policies that protect VR users and (2) Common practices for exposure and experimentation with VR. Lastly, the next section describes in detail the Participatory Observation done.

3.1. Participant Observation

In addition to the collected multimedia content, a Participatory Observation was performed by visiting a major game conference in Europe. The purpose of the study was to experience personally some of the VR demos (small and large game studios) in a public space. The authors have no affiliation with these expositors, and they were selected randomly among the different exhibits that were available in the conference. In all cases, expositors were told about the purpose of the questions and the motivation of the study in general. The questions and answers can be seen in Section 4.2.1.

4. Results

This section presents a synthesis of the information obtained, clustered in two categories: user protection and exposure to VR.

4.1. User Protection

User protection was considered to be one of the key elements for this review. To offer a clear overview regarding the different guidelines and procedures that aim to ensure user protection, this section analyses VR users from the perspective of both, a product consumer and a research participant.

4.1.1. Protection as a Consumer

Existing legal frameworks from the United States of America (USA), European Union (EU), and China were reviewed. Specifically, from U.S.A. the directive 15 U.S.C §§41-58 [Fed06], from the EU the directive 2001/83/EU [Eur01], and from the People's Republic of China the Law on Protection of the Rights and Interests of Consumers [Nat13]. These documents are considered to be a representative sample, but should not be understood as a comprehensive review of the global regulations regarding consumer rights. The overlapping ideas found on these documents were:

1. The right to acquire products that have a minimum standard of quality.
2. The right to obtain truthful, precise and sufficient information regarding both, the products themselves and the risks associated with their use.
3. The right of making a direct claim to manufacturers and receive compensation.
4. The right of freedom of choice in providers, products, and services.
5. The right of being protected from abusive clauses in contracts as well as a fair transaction system.
6. The right of being legally represented.
7. The right of having legal mechanisms to make claims and protect their interests.

4.1.2. Protection as a Research Subject

After WWII, the Nuremberg Code (1947) [Cod49] was written, setting fundamental guidelines for the protection of human subjects' rights during medical research. Although not a law, this code permeated into the lawmaking process and contributed towards an accepted common ground of ethical practices seen today in law and code of ethics. Another essential reference is the Declaration of Helsinki (1964) [Wor08], although focused in biomedical research involving humans, it addresses many aspects of human subject research that are relevant to other scientific areas. Lastly, the Belmont report (1979) [Nat78], "an analytical framework to guide the resolution of the ethical problems arising from research with human subjects", covering practice versus research, fundamental ethical principles and applications aspects of human subject research. Today, most participant protection guidelines are covered within the codes of conduct and ethical regulation for scientific research and the responsibility of the participant's well-being lies on the researcher that should follow these.

For this synthesis, the ACM Code of Ethics and Professional Conduct [And92], the APA Code of Ethics and Professional Conduct [Ame02], the Software Engineering Code of Ethics [GMR97], the ISO Guidance on Social Responsibility [ISO10] and the ETSI Standard on Usability evaluation for the design of telecommunication systems, services and terminals were reviewed [Ins00]. The following overlapping aspects were found:

1. Beneficence and non-maleficence: the main intention of the research means no harm to the participants, and all potential risks must be considered.
2. Fidelity and Responsibility: All agreements between participants and researchers must be clear and respected before, throughout, and after the research.

3. Justice and Integrity: Fair, honest and objective selection of participants, evaluation data and delivery of conclusion.
4. Dignity: The respect for participants rights, confidentiality, privacy, and autonomy.

4.2. Exposure to VR

This section presents results regarding how VR is used in different settings, including research laboratories, conferences, and exhibits. Usage by consumers in the private realms is more difficult to analyse and was not included. It can be seen in many of the videos uploaded to sites such as Youtube that individuals do not follow the health and safety guidelines, but from an ethical and legal perspective, it is difficult to argue how they should behave within their homes as long as they do not break the law.

4.2.1. Industry and Expositions

One of the motivations of this work was to investigate the particular aspect of how VR is being used in public spaces, and what can be said about the ethical practices. These spaces include technology and research conferences, as well as VR hardware manufacturers or major partners retail stores. The parties involved in this are the following: the VR manufacturer (**vendor**), the site owner or whoever rents the venue (**organiser**), the expositor (**VR demo**), and the **individual**.

The **vendor**, in all cases, provides detailed *health and safety* guidelines in written form and updated versions online [Ocu17, HTC17]. These, serve the following purposes: (1) to avoid legal issues in case of accidents by misusing the device, (2) to warn users with specific medical conditions about the inherent risks of the technology, (3) to recommend optimal setups when using the device, and (4) to give advice regarding side effects and recommend paths of action in case issues arise. It is important to emphasise that these guides are comprehensive and clearly written, and it is not necessary to be an expert to understand the language.

There was not much information regarding the role of the **organiser**, whether it is the owner of the premises or sublets the space. The only information that could be found is related to normal practices of legal liabilities disclaimers where the party (**VR demo**) that rents the booth or exhibit is solely responsible for any issue that occurs within this space.

During the Participatory Observation, all booths regardless of featuring VR or not, were of the same size, which is interesting considering that many VR interactions (standing and with locomotion) often require more space than non-VR demos.

