

VIRTUAL REALITY

AND ITS POTENTIAL FOR EUROPE

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Credits



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PREFACE

Virtual reality (VR) and augmented reality (AR) are technologies which have the potential to transform the way we work, communicate, and experience things. Not only will they have an impact on our daily lives, but they are also expected to create a multi-billion-euro industry. Both start-ups and large companies could benefit from VR and AR. These technologies have the potential to build on Europe's creativity, skills and cultural diversity, and impact various domains – from manufacturing, engineering and architecture to education, healthcare, arts, entertainment and culture.

The VR industry is now in an exciting stage. After years of research and development, technology has reached a tipping point where it is accessible to both consumers and industry, and allows large-scale market introduction. Every day there are new ideas on how VR can be used, new start-ups, increased investment and new projects, and they all build on the growing expectation of what VR technology can offer.

This report maps the VR industry in Europe and analyses the dynamic VR and AR ecosystem.

This is done through a combination of various methods and data collection techniques, including:

- creation of a unique database of around 1000 VR and AR entities in Europe by pooling data from multiple sources, including the EU VR.org association. The entities included in the database range from policy makers, accelerators and innovation hubs to researchers and VR & AR companies
- extensive desk research of existing market reports and mappings, as well as wider literature on both VR and technology adoption
- a survey with participants from more than 100 VR and AR entities across Europe
- participation in major European events on VR and AR
- over 80 interviews with companies, policy makers, support institutions, researchers and other experts on VR and AR in Europe
- consultation with the relevant VR & AR expert of the European Commission
- econometric analysis and quantitative approximation based on observed developments in similar high-tech industries.

Our efforts resulted in a report that provides a snapshot of the state of play of the fast-changing VR and AR industry in Europe in 2016/2017. It describes the potential of this industry to sustain and grow its position as one of the key players on the global VR and AR scene. The key findings of the study include:

- Europe is a strong and promising player on the global VR scene its competitive advantage formed by a long-standing tradition in VR research and manufacturing industry applications, as well as creativity and cultural diversity
- Stable growth of the VR & AR markets is expected both in Europe and around the world. The total production value of the European VR & AR industry is expected to increase to between €15 billion and €34 billion by 2020 and account directly or indirectly for 225,000 to 480,000 jobs
- European companies and researchers can benefit from accelerators and start-up hubs, as well as national and EU public funding
- The European VR frontrunner countries include France, the UK, Germany, the Netherlands, Sweden, Spain and Switzerland. A lot potential for future growth can be found in Finland, Denmark, Italy, Greece as well as Eastern and Central Europe including Poland, Estonia and the Czech Republic
- VR is capable of transforming and innovating traditional sectors such as manufacturing industries, construction and healthcare. It can also revolutionize education, culture, travelling and entertainment. Europe will play an important part in this "VR revolution"
- Policies of the future enabling good access to finance for innovation and the development of the digital economy will play an important role in developing the VR industry.

We would like to thank all the people who actively supported us with valuable insights on this industry. We hope that our findings will make the potential of VR and AR well understood and will be beneficial to the development of the European VR and AR industry.

Brussels, Lausanne, May 2017

01

EUROPE WITHIN THE GLOBAL VR & AR LANDSCAPE

Virtual Reality (VR) is described as a 3D environment in which a person can become immersed, using a dedicated headset, powered by a computer, game console or smartphone. The VR experience can be enhanced thanks to 3D audio sounds and by using haptic devices that use sensors to transfer body movement into the virtual space. **Augmented Reality (AR)** refers to a real-world environment enhanced with computer-generated information such as sound, video or graphics.

Although they are different, VR and AR share common processes and technologies, such as audio software and data processing. They also tend to concentrate in the same business and research worlds hence creating overlapping ecosystems. This study is primarily focused on VR, however we sometimes talk about VR & AR ecosystems or industries – this is because the VR & AR communities and their development are so interlinked, that in some instances it is also impossible to separate them.

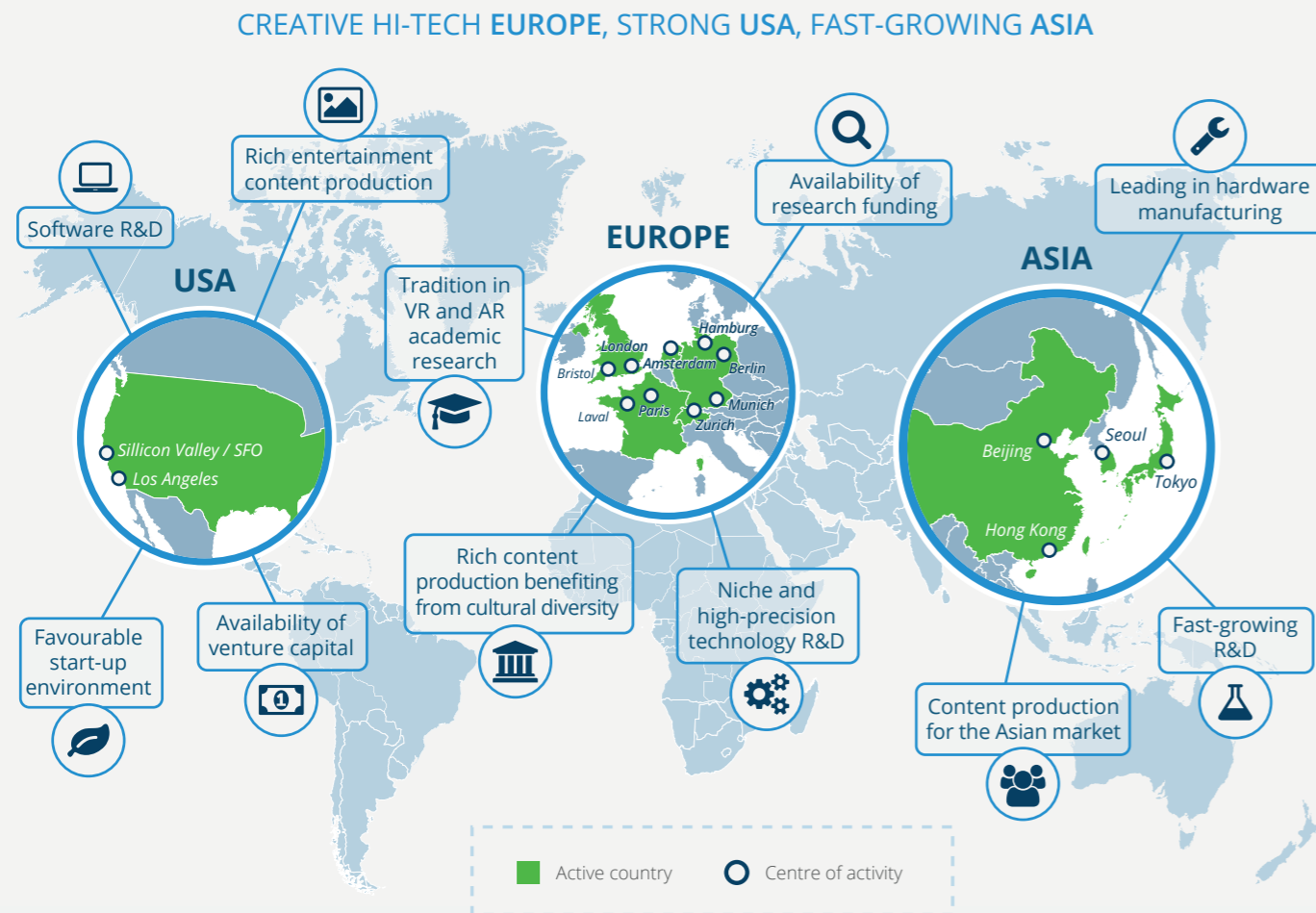
VR is used within a wide array of areas, ranging from the gaming industry and entertainment, to training and simulation, including training in the medical field. Other areas of application include education and culture, sports, live broadcasting, real estate, advertising, architecture and arts. More areas of application are still to come. AR has an almost limitless range of uses in a wide variety of areas, be it commerce, technical applications, work processes or education. VR & AR serve both consumers and professional users that can be private and public.

Interestingly, VR & AR ecosystems are also closely related to the industry of **artificial intelligence (AI)**. This advanced technology helps to create more realistic simulations in the virtual space, as well as independently acting avatars. AI is not a subject of this study, however it is important to be aware of the synergies amongst these three high-tech industries and their closely related ecosystems with a great importance of R&D and creativity.



1.2 The global VR & AR landscape

As with many new technologies today, VR and AR are industries characterised by global value chains where activities, ranging from research and development (R&D) to hardware production and content creation, are spread out across the globe. A number of regions are of clear importance, including Europe, Asia and the USA.



Europe, by which we understand not only the 28 states of the European Union (EU), but also Switzerland, Norway, Iceland, Lichtenstein, the Balkan countries and Eastern Europe, has a rich tradition in academic VR & AR research and is also the place where niche and high-precision technologies are developed. These technologies can be used for industrial purposes or in specific areas such as manufacturing, medical trainings or engineering development. At the same time, Europe is diverse in terms of languages and cultures, which inspires creative content creation. Across Europe there are various VR & AR hubs where people with different backgrounds share expertise to create new VR and AR applications. European companies and research institutes benefit from research funding from both national and EU sources. Interestingly, also non-EU players can benefit from EU VR & AR research funding, if working in consortia with EU companies or research institutes.

The **United States of America (USA)** have a leading position in the global VR & AR market. R&D for hardware and software is centred around Silicon Valley with IT giants such as Google, Apple and Facebook. The content production is concentrated around big gaming studios and production studios in Los Angeles. The USA offers favourable conditions for VR & AR start-ups. The country has the most active VR & AR venture capital (VC) funds and is willing to invest in early technology start-ups, which is why commercial VR and AR companies started in the US earlier than elsewhere in the world.

In the **Asian market** many VR and AR companies are popping up especially in China, Japan and South Korea. Major Asian technology firms such as HTC, Sony and Samsung are active in the mass manufacturing of VR and AR hardware and they benefit from the competitively priced workforce. The Asian VR and AR market has been growing at a high rate also driven by the support of local governments. Asian VC funds, such as the Japanese company Gumi, support the Asian development but are also interested in VR talent globally, including Europe. Asia is also active in content creation, however, for cultural and language reasons, it is mainly focused on the Asian market.

1.3 Europe's strengths in the global VR & AR industry

Europe has a number of particular strengths that enable it to be an important player in the global VR & AR industry:

VR research and development

in Europe has a long-standing history, for example in the **industrial design, medical sector and psychology**. Since the early 1990s, EU research funds have supported more than 450 projects dedicated to VR and AR, with a total of over €1 billion. Due to the availability of public research funding (European Union and national public funds), European **universities and research centres** have been **experimenting with VR and AR since the 1970s** and are well advanced in coming up with successful applications. For example, MindMaze, a hugely successful Swiss VR med tech company, is a spin-off of neuroscience research at EPFL Lausanne and ETH Zurich.