The role of the **VR Demo** is of course of much importance in this work. Among other things, the **VR Demo** company or individual decides how to use the space available, what VR content to present, how to address the individuals, how to deal with accidents and issues, etc. It has been observed in online videos that some accidents could have been avoided if the VR setup would have followed the safety guidelines provided by the **vendor**. These include participants losing balance and falling against the floor and walls [Wal17, The17]. It has also been observed deliberate attempts to induce fear in participants for no apparent reason [Web17].

During the participant observation, the following questions were gathered:

1. How long does the session last? 2-3 minutes in average in all five cases.
2. Have people testing your game experienced symptoms related to simulator sickness? No, in all five cases.
3. Do you use the *Chaperone* feature? Affirmative in 3 out of 5 cases.
4. Do you have any measures after the VR session has finished? No, in all five cases.

The HTC Vive *Chaperone* [HTC] is an adjustable visual feedback, provided to warn the user about close physical limits in the surrounding.

Other observations were done, such as available space for VR, furniture or other hard objects near the VR setup, and cabling handling. All five VR experiences tested were, based on our findings of good practices and ethical considerations, lacking some aspects of health and safety regulations stated in the manufacturers "Safety and Regulatory Guide" [HTC17]. Among other observations about the overall setup, it could be seen that space was not sufficient according to the manufacturer's guidelines and there were physical objects nearby the participants. It was also noticed that due to the level of noise in the hall it was difficult to hear the voice of the staff or ask them any question. In all cases, VR safety and health guidelines from manufacturers were not on display nor on offer for the visitor to read.

Finally, for the **individuals**, there is not much information specific to VR. It could be assumed, that in average most participants of a technology conference are familiar with technology and maybe VR, although the different regulations in each country can vary significantly when it comes to assigning responsibilities.

4.2.2. Academic

Research performed within institutions is often done following the national and local laws. It is also common that there exist Institutional Review Boards (IRBs) for each region of a country where researchers must submit applications every time participants are involved (user studies) [BGC*10]. These applications help the researcher to formulate the methods and research questions systematically, clarifying the motivation and justifying the participation of human subjects. In Sweden for instance, there is one IRB for each geographical region in the country where researchers can submit applications.

Experiments are run in controlled spaces, and often take into consideration all related risks that could appear during the study. Participants also know in advance the estimated length of the experiment, must give informed consent to participate and must be told that they can withdraw at any time without any consequence or explanation.

5. Analysis

Within the extent of this analysis, the only similarities that were identified between industrial and academic practices were the hardware and software (Unity3D in many cases) used. On the hardware

side, it is common to see the HTC Vive and Oculus Rift as the preferred platforms for high-end VR.

On the other side, there were several differences in how VR was implemented and exposed between academia and industry. These might be due to the objectives that each area aims for: research studies pursue exploration and acquisition of new knowledge, regardless of the technological platforms and the implications related to its use, while industry has a much stronger focus on economic revenue and is driven by market values. It is important to note that industry also learns from exhibitions in public spaces, and can feed back these experiences into the development process to deliver a higher quality VR experience.

As Friedman [Fri07] argues in his seminal work *The Social Responsibility of Business is to Increase its Profits*, "...there is one and only one social responsibility of business–to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception or fraud." [Fri07, p. 6]. There has been significant progress in promoting CSR [ISO10], as it can also be seen as added intangible value to a brand or corporation [CT10]. The Small and Medium-sized Enterprise (SME) sector does not attract much attention from media as large corporations do, and although there are opportunities for CSR they are not often developed [Jen09]. Having these ideas in mind, the discussion is divided into three major parts: participants, setups for VR, and content.

5.1. Participants

From the participants perspective, it is clear that final consumers in their private spaces are mostly responsible for reading and ensuring they understand the manufacturer's health and safety guidelines. It is out of the scope of this paper to discuss how liability is assigned to the different parties in private spaces (manufacturer, content developer, final consumer).

The amount of possibilities in which a VR experience can be delivered (content and interaction modes) cannot be predicted by manufacturers. For example, this video [Mar17] shows a player jumping to impact a high tennis ball and hitting the ceiling with the controller. When immersion occurs, the user sees the sky inside the game and completely forgets about the physical world limits.

In public settings (exhibits, exposition booths, etc) it is not so clear where the responsibility lies. No one is forcing people to approach an exhibit and test VR (strictly speaking). Although, considering that this is a new technology, it is ultimately the staff showcasing the product who must provide all important health and safety guidelines. Furthermore, participants should be informed about the possible post effects of the VR experience, to ensure these are minimised or removed completely.

For example, it is not recommended that a person with a pacemaker uses VR [HTC17]. Who's responsibility would be in the case of any interference with the pacemaker? the person who did not ask or the VR staff who did not ask or inform about the risks? A person with a pacemaker knows that electromagnetic interference is bad for the pacemaker, though office computer equipment is often deemed as acceptable [Nat17].