The cultural diversity in Europe

enables rich storytelling that provides an excellent basis and inspiration for VR films and games production. This makes European content stand out on the global VR scene. European creativity in VR has been described as rivalling Hollywood and is promoted by public broadcasters such as the BBC (UK) and ARTE (FR/DE) who are already actively exploring the artistic and educational potential of VR. Public funds such as CNC (FR) are further supporting the diversity and quality of the content.

A skilled workforce

makes it relatively easy for companies to find employees and grow. Europe has many highly skilled and qualified workers capable of 3D modelling and creating computer-generated (CG) content for the gaming industry and VR animation. European universities teach developers to approach VR from different perspectives, including art, design, industrial production, film, game design etc.

European cities are historically diversified

attracting people and experts from different backgrounds and cultures. They offer excellent breeding grounds for VR and AR technologies that will be used for different aspects of work, living and creation. The multidisciplinary nature of cities in Europe is an important asset. VR and AR applications arise when creative people meet with engineers, programmers and editors, who in turn meet with people from application domains in industry who work closely with marketing and business experts.

There is a tradition of collaboration

within VR communities in Europe, as well as between different industrial sectors. This is largely thanks to the funding of collaborative research in Europe, the increasing number of national and European associations (e.g. EuroVR, KTN (UK)), incubators and accelerators (e.g. Realities Centre (UK), VRBase (NL), Invest Stockholm (SE)), think tanks (e.g. UNI-VR (FR)), and many spontaneous VR meet-ups and events where networking takes place (e.g. World VR Forum (CH)). For the time being, the spirit of collaboration seems to outweigh that of competition.

High-precision and niche manufacturing

as well as hardware development are well established in Europe. They now feed into state-of-the-art audio and optical technologies and VR & AR for the medical sector. Europe is strong particularly in middleware and software, both of which are soon expected to emerge as the areas of true value for VR. On the user side, the European automotive industry, aviation and machinery are early adopters of VR and AR technologies.

02

THE SIZE AND POTENTIAL OF THE EUROPEAN VR/AR MARKET



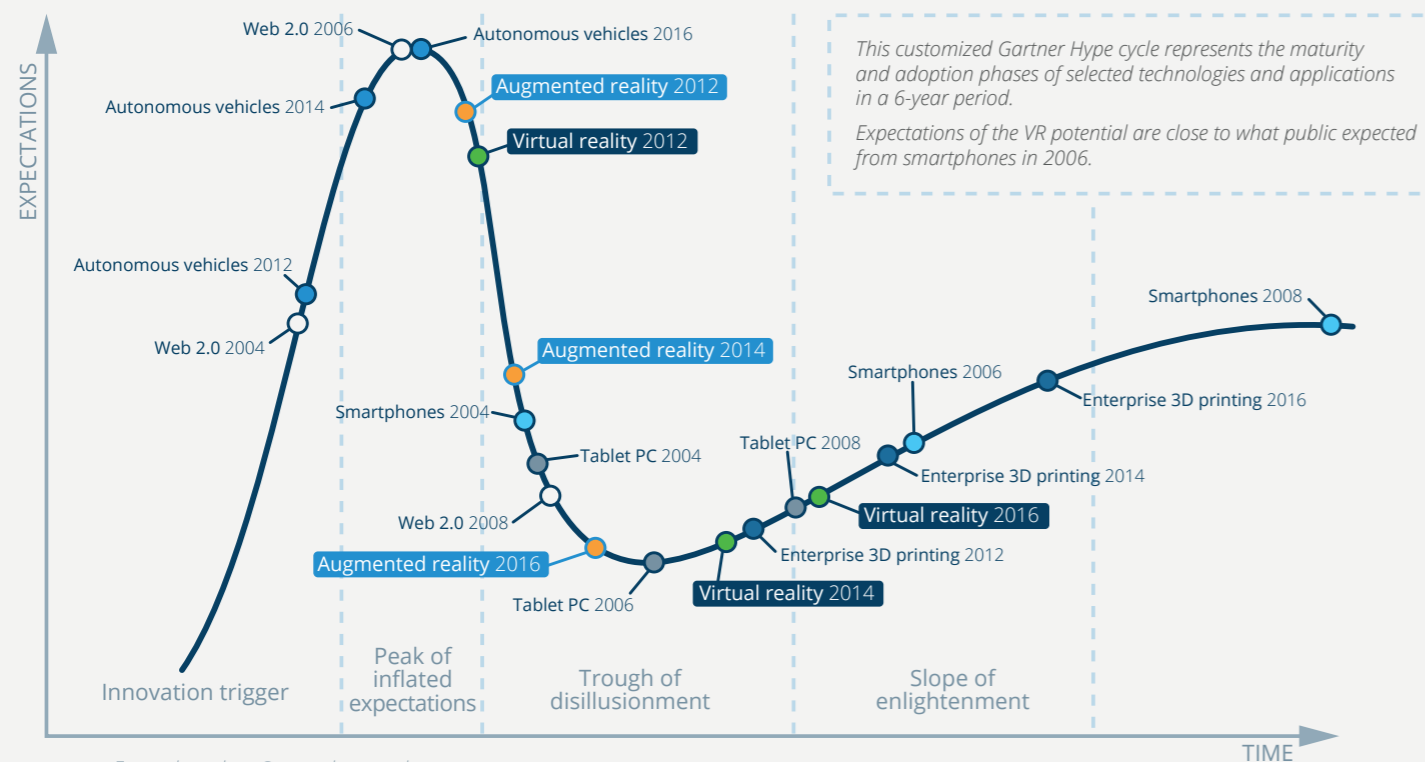
2.1 State of play of VR technology – an emerging industry

VR and AR technology has gone beyond its early exploratory stage and is increasingly accepted and demanded. VR has reached **a tipping point for large scale adoption**, in particular thanks to the development of more comfortable and affordable hardware. Even though VR has been around for a while, initially it was not available for the wider audience. Headsets were either too clumsy and not allowing for smooth virtual experience, or they were too expensive and powered by large-scale computers. As a result, VR was mostly used by large companies in industrial design or by specialised research centres.

Today headsets have become affordable and powerful and even smartphones are capable of VR data processing. They create opportunities for consumers, researchers and businesses, including SMEs, to work and enjoy life in a virtual space.

The fact that VR is likely to enter a period of accelerated growth can be illustrated with a well-known typology of the acceptance of new technology – the Gartner hype cycle. According to this typology, both VR and AR have already passed the peak of inflated expectations or a “hype” and **significant part of the population is expected to adopt VR technology in about 5 years** (AR in 10 years). In the below figure this has been compared with other emerging (previous and new) technologies.

GARTNER HYPE CYCLE FOR EMERGING TECHNOLOGIES

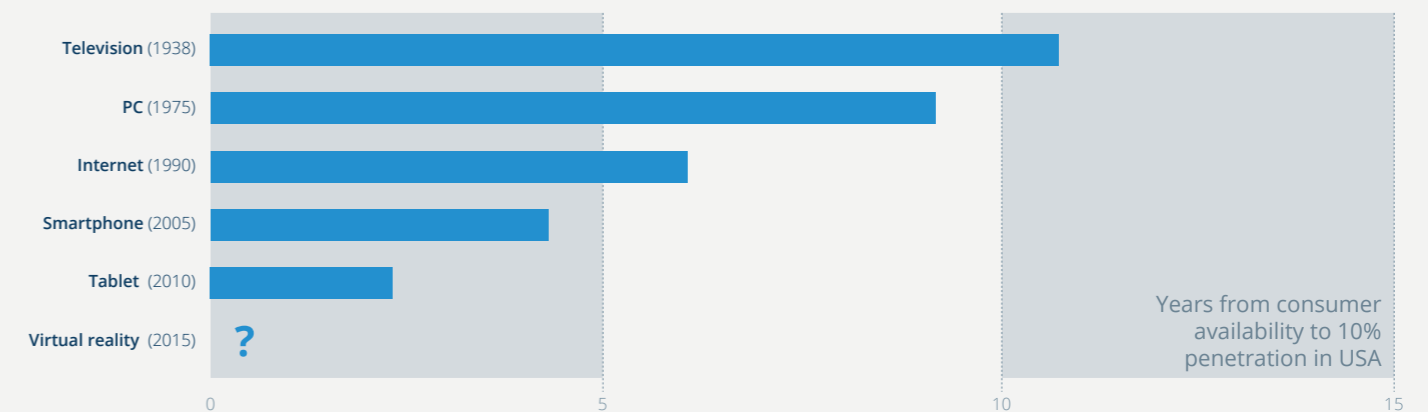


source: Ecorys based on Gartner hype cycles

This development has been observed for all technologies we are using today – be it tablets, video gaming, 3D printing or e-banking. The pattern coincides strongly with the product life cycle where new technologies are first applied by early adopters, which can be observed at present, eventually followed by a fast increase in demand and production.

To put this in perspective, VR is now entering the “Slope of enlightenment” that smartphones entered around 2007. For smartphones it took 9 years to reach a 50% adoption rate by consumers in Europe. Today, smartphones are used by a third of the world population and the global sales of smartphones reached more than €375 billion in 2016. This took less than 10 years. In addition, a growing industry for the development of mobile apps is connected to the rise of smartphones. This has brought a revenue of €16.5 billion to the EU economy.

ACCELERATED ADOPTION OF NEW TECHNOLOGIES OVER TIME



sources: Bertelsmann Digital Media Investment, Technology Review, The world Bank, Asympoo

VR is currently ahead of AR when it comes to realistic expectations and real potential of use in various consumer and business areas. And its adoption can happen very quickly as the timespan needed for adoption of new technologies has been systematically decreasing.

These developments are confirmed by our research among actors in the European VR landscape. Most actors indicate that the current state of play of VR technology has induced growth of the VR industry which will further accelerate in the years to come:

European VR & AR companies are growing – over 50% of existing companies indicate that they have expanded their VR teams and for 35% this growth was substantial. Towards the future, one third of existing companies will double their VR activities in 2017 and another third expects to increase their activity even more substantially.

An increasing number of new start-ups is observed. About a quarter of current VR & AR businesses started in the last two years (VR company database).

Customers are increasingly accepting VR & AR technology, whether for professional or private use or as consumers. This acceptance rate is significantly higher compared to two years ago. An increasing number of customers are actively requesting VR solutions, whereas others are curious about VR and demand information and trials¹.

1. According to Survey of 100+ VR & AR entities in Europe.

2.2 Current size and growth of the European VR & AR industry

To determine the impact of the growing demand for VR & AR on European economy we have made an assessment of the current and future size of the European VR & AR industry. This is based on an analysis of a range of different market studies, taking into account the specific characteristics of the European industry. Our assessment is supplemented with a detailed mapping of VR-related companies in Europe.

According to our estimation, based upon an analysis of multiple market studies, the production value of the global VR & AR industry is estimated at €3 billion in 2015. The **European VR and AR production value accounted for almost €700 million in 2015**, or one quarter of the global value. The total production value of the European VR & AR industry is expected to increase to between €15 billion and €34 billion by 2020.

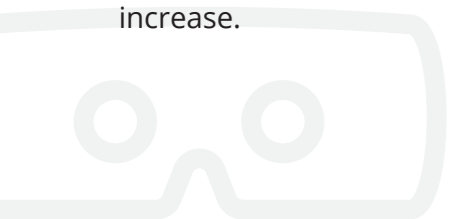
The estimation of the 2020 production value is based on two scenarios that consider different parameters and potential future developments, such as investments by major technology firms leading to innovation, and the creation of new hardware, software and content.

The **baseline scenario** counts on the steady growth of professional applications of VR, for example in industry and medical training, and on the moderate growth of the mass market of consumer applications.

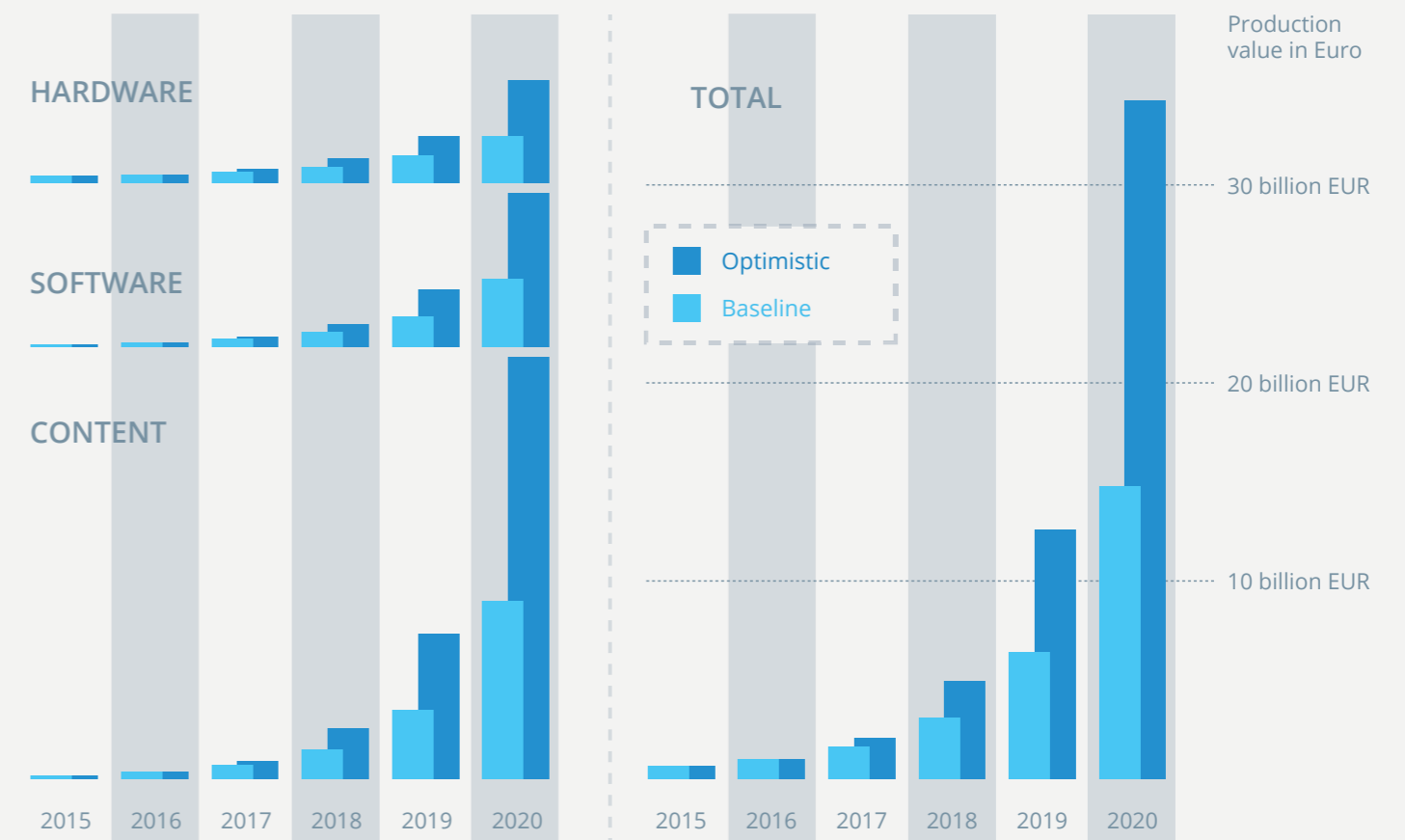
In the **optimistic scenario**, optimal conditions exist for the growth of VR/AR that will spur the purchase of headsets by a large number of consumers. This includes more user-friendly and comfortable hardware in combination with further price decreases, software optimisation to allow minimal motion sickness and breakthrough consumer applications (like social VR), and new content.

For each scenario, the development of the VR & AR market has been estimated using a set of growth rates for hardware, software and content. These growth rates were developed individually for each year on the basis of the analysis of market studies and econometric predictions, interviews with industry experts, approximation to past development of similar industries, and the results of the VR & AR industry survey. For details on the methodology please consult Annex B.

In these scenarios, by 2020 the European production value is expected to increase to between €15 billion and €34 billion, representing a gross value added of between €9 billion and €21 billion and directly creating employment for some 140,000-300,000 people. Also, wider supply chain impacts are expected to indirectly increase the production value with between €5.5 billion and €12.5 billion and generate an additional 85,000-180,000 jobs. This will bring **the overall economic impact of the VR and AR industry for Europe at a total production value of between €24 billion and €54.5 billion, a gross value added of between €14.4 billion and €33.6 billion and 225,000-480,000 jobs**. Due to the strong growth of content-related VR activities the share of Europe in the global market is expected to increase.



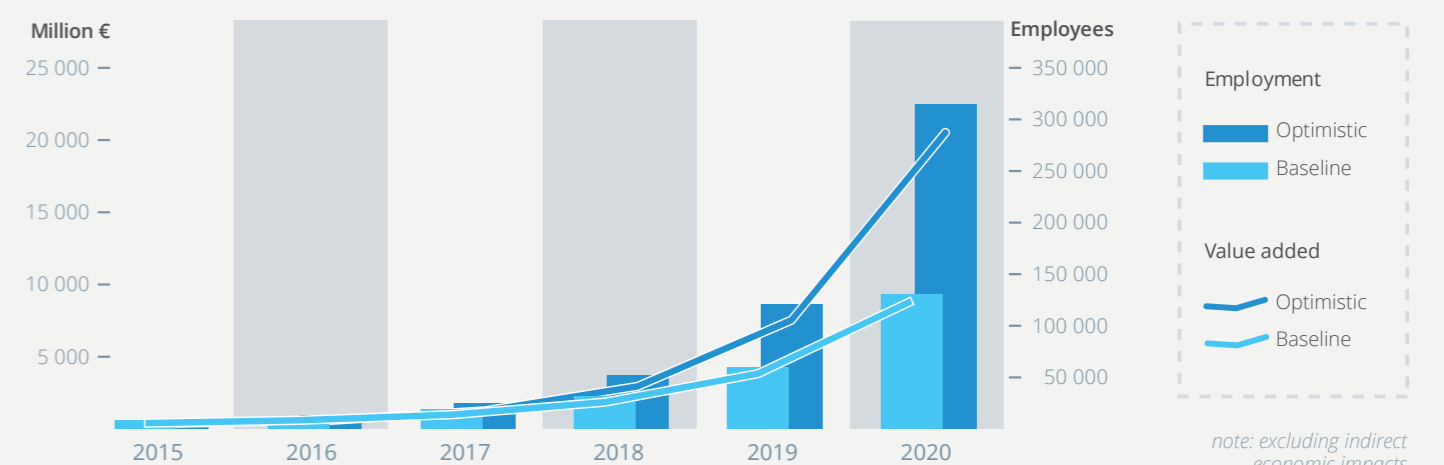
EUROPE: FUTURE GROWTH DRIVEN BY CONTENT



note: excluding indirect economic impacts

Scale is identical on all charts.

EMPLOYMENT AND VALUE ADDED IN THE EU



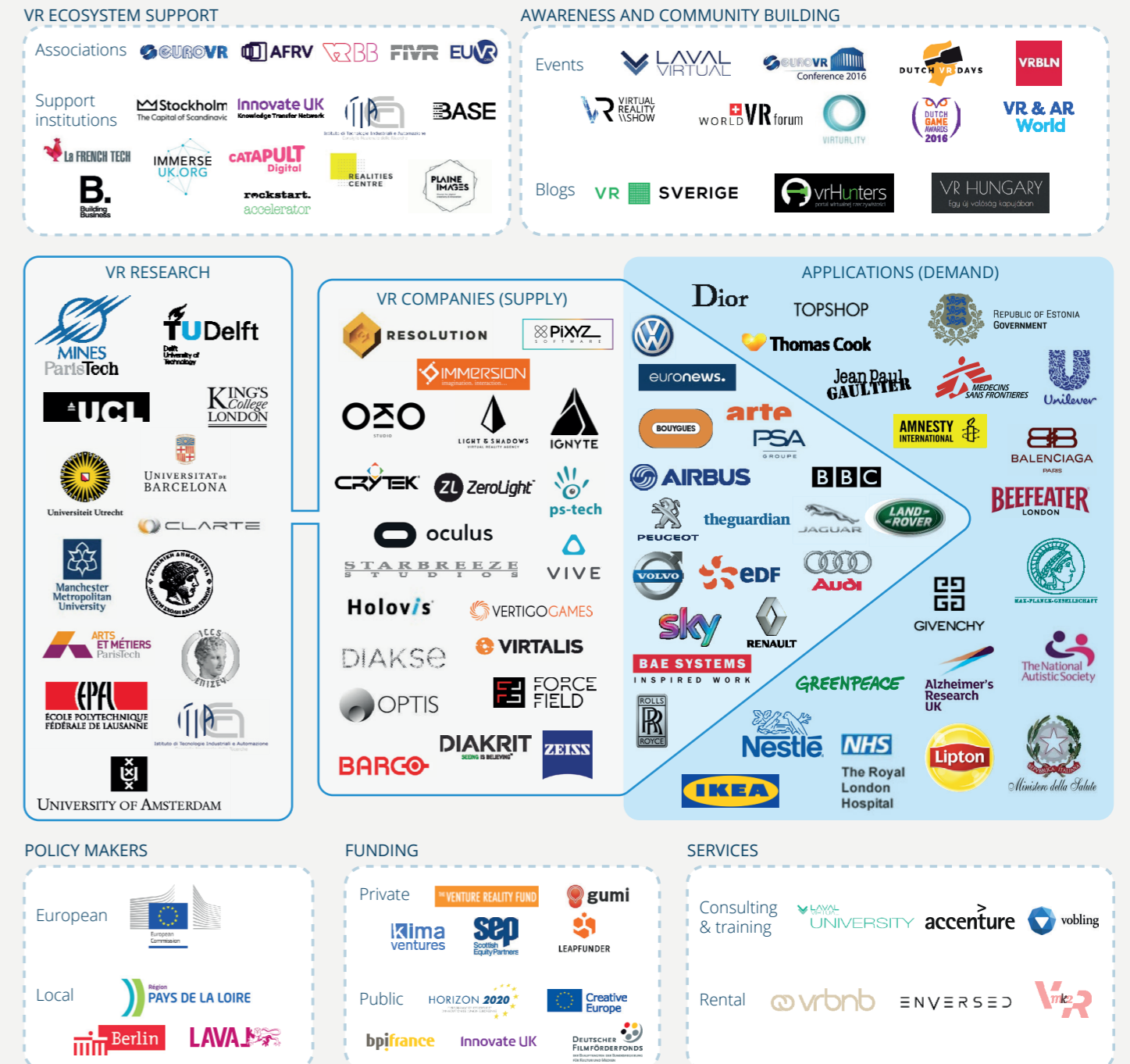
note: excluding indirect economic impacts