In contrast, how the academia approaches participants for research is very different. In a way, research participants are protected by a system put in place that enforces the researcher to validate his protocol and methodology through an IRB. It is ultimately the participant, who agrees to an experiment after reading in detail the procedures and tasks he will be exposed to. There is a clear contract between the researcher and the participant, and all information is disclosed and agreed upon.

On this aspect, there seems to be a need for some form of collaboration between these two actors, to transfer experiences and knowledge from research to the industry practitioners to educate and inform about the risks related to the use of VR. The objective would be that the provided safety and health regulations are adopted accordingly by all stakeholders involved.

5.2. VR Setup

It could be argued that, the risk of having a bad VR experience is much higher in an informal setting than in a research facility.

Researchers must follow ethical guidelines and vetting, and have better laboratory space and equipment to run experiments. Furthermore, in research there are protocols in place for when things go wrong, and researchers have allocated time to ensure the well being of the participants after they have finished their experiment.

On the other hand, manufacturers, publishers, and game companies use VR as a mean to conduct some form of business or market research. Because of this and other limitations such as location, space, and the portability of the equipment, industrial practices are perceived to be less controlled and less consistent with the reviewed consumer rights and ethical values.

Some of the industrial setups visited during the Participatory Observation did not provide sufficient space and an obstacle-free environment for VR participants, as recommended by regulations from the vendors. It is not clear why there is a lack of information available for the public about potential side effects, as they are clearly stated in the user safety and health regulations. A possible explanation could be the assumption that users that attend these places are technologically savvy and are aware of the issues. Another possibility is that such level of warnings and disclaimers could put people away from even trying these experiences.

For public settings, it is suggested to have a written and clearly visible summarised disclaimer of potential adverse effects of VR and also to encourage participants to ask about these. Furthermore, all VR simulations should provide a simple mechanism to exit the experiment or to force the HMD to display a neutral image that is established to not cause any discomfort.

Another issue noted in the conference we visited was the surrounding noise and immersion, and how it isolates the participant from the outer environment. Although this is good for delivering a successful immersive experience, we think that in noisy environments a direct audio channel of communication between the participant and a staff member could be used to reassure, warn or guide in any way the participant. In user studies (research) this is not often a problem as the environment is highly controlled.

It is encouraged that industrial practices are improved in order

to provide an appropriate environment for the public exposition of VR. Following the suggested guidelines for its use, and stating clear, sufficient and precise information regarding the potential risks associated with this technology. Since the hardware platform is a common denominator between both academia and industry, it should be the hardware (display) which presents a normalised set of disclaimers and simple guidelines that all parties agree to use and improve upon to communicate effectively this information.

5.3. Content

The type of VR content between industry and academia differs, as they have diverging goals. Research has as a main aim to explore and understand causes and consequences, studying variables in isolation under controlled environments and in many occasions taking a utilitarian approach to ethics. For instance, it is acceptable for academia and researchers to design and perform a user study to compare two alternatives of locomotion and measure which one produces less simulation sickness [JM01].

On the other hand, the industry tries to provide an immersive experience, with the goal of communicating an idea or providing entertainment for the benefit of the company. In this sense, these VR experiences have been designed and tested to not have any physiological adverse effect.

Here lies an interesting point, whilst the industry tries to produce the best VR experience, that should not induce physiological adverse effects, the academia deliberately pushes some ethical boundaries for the sake of the greater good (acquiring knowledge). Both approaches have legitimate intentions, although we would like to see some of the ethical considerations established in academia transferred to practices in the industry. Especially during this period of massive adoption until all the side effects and ways of mitigating them are well known by most users and practitioners.

6. Conclusions and Future Work

VR is a technology that is growing and brings great opportunities and challenges for both, academic and industrial practitioners. The recommendations proposed are considered to be important, to ensure an appropriate exposition of VR to research participants and final consumers. In academia, to a high degree, the ethical issues highlighted are accepted and agreed upon when a participant decides to be part in a study. In public settings this is more difficult, as discussed. As a summary from Section 5, the following points are considered relevant for a responsible and ethical usage of VR in public spaces and academia.

- Staff demonstrating VR experiences must be well aware of the potential risks of VR and have a protocol in place in case adverse effects occur.
- Participants of VR in public spaces should be informed about possible adverse effects, regardless of what the experience is or what the past participants have reported.
- A written and clearly visible disclaimer of possible adverse effects should be standarised and used among practitioners.
- Safety regulations from vendors must be carefully checked by staff setting up the VR. Including warnings about radio frequency interference with any medical device. A written copy of the EULA of the VR hardware should be available if requested.
- Ensuring that enough space surrounding participants is safe in case of tripping or falling to the floor.
- A designated (and hopefully widely adopted) mechanism should be used to exit the VR experience immediately.
- An audio communication channel (via an audio mixer for instance) between the participant and the practitioner should be available in noisy environments.

We consider the platform used to deliver VR to be the ideal venue to communicate and pass the usage guidelines and disclaimers, new comers should always be properly informed.

A larger adoption of the VR technology is expected. It would be interesting to analyse if the issues addressed are exacerbated or the lessons learned can help the different parties improve their practices. Also, ideas such as the *policy vacuum* [Moo85] by Moor, should be reconsidered to be more inclusive to ethical and social responsibility guidelines in industry practices.

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