03

THE EUROPEAN VR & AR ECOSYSTEM

The VR & AR ecosystem consists of various actors who are all interrelated. In the centre of VR and AR ecosystem are naturally companies creating technical solutions, software and applications. Nevertheless, the ecosystem is reliant also on other players. The following map provides typology of all actors and illustrates them with non-exhaustive examples that were selected from our database of 900 VR and AR European entities.

VR & AR ECOSYSTEM MAP BY TYPE OF PLAYERS



The entities presented in this scheme are randomly selected examples only

3.1 VR research

VR research is represented by **universities, schools and research centres** around Europe and their activity closely relates to that of VR/AR companies (supply of technology solutions). Their key importance for the ecosystem is twofold. On the one hand they run **VR research projects in technical and creative fields** and help advance VR technology and applications; on the other hand they also supply **qualified workers to companies** and other entities.

The most popular research subjects among European academics are industrial design, healthcare and training, and simulation.

VR research, especially in the areas of industrial design and mechanical engineering, has a long standing tradition within universities such as **ParisTech (FR)** or **Technical University of Munich (DE)**. Technical universities often cooperate well with manufacturing industries – for example Paris Tech has a long standing partnership with **SNCF (FR)** or French car manufacturers. In the engineering sector, the cooperation between academia and the private sector seems to work well even though not all inventions get applied in the end. For example, more than a year ago **CLARTE (FR)**, a top French VR research centre, invented a high-tech VR conferencing system that allows collaborating on the industrial design process in virtual space with fully realistic avatars and without the use of headsets. However, the company has not yet been able to commercialise its invention.

Another area where European universities are active and successful is neuroscience, psychology and psychiatry. Among them **King's College (UK)** has been researching for years on VR possibilities in treatment of phobias and deformed body image. The university is currently discovering opportunities to use their methods in the wider psychology practice. Other universities active in the field of psychology are the **University of Barcelona (ES)**, **University College of London (UCL)**, **University of Oxford (UK)**, **University of Milan (IT)** and **Groningen University (NL)**. **École Polytechnique Fédérale de Lausanne (CH)** has been active in neurology technology and its research successfully resulted into the creation of the global leader in medical VR **MindMaze (CH)**. Psychology VR applications in the past have sometimes struggled to find public research funding, however this is currently changing.

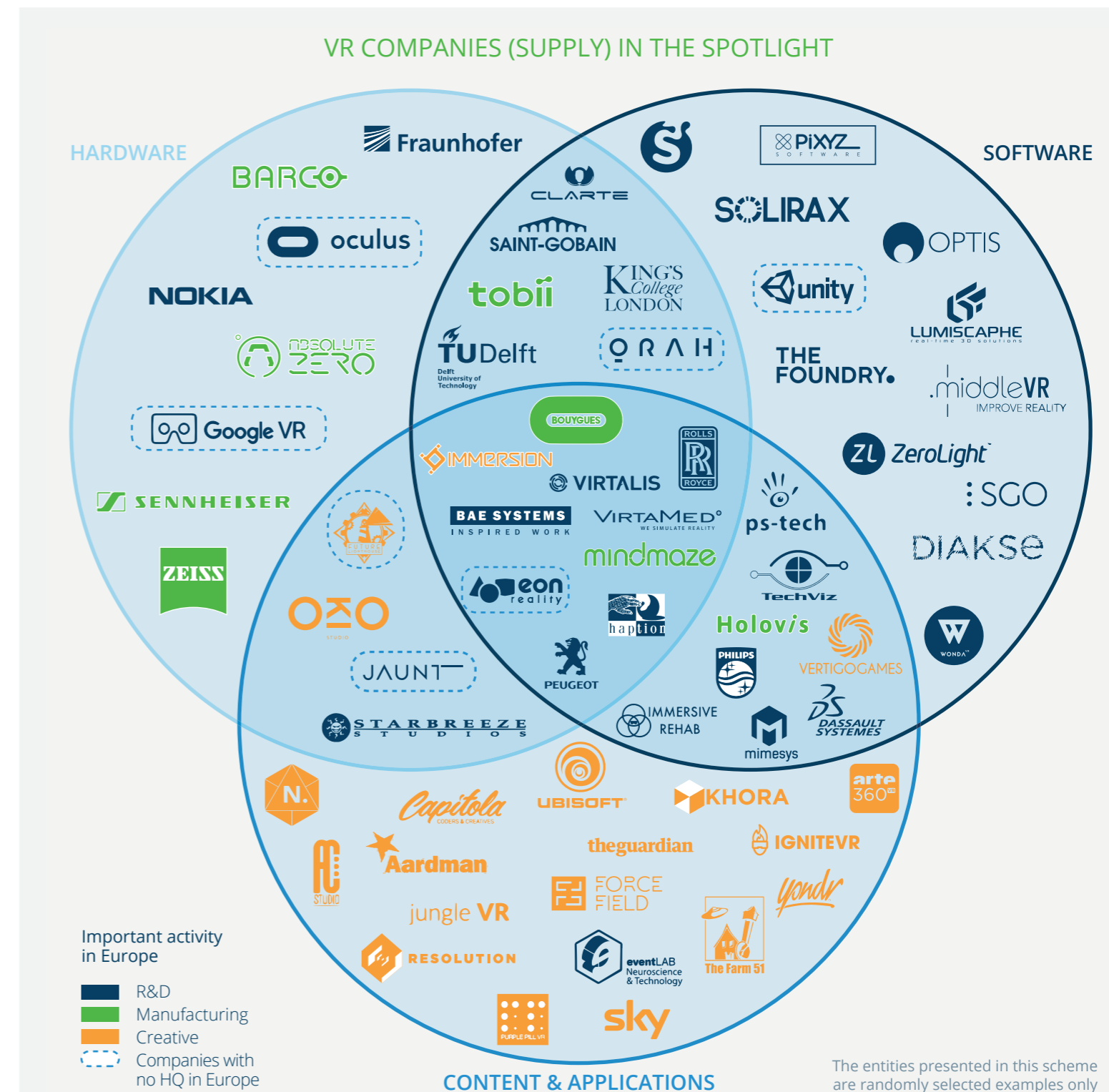
Another category is **creative schools and art degrees**. They are active in content creation in VR and teach how to capture images or create 360-degree movies. For example, **University of Paris 8 (FR)** in cooperation with a **Athens School of Fine Arts (GR)**, teaches a degree connecting art and VR technology. This results in an art project involving a haptic device where the visitor moves around in a virtual space. Practical schools of gaming such as **Futuregames (SE)** help to advance computer graphics and software development, while movie making centres such as **Bayerisches Filmzentrum (DE)** help to advance cinematic production and also actively cooperate with local universities to find new technical solutions for a truly immersive VR experience.

In general, European universities' prime focus is on **fundamental research**. Their main goal is **to improve scientific theories and to better understand** phenomena in a scientific domain with findings published by credible academic articles. Next to fundamental research, **applied research** projects, attempting **to solve issues** brought by a private sector partner, are relevant to many universities (two-thirds of universities are actively in touch with businesses). Also, universities across Europe are well connected and they actively work together – in fact, some EU research funding requires such international collaboration. Funding comes mostly from **national public funds**, however more than half of the universities and research bodies are using **European research funds** and one-third also receive private funding.

3.2 VR companies

VR companies are involved in three main core activities – R&D, manufacturing and content creation. European VR companies produce three main types of products: hardware, software and content. Many companies provide more than one of these product types at the same time.

Companies are taking advantage of the VR research infrastructure and the skilled workers it produces. The map below shows the relationships and overlaps between the three main product categories and illustrates them with selected non-exhaustive examples from our European VR & AR database.



Hardware manufacturing in Europe is mostly precision and niche technology. As an illustration, the company **Tobii (SE)** is involved in advanced eye tracking and manufactures all its products in its home country. The same applies to **Zeiss (DE)** that specialises in optics, or **Fraunhofer (DE)** that has been running its VR Solutions Centre since 2001 and in addition to other VR products provides globally renowned audio solutions. **MindMaze (CH)** is making its own neuro-treatment devices backed by hi-tech research. In the European context, companies involved in manufacturing also perform their own R&D activities, often in cooperation with European universities and research centres. When it comes to hardware for mass production, R&D is often done in Europe while the actual products are manufactured elsewhere. Interesting example of that is a joint initiative of **Starbreeze Studios (SE)** and **Acer (TW, Asia)** that resulted in the high-end headset **StarVR**.

Europe is a centre of R&D for both software and hardware and specialised applications. Interestingly, even non-European companies such as **Jaunt (USA)**, **Oculus (USA)** or **EON (USA)** often locate their R&D departments in Europe to benefit from the presence of high-skilled workforce. Some successful software and hi-tech companies such as **Unity (USA-DK)** or **Metaio (USA-DE)** kept their R&D in Europe but either relocated their business development and official headquarters to the USA or were acquired by big global brands such as Apple.

Some specialised applications are R&D intensive and require content creation, but also need software expertise to coordinate virtual images with real-time movement. These are for example healthcare companies such as **Medical Realities (UK)**, **Psious (ES)**, or industry companies like **Jungle VR (FR)** and **Light & Shadows (FR)**.

Content that can be either 360-degree videos or computer-generated images (CGI) is mostly associated with the creative processes of making video games, VR experiences and movies. Europe is strong in creative processes, with studios such as **Okio (FR)** providing independent movies and VR experiences. European broadcasters including the **BBC (UK)** and **ARTE (DE/FR)** are also involved in the VR content creation process. Some content studios would also build their own cameras to fit their needs.

European companies in the European VR & AR ecosystem are mostly small and medium-sized enterprises. Together they employ over half of the total number of employees. The large companies are often established firms that come from manufacturing industries and deploy VR solutions for engineering. About half of these companies are at initial phases of product development, meaning that they are either in an R&D phase or at the very early stage of product launch, and they are not making any profits yet. The rest of the companies are already generating profits and/or have already launched their products.

Results from our survey indicate that the European ecosystem is to a great extent part of a global value chain. VR & AR companies are split between those that choose their suppliers from around the world and target customers globally and those that choose their suppliers from Europe and focus mainly on the European market.

Access to finance is a major challenge for European companies as many of them had to be creative to make it to the market. Most companies are either self-funded, or are financed as part of the larger company to which they belong(ed). Less than a quarter of European companies found access to venture capital to start their business.

3.3 VR applications (demand)

Companies that apply VR solutions and thus create the ecosystem demand are driving the adoption of VR technology. Sometimes they are an intermediate platform to the use of applications by consumers. In general demand can either come from:

- **consumers** that currently use VR mostly for entertainment (e.g. gaming) and shopping, but increasingly adopt VR apps for healthcare, commerce or education
- **professional** users from the **public** sector such as ministries and governments who are particularly interested in VR trainings, the potential of VR rehab and psychological treatment, and the immersive value added for promotion of countries and regions
- **professional** users from the **private** sector who demand VR to improve the internal production process, offer new value to their customers or implement a new media in building relations with customers
- **universities** that advance (basic) research.

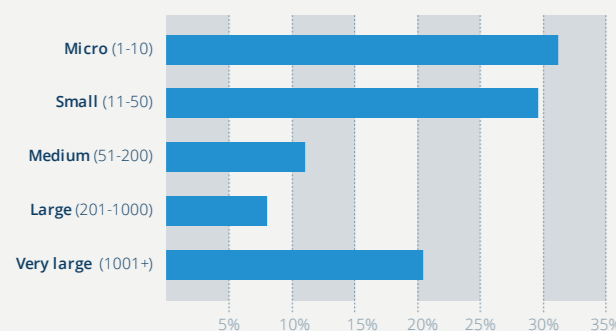
Some entities that demand VR & AR either for internal processes (e.g. **Airbus (FR)** or **Jaguar Land Rover (UK)**) or to provide content for the public (the **BBC (UK)** and **ARTE (DE/FR)**) develop VR internally but also hire external suppliers.

Demand for VR is generated in a large number of domains, ranging from the manufacturing industry to consumer applications.

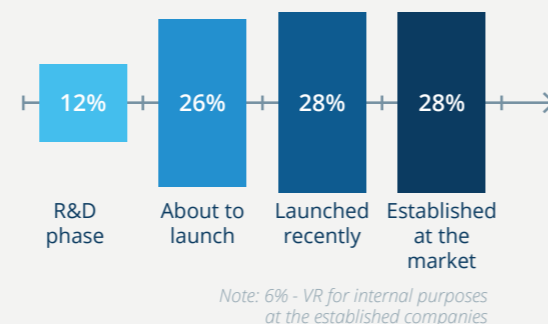
— More details on application domains in VR can be found in [Chapter 5: The application of VR and AR](#)

VR & AR COMPANIES IN NUMBERS

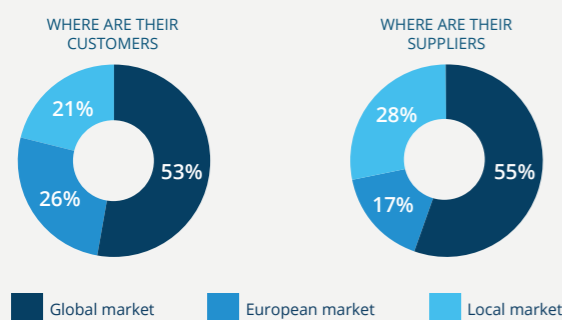
VR & AR RELATED EMPLOYMENT PER SIZE OF ENTERPRISE



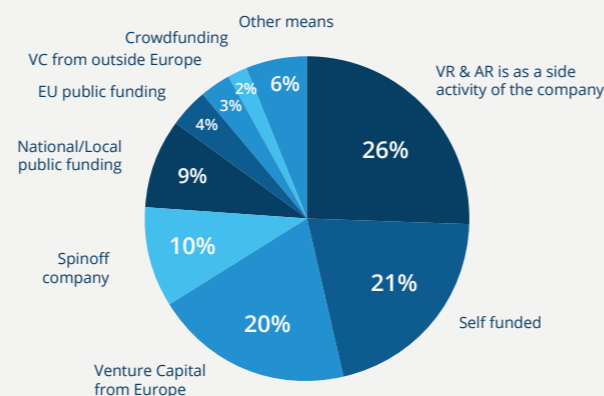
MATURITY OF THE VR/AR PRODUCT



INTERNATIONAL DIMENSION OF EUROPEAN VR&AR PROVIDERS



FUNDING OF EUROPEAN VR & AR START-UPS



3.4 Other actors in the European VR & AR ecosystem

An important part in the European VR ecosystem is played by actors beyond the demand and supply. These actors hold the ecosystem together, enable exchange of information and know-how, and facilitate business and research activities. These actors are:

Associations, think tanks and other **support institutions** that gather VR and VR-related companies and represent their interests. Some of these actors work on the European level (**EuroVR**) connects researchers from universities and research-oriented companies from around Europe, **EUVR.org** is more business-focused and targets start-ups, the **European Broadcasting Union (EBU)** gathers broadcasters), and others work on the local level (**Finnish Virtual Reality Association (FIVR)**, **Uni-VR (FR)** – a VR think tank that connects actors across industries and specialisations).

“Support institutions” are often (semi-)public bodies and their goal is to provide support for innovation in general or VR in particular. Examples include **Realities Centre (UK)** or **Invest Stockholm (SE)** which have their activities aimed specifically at the local VR communities. **VRBase (NL/DE)** is a venture capital-funded initiative which is an example of a multi-country VR-specialised institution. It works as a city hub for VR companies and is currently placed in Amsterdam and Berlin, but expanding to Paris and Barcelona. Startup campuses such as **Station F (FR)** enable the sharing of knowledge and experiences between innovative entrepreneurs from different sectors.

Awareness and community building actors include **events** and **VR blogs**. Events help the VR and AR community to periodically meet up and exchange the latest information across the border. Europe hosts some events of global importance such as **Laval Virtual (FR)**, currently the biggest VR & AR fair in Europe dedicated mostly to professional uses of VR. Other important events include **World VR Forum (CH)** and **Dutch VR Days (NL)** focused on content production or the **EuroVR** annual conference dedicated to VR & AR researchers. Local meet-ups and smaller informal events happen almost daily at VR hub cities such as London or Berlin. Blogs run by VR enthusiasts, such as **vrsverige.se (SE)**, or operated by companies further support flow of information and knowledge sharing.

Funding from both private and public sources enables development of VR technologies and paves the way from research to VR products. It also supports content creation. Venture capital funds that provide finance to new innovative businesses are less typical for Europe. However, some of the largest global VCs, such as **Gumi (JP)** or **Venture Realities (USA)** are active in Europe as well. National funds provide research grants to support development of technology and relatively large amounts are provided via EU schemes, such as **Horizon 2020**. **Centre national du cinéma et de l'image animée – CNC (FR)** or **German Federal Film Fund – DFFF (DE)** provide grants for independent VR content creation.

Policy makers at the European and local level help to form favourable business and research environment. The **European Commission (EC)** provides a European policy framework for Internet networks, research investment or business rules. EU institutions have the power to ensure coordinated action at the European level and set up rules for the internal market. **Policy makers at the national level, as well as those at the regional and city level can provide more targeted support to industries and can create VR communities.** A great example is the administration of the city of **Laval (FR)** that started providing incentives for the growth of the VR community already 20 years ago.

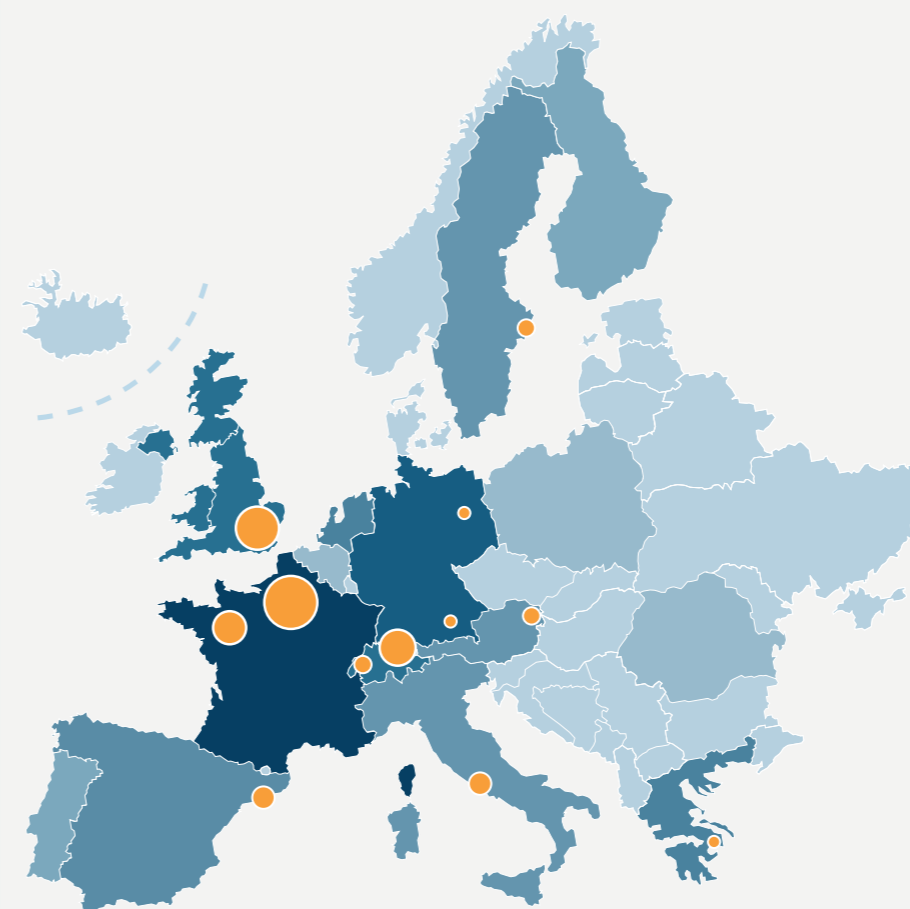
Gradually there is a growing need for VR and AR services that support the demand side in particular. Specialised training and consulting services help companies **to understand what VR and AR are and how to benefit from them. Rental services allow companies to borrow high-end VR & AR equipment either to create VR content or to use them for example for VR trainings or promotional activities.**

04

EUROPE'S VR GEOGRAPHY

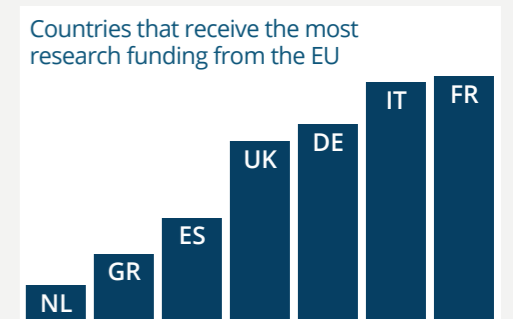
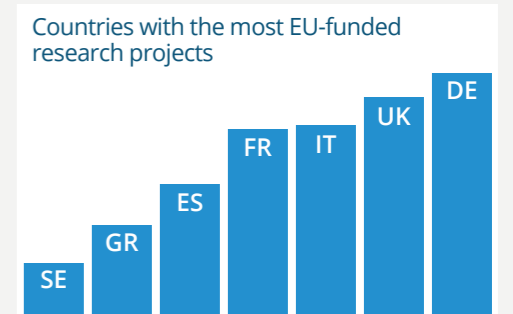
The analysis of the location of VR & AR research centres, universities and companies reveals that there are specific clusters of activity in Europe.

The European **research scene** is concentrated in **France** (especially in Paris and Laval), the **UK** (London and Manchester universities), and **Germany** (Berlin and Munich). Spain (Barcelona), Sweden (Stockholm), Austria, Italy and Greece are also engaged in virtual research. R&D is focused on **health care, industrial use of VR or general advancement of VR and AR technology**. European universities are used to working together and also cooperate on large-scale international projects funded by European research funds.



Number of VR and AR research centres
 Research centres by quantity of research entities

VR & AR RESEARCH

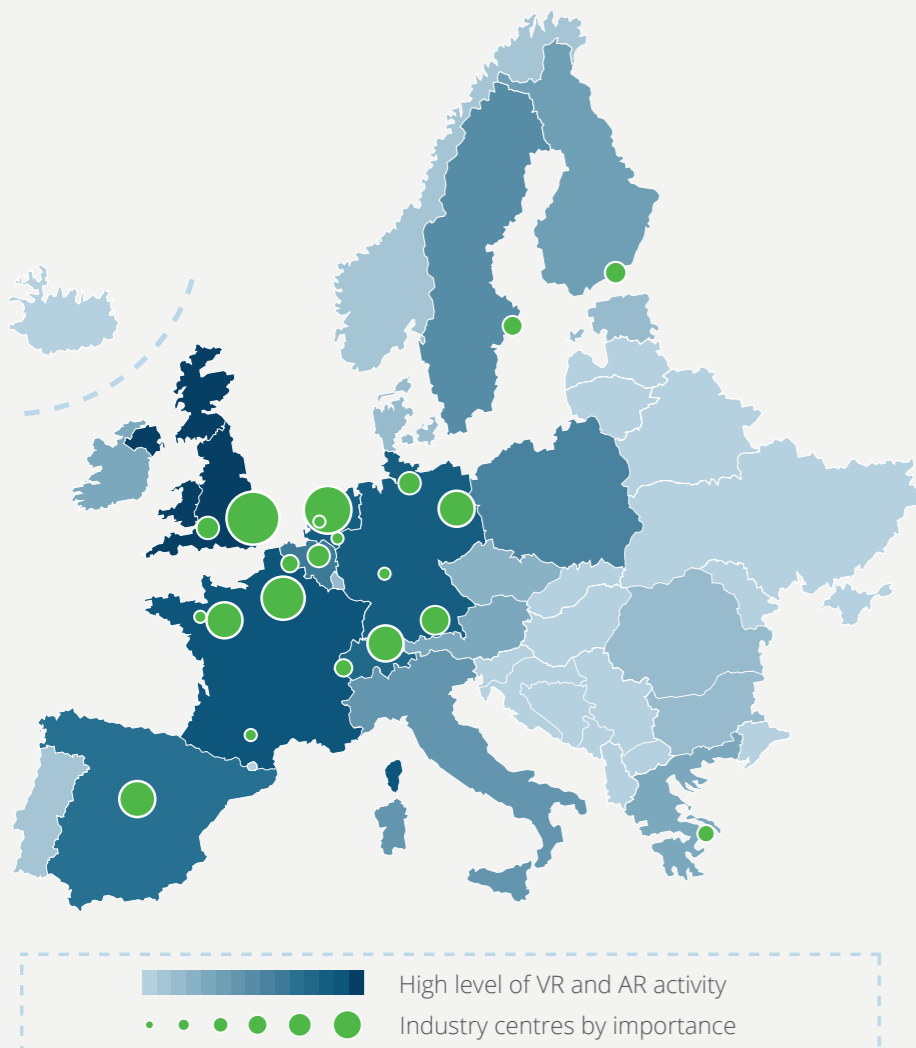


Source: Ecorys VR database, analysis of CORDIS database

In terms of European VR and AR businesses France, Germany, the United Kingdom and the Netherlands are clear frontrunners, with growing VR and AR activity to be observed in the Nordic Countries (Sweden and Finland), Switzerland, Spain, Italy and to a more limited extent Eastern Europe (Poland and the Czech Republic). Specific “hot spots” of VR activity can be found in Paris, Laval, London, Amsterdam, Berlin, Munich, Stockholm, Zurich and Madrid.

In terms of business environment, London and Amsterdam in particular create a favourable atmosphere for new VR and AR start-ups thanks to their vibrant business environment and innovative culture. Meanwhile, Paris and Stockholm are likely to go through a rapid growth in the upcoming years as they record the highest annual increase in investment.

The top application areas in Europe are entertainment and gaming, simulation and training for professional and industrial use, healthcare, real estate and architecture.



VR & AR COMPANIES

EUROPE'S VR AND AR FRONTRUNNERS		
COUNTRY	TOP APPLICATION AREAS	TOP TYPE OF PRODUCT
UK	Cinematic entertainment, Gaming	Content - video, 3D modeling
FR	Manufacture & engineering, Cinematic entertainment	Software and content
NL	Entertainment, Advertising	Content - video, 3D modeling
DE	Manufacture & engineering, Entertainment	Software and content

VR AND AR RUNNER-UP COUNTRIES		
COUNTRY	TOP APPLICATION AREAS	TOP TYPE OF PRODUCT
SE	Entertainment, Gaming	Software and content
ES	Gaming, Entertainment	Software and content
CH	Healthcare, Gaming	Software and content
PL	Entertainment, Gaming	Content - video, 3D modeling

4.2 Europe's main VR & AR countries in detail

4.2.1 FRANCE

LEADING CUTTING EDGE RESEARCH IN TECHNOLOGY

KEY CHARACTERISTICS

Early adopting industries
Strong research background
Solid public support and structures of cooperation

KEY INSTITUTIONS

AFRV • Uni-VR • Laval Virtual center
Plaine image • VR connection

SUPPORT MEASURES

CNC • BPI France • ANR
French-tech • Regional funds

KEY PLAYERS

ESTABLISHED COMPANIES

Light and Shadows • Lumischape
Thales • Techviz • Immersion
Haption • Backlight • ac3 studio
ARTE • Diota • TF1 • Allegorithmic
Saint-Gobain

START-UPS

Diakse • Wonda • Art of Corner
Incarna • Okio studio • Novelab
Timescope • Adok • Hypersuit
Realtime Robotics • Wepulsit
Holostoria • Artify • VR-bnb • Hololamp

UNIVERSITIES / INSTITUTES

Arts et Metiers - Paris tech • Mines - Paris tech • Clarte • Paris 8 • Université de Caen • Université de Strasbourg • Université Aix-Marseille • Université de Reims Champagne-Ardenne



Counting already a couple of decades of VR activity, **Paris and Laval** are the pioneer hubs that stand out as centres of excellence in the French and European VR landscape. Industrial VR applications dominate the French landscape, varying from 3D modelling and industrial design to highly specialised training applications. Many companies with a strong focus on VR film, art and new media content production are located in Paris, as well as companies working in social VR and VR teleconferencing. The second largest VR cluster in France is located in Laval – a city of less than half a million inhabitants which since 1999 has hosted one of the most important VR events in Europe - **Laval Virtual**. A lot of VR activity also occurs in **Lille**, as an outcome of the established high-tech cluster in 3D imaging, and **Bordeaux**, as a well-established regional industrial ecosystem.

France benefits significantly from the early adopting industries (e.g. automotive, fashion) and public broadcasters (e.g. **TF1**, **ARTE**) that created an early demand for VR. Collaboration with innovative start-ups and bigger players brings mutual benefits and takes place throughout the country. In this respect, **Laval Virtual** has significantly helped stimulate the exchange of **best practices**. A new facility called **Laval Virtual Center** is expected to open its doors in September 2017. It will be hosting a VR and AR technological accelerator for start-ups and more developed businesses, Laval Virtual University, which is offering trainings for VR and AR professionals, and the annual Laval Virtual exhibition. This multi-function venue focusing on VR is expected to boost further France's VR performance and support multilateral collaboration between different VR actors.

The strong research tradition and the high quality of educational programs of French universities contribute to the VR industry by being a source of highly qualified developers and VR professionals, and by partnering up with companies that provide solutions to real problems. **MINES ParisTech University** has 25 years of research on using VR in industry and strong links with companies such as **SNCF** (France's national state-owned railway company). It also runs a programme for the creation of research spin-off start-ups. Similarly **Arts et Metiers ParisTech University** and **CLARTE** research institute cooperate closely with most of Laval's VR ecosystem as well as other French and international companies and universities.

Policies promoting high tech innovation and funding opportunities are well established in France and VR & AR also benefit from them. **Bpifrance**, **Les pôles de Compétitivité** and the **French National Research Agency (ANR)** are the main public bodies that fund VR companies and

research institutes. The **French-tech** label identifies 13 metropolitan areas of high innovation, offering to the companies in these areas premium access to public services and support opportunities for conducting research in the US or participating in international events. Tax incentives exist for promoting cooperation between companies and universities or for non-French companies that produce creative content in France. Since 2014 original French audiovisual content has been promoted by the **National Center of Cinematography and the moving image (CNC)** which has invested €3 million in the production of such VR films and VR video games. Lastly, **regional funds** also support the creation of local hubs. The success stories of Pays de la Loire (Laval) and Hauts-de-France (Lille) regions prove how these

decentralised areas have successfully created and maintained an ecosystem and become attractive places for global players (e.g. **EON Reality** in Laval).

Structures of cooperation, such as the **National Association for Virtual, Augmented and Mixed Reality (AFRV)** and the **think tanks Uni-VR, Laval Virtual** and **VR-Connection** encourage exchanges between the country's VR players, as well as meet-ups and collaboration at the city level. VR-Connection has also created a tech mark for motion-free content, supporting in this way the production of high-quality content in the French VR industry. Similarly, Laval Virtual is developing a tech mark for high-quality VR hardware and software. These initiatives show the focus of France on high-quality output in VR.

4.2.2 UNITED KINGDOM

A BUSINESS MINDSET AND INNOVATION MENTALITY

KEY CHARACTERISTICS

Healthy start-up environment
Good access to finance
Lots of investment into tech and innovation

KEY INSTITUTIONS

Innovate UK • Immerse UK
Knowledge Transfer Network (KTN)
Digital Catapult • Realities Centre
SeedCamp • Vertigo

SUPPORT MEASURES

Good access to finance for tech & innovation through Innovate UK.

KEY PLAYERS

ESTABLISHED COMPANIES

BBC • McLaren • ILM • Jaguar
Land Rover • The Guardian
Holovis • The Foundry • Rolls
Royce • Virtualis • BAE Systems
Inition • Rewind • Cross Rail

START-UPS

Medical Realities • ZeroLight • Gardner
Creatives • OwlVR • VRCity • Future
Visual • Bandwidth • Cityscape VR
TruVision VR • Savvy • Neutral Digital
ChroniclesVR • VMI • Hammerhead

UNIVERSITIES

King's College • UCL • MMU
University of Portsmouth • University
of Reading • University of Nottingham
University of Sheffield • University of
Bath • Bournemouth University



A buzzing hub of VR/AR activity, **London** boasts a healthy start-up environment, benefitting from good access to finance as well as a **substantial amount of governmental investment into technology and innovation**. The latter serves to support the development of VR/AR companies not just in London but all over the UK, in particular along the **East Coast** and in **Greater Manchester** (where much of the BBC's activities take place). While the VR/AR community in London shares close ties with communities in other VR/AR hubs across Europe, such as Amsterdam and Berlin, the strongest channel of collaboration runs between London and Palo Alto (USA), not least because of the common language and similar business mindset. Even as the UK prepares to leave the EU, it continues to build, strengthen and/or solidify its relationships with the other hubs across Europe (particularly the engineering camp in the Netherlands and the research base in France).

As one of the world's largest financial centres, the opportunities for venture capital in London are more numerous, hence attracting VR/AR entrepreneurs and developers from all over the continent. London is a global media and post-production hub, as well as the home to many large businesses with departments active in VR & AR. Many of the main players within the UK's creative and media industries have their own

dedicated R&D departments for VR/AR (e.g. the **BBC**). Meanwhile, companies like **Unilever** ensure that, not least in terms of marketing and advertising, there is plenty of opportunity for start-ups active in immersive content creation to get a foot in the door. For example **Jaunt**, although headquartered in the USA, has found it fruitful to expand within Europe and has a big presence in London (as well as in Amsterdam). Start-

ups within the VR/AR industry in the UK are able to develop and grow into companies of considerable size and stature, as exemplified by VR companies like **Holovis, The Foundry, Virtualis, and Happy Finish**, that have established a strong global presence.

There is an established collaboration within the creative industry as well as among various industrial sectors that are well supported by multiple VR and AR-dedicated events, such as **VR & AR World** or **VRUK**. The sheer number of events on VR and AR in the city of London is immense. **These connect industry and academia** and they seem to work better for VR/AR than for other industries in the UK. This is probably because the pool of VR talent is as yet rather restricted and the community is well networked, supportive, and with established working relationships. Many universities all over the UK have VR/AR labs, (**UCL, MMU** and **King's College**) or a good number of immersive studios, and a growing number of accelerators (**Realities Centre**).

London also benefits from a positive attitude of the public authorities towards VR & AR, which is making available investment for tech and innovation. The UK government supports the sector by allocating funding to innovation through the government agency **Innovate UK**. For the year 2016/2017, this funding amounts to £561 million, £86 million of which is dedicated to "emerging and enabling technologies", one of five priority areas. Innovate UK works closely with networks and accelerators, such as **Knowledge Transfer Network (KTN)** or **Digital Catapult**, to help develop the industry. Together they have recently set up **Immerse UK**, which shall focus on connecting businesses and research organisations across all parts of the UK that are active and interested in VR/AR. What is more, start-ups in the UK enjoy some appealing tax breaks, such as R&D tax credits and the Enterprise Investment Scheme, that is incentivising angel investors. Private individuals who make 'perceived' higher risk investments can get a 100% tax relief on new equipment upon starting a new business, against profits on the 'first' £200,000² of capital expenditure each year.

4.2.3 GERMANY

INDUSTRIAL MEETS HIP

KEY CHARACTERISTICS

Decentralised character of the VR scene • Large industrial base using VR for industrial design • vibrant start-up and meet-up scene

KEY INSTITUTIONS

Berlin VR meet-up • VR Base Berlin
Berlin-Brandenburg VR • VR business club • Bayerisches Filmzentrum
G-Tech • Start-up Berlin

SUPPORT MEASURES

German Federal Film Fund (DFFF)

KEY PLAYERS

ESTABLISHED COMPANIES

CryTek • Metaio • Fraunhofer
Zeiss • Imagination • Schenker
Bosch • Siemens

START-UPS

All VR • Spice VR • Wonderlamp
Vragments • Gestion • Demodern
Ignyte • Splashapp

UNIVERSITIES

Technical University Munich • Max
Planck Institute • Deutsche Welle
Akademie • Mediadesign
Hochschule • CryTek VR labs



Germany has its VR and AR centres spread out across the country. Its most vibrant centre of VR is definitely **Berlin** with its animated informal meet-up scene and creative industries giving rise to creative start-ups. VR in the **south of Germany** is rather focused on the manufacturing industry base with large car makers, but also large film making and animation studios. VR in Germany is benefiting from the presence of Europe's biggest industrial manufacturers and thus business opportunities in design, training or production. It also offers numerous creative centres for start-ups and freelancers. An issue for striving start-ups in Germany is a relative gap between the start-up environment and the big corporations, due to the formalised and hierarchical structures of traditional German industries.

2. The amount fluctuates, updates here: <https://www.gov.uk/capital-allowances/annual-investment-allowance>

Berlin is often mentioned as the German VR hub and also the upcoming VR centre in Europe. Its cultural scene has a blooming start-up environment and attracts creative minds and developers. Young entrepreneurs from around Europe are attracted by the multi-disciplinary character of the city, good access to start-up incubators and co-working spaces, as well as relatively low costs of living compared to other European metropolises. The Berlin VR meet-up scene is one of the largest in Europe and this well-working informal networking structure fosters collaboration in Berlin's VR star-ups. Besides the main VR meet-up that has around 200,000 participants, there have been other specialised VR meet-ups, such as for psychology, "room-scale" VR developers, filmmaking, creative, science and mixed reality – these themes nicely illustrate the current focus of Berlin start-ups. The **Munich** VR scene also gathers VR filmmakers. The animation and special effects scene benefits from the presence of the German film industry and the **Bayerisches Filmzentrum**. At the same time VR in Munich is also driven by a strong industrial presence. **Hamburg** is mostly focused on VR content creation for advertising. VR activity is flourishing also in **Frankfurt** and **Cologne**.

The VR research in Germany is concentrated around car producers such as **VW** or **BMW**. For example, the Technical University of Munich works on VR for industrial design. Fundamental research is also taking advantage of VR technologies – for example the NeuroCure cluster at **Humboldt University of Berlin** or **Max-Planck Centre Munich** uses VR for neuroscience and research on the human brain. **CryTek**, a leading game development studio and creator of the software CryEngine, has recently started the VR First programme that brings VR to university labs around the world and supports cooperation between academia and the private sector.

The growth of the VR community motivated several German cities and regions to research the potential of VR or support directly its development. The **City of Berlin** launched its own research on the Berlin VR scene while the **Berlin-Brandenburg region** started the initiative Berlin-Brandenburg VR with a goal of promoting VR in the area and eventually across Germany. Centres such as the **German Technology Entrepreneurship Center (G-Tech)** in Berlin and Frankfurt help to bring the tech community together with academia and businesses, as well as to promote new tech entrepreneurship, including VR in Germany and globally. **Start-up Berlin** works as a network and helps to connect start-ups with investors while **VR Business Club** connects VR companies with the business and the marketing community to help them commercialise their ideas. **VRBase Berlin** helps the industry by providing co-working space for VR and AR companies, building the community, providing advice and organising training and events. VR movie making and content can benefit from the support and funding of the **German Federal Film Fund (DFFF)** that supports VR as a media for film making.

4.2.4 THE NETHERLANDS

INTERNATIONAL INDIE SCENE FOR FILM AND GAMING

KEY CHARACTERISTICS

Willingness to experiment
Creative & highly skilled labour

KEY INSTITUTIONS

VRBase • B. Amsterdam • Rockstart
VRDays (event) • Dutch Game Awards (event) • Enversed Center

SUPPORT MEASURES

Tax benefits • Innovation credit and grants for companies that develop innovative products

KEY PLAYERS

ESTABLISHED COMPANIES

ForceField • Purple Pill VR
Capitola VR • Vertigo Games

START-UPS

WeMakeVR • Polar Effect • YellowBird
Warp Industries • ps-tech • Scopic
MD Linking

UNIVERSITIES

University of Amsterdam
Delft University of Technology
University of Utrecht



The film and gaming industries dominate the VR field in the Netherlands, and the indie scene, being rife with creative minds, is big in both of them. Although it may be that filmmakers and gamers are not yet on the same page in terms of what is the best way to tell a story using VR/AR, within the Netherlands **Amsterdam** in particular is a place with a **strong entrepreneurial spirit, a knack for experimentation, and a dedication to deliver quality content.** The city and its surrounding areas are vibrant and international and they attract people from all over the world. With its quality of life and affordability, the Netherlands is also an inviting place to stay. A friendly place for English-speakers, Dutch entrepreneurs and developers may likewise easily find their place abroad, however rather than due to their language skills such transitions are mainly due to a lack of funding opportunities at home.

The level of venture capital opportunities for start-ups in the Netherlands lags behind that in the UK, Germany and Scandinavia. As a direct consequence start-up growth and development in the Netherlands tends to be rather cautious and slow. This is also due to having access to few available projects as the size of the national market is quite small. **The VR start-up scene in the Netherlands is nevertheless very dynamic and the third most prominent in Europe, after London and Berlin.** There is a number of prominent accelerators and incubators that make Amsterdam an ideal launching pad for start-ups. These are **B. Amsterdam** and **Rockstart**, as well as **StartupDelta**, promoting the Netherlands as a destination for start-ups. Much like elsewhere in Europe, Dutch VR start-ups often find funding in big brands, who are looking to up their advertising game. Once they consider their business model to be a viable one, they generally do well focusing on steady growth. Some successful examples of VR start-ups that have made it big within their field include **Force Field** and **Vertigo Games**. Once established within the Netherlands, however, and having reached the confines of the Dutch market, some companies then choose to move to the US in order to be part of a wider VR and AR ecosystem

and to grow further. Although from the interviews it seems that expanding within Europe would be preferred, it does not always seem to be that simple to do.

There are therefore a number of **ongoing efforts to connect the players within the VR/AR industry across Europe.** An important one is championed by **VRBase**, an accelerator (with "bases" popping up in other key European cities) which seeks to connect actors in the field and encourage knowledge sharing and mutual learning as a means of strengthening the Dutch and European VR scene. **Purple Pill VR**, for example, runs a blog where they share the latest tips and knowledge with others in the field. There are also many meet-ups across the Netherlands, bringing together actors from all over Europe, such as **VRDays**, an annual event since 2015. Across the country, networks of collaboration are already well in place, including between companies and universities (or simply students). They produce an abundance of highly skilled people. For example, among the VR/AR crowd **Unity** has been embraced early on, and a number of US-based companies have opened up their European HQs in Amsterdam due to the access to qualified labour.

Much like in the UK, the Netherlands have made tech and innovation a funding priority, although the focus rests somewhat more heavily on research. There is a favourable tax code, and innovation credits and grants are made available for developing innovative products. These tend to be quite result-oriented and risk-averse – not quite what a sector as nascent as VR/AR needs, as the nature of start-ups is to succeed after learning from previous failures. What is more, not all technologies that fall under VR/AR are considered to be ‘innovative’ and therefore eligible for funding. They are sometimes described as problematic by companies that focus on building cameras and filming 360-degree videos.

4.2.5 SPAIN

CREATIVITY AND A GOOD SOUTHERN VIBE

KEY CHARACTERISTICS

Small creative companies • Competitively priced workforce • Growth despite lack of investment

KEY INSTITUTIONS

eventLAB • Barcelona VR Meetup • VR centre Barcelona (to be opened in June 2017) • Lanzadera • Wayra

KEY PLAYERS

ESTABLISHED COMPANIES

Future Lighthouse
Zerintia
SGO

START-UPS

Visyon360 • In-flight VR
Virtual Real Porn • Psious

UNIVERSITIES

University of Barcelona
Technical University of Madrid



Following the economic crisis in 2008, Spain has been putting a lot of effort into attracting foreign investors to support the growth of its businesses. Despite a struggle to win investment over countries such as France or Sweden, the Spanish VR scene has been developing, building upon the creativity and skills of the local professionals as well as on the competitively priced workforce. The creative scene is characterised by small companies keen on experimenting and centred around Barcelona, while VR and AR for industrial purposes grow around Madrid. Spain is active in creative VR production and experiences, industrial applications, and post production software. VR companies in Spain may benefit from loyal, creative and skilled workers and a good “southern vibe”, but may experience issues with finding both private and public investment.

In terms of the business scene, **Barcelona** is leading in attracting small creative VR start-ups focused on content creation. Its VR scene is often described as similar to the one in Berlin, with creatives and designers, hip environment and vibrant VR community. The living costs are relatively low and many young VR entrepreneurs are also attracted by the lifestyle offered by this coastal city with a range of cultural activities and social life. Barcelona hosts three annual thematic meet-ups, besides the biggest general VR meet-up. Smaller specialised events focus on 360-degree videos and creative content production. Barcelona also hosts several companies active in VR adult industry.

Madrid's VR industrial scene, on the other hand, is more formalised and concentrated around branches of big European companies such as **Airbus**. The industry-focused companies are small to medium-sized with a focus on software and training applications. Unfortunately, in Spain, VR start-ups experience issues while trying to scale up and often opt for a formal headquarters and business presence to be located outside of Spain to be closer to big businesses and potential investors. This is the case of the successful content-production studio **Future Lighthouse** that combines 360-degree camera shots with computer animations to create high-level VR content. Despite being founded in Spain and having its developers located in Madrid, its initial headquarters was chosen to be in the UK and currently its official base is in the US.

VR research is centred around engineering schools in Madrid such as the **Technical University of Madrid** and around the **University of Barcelona** and its Event Lab with experimental virtual environments for neuroscience. The research here is focused on body perception and ownership. Both Spanish universities and research-oriented companies are well used to European funding and take advantage of it.

In terms of support measures, in Spain support of new technologies hasn't seemed to be a priority of the public sector. However, some private initiatives exist. **Lanzadera incubator** in Valencia helps start-ups to create business plans and find funding. **Wayra** is an incubator from the telecom giant Telefonica. It functions as a global accelerator and also creates connections with Latin America. In Barcelona, a VR Awareness Centre is soon to be opened, financed privately by **ThoughtWorks**. Its mission will be to educate about VR and offer possibility to aspiring VR creators to borrow or rent VR hardware.

4.2.6 SWEDEN

TECH-SAVVY HUB WITH A PASSION FOR GAMING

KEY CHARACTERISTICS

Gaming studios and schools • Community character of the VR scene • Gender equality in VR and powerful women's scene

KEY INSTITUTIONS

Innovate Stockholm
Women in Tech
Stockholm VR Meetup
Stena Centre

SUPPORT MEASURES

Targeted tech-community
Innovate Stockholm

KEY PLAYERS

ESTABLISHED COMPANIES

Tobii • Starbreeze • Resolution
Games • Dice • Ubisoft

START-UPS

Neat Corporations
Fast Travel Games
Srvive • Scio VR

UNIVERSITIES

Stockholm School of
Entrepreneurship
Stockholm University



Sweden is one of the most tech-savvy countries in Europe. There is no surprise that in a place where the population owns 1.5 smart devices per person, and foreign investment in tech companies has one of the highest growth rates in Europe, the VR community is flourishing. Stockholm is a hub of gamers and game-production companies have been present for years. Established game companies and start-ups are now actively working to become the leaders of the world gaming industry. Younger generations have access to the educational programmes specialised in game development. **The Stockholm VR community is also characterised by its sense of collaboration and camaraderie.** Company owners know each other, cooperate and share experiences, and are focused on gender equality issues, for example by creating strong female characters in VR video games. Sweden is also characterised by high-speed broadband network that is important for the smooth running of VR applications. The slight disadvantages of doing VR in Sweden can be the higher workforce and living costs and the taxation rate. Another area typical for Sweden is high-precision technologies, represented by the eye tracking solutions provider **Tobii**.

Nordics love games and global top gaming companies have had their home in Stockholm for years with practically oriented schools like **Futuregames** or **Hyper Island**. Established gaming studios such as Dice have naturally embraced the new technology, producing games for VR. The VR wave gave rise also to numerous new companies either by experienced game producers, such as **Resolution Games** (currently the most successful

producer of mobile VR games, founded by the creator of the popular game Candy Crush), or by new, young, often female talents in VR, such as **Neat Corporations** and **SVRVIVE**. Gaming drives the VR scene in Stockholm, but Sweden's business scene also includes successful hardware companies producing high-end headsets and eye tracking technology, as well as medical VR start-ups. The VR business in Stockholm is driven by

collaboration as the members of the VR community know each other, meet regularly, cooperate and help each other. There is an atmosphere of camaraderie and employees change companies with no hard feelings. Thanks to this community expertise and openness, Swedes learn from each other's mistakes and success. Access to finance is also not an issue in Sweden – venture capital funds, both local and from abroad, are interested in investing in Swedish VR companies. Some bigger players also gained funds by becoming public listed entities.

Swedish research tends to be mostly applied and in close collaboration with companies and the business scene. Joint projects between universities and businesses are very common. **University of Stockholm** and **Stockholm School of Entrepreneurship** encourage cooperation amongst different fields and start-up projects.

The public organisation **Invest Stockholm** periodically monitors the needs of the local tech industries and helps to build the communities from the bottom up by providing financial support or resources, for example by creating dedicated co-working spaces. The public support in Sweden is thus focused mostly on growing the community from its roots, rather than applying a top-down approach. As for other tech communities, **Invest Stockholm** makes sure that the VR community has its co-working space and can provide small financial incentives if necessary. Stockholm also tries to attract investors from outside Sweden to grow financial resources for the local tech companies. The community character of the Swedish VR sector is supported by numerous networking events such as **Women in Tech**, where female tech entrepreneurs regularly meet and share their experience, or **Stockholm VR Meetup** that plays important role in informal networking. Co-working spaces such as **Stena Center**, that popped up recently, have since become characteristic for Stockholm. Last but not least, blogs and journalist servers, such as **vrsverige.se** do a great job keeping the community informed.

4.2.7 SWITZERLAND

TURNING INNOVATION POTENTIAL INTO VALUE FOR THE ECONOMY

KEY CHARACTERISTICS

Top class research centres • Successful cooperation between research and business • Good access to funding

KEY INSTITUTIONS

Virtual Switzerland
Technopark Zurich
Artanim foundation
World VR Forum

SUPPORT MEASURES

Swissnex • ProHelvetia
Kommission für Technologie und Innovation (CTI)

KEY PLAYERS

ESTABLISHED COMPANIES

Mindmaze • Dacuda • OZWE
Artanim Interactive • Somniacs

START-UPS

Kenzan Studios • WEAVR
Crealogic

UNIVERSITIES

Ecole Polytechnique Federale de Lausanne (EPFL) • Swiss Federal Institute of Technology Zurich (ETH)



Thanks to a well-developed support structure, technology-focused VR/AR companies in Switzerland are state of the art. **Zurich** is a dynamic tech hub that is becoming a VR/AR centre especially thanks to the proximity to ETH University. Major technological companies have their Swiss representation based in Zurich (Apple, Sony, Ricoh, Panasonic, Samsung, Autodesk etc.) which promotes the growth of the industry. Disney Research closely collaborates with **ETH University**, Leap Motion recently acquired the 3D scanning facility of the Swiss start-up **Dacuda** and created their European base in Zurich. **Lausanne** is a hub thanks to the **École Polytechnique Fédéral de Lausanne (EPFL)** that has one of the best technical and life science departments in the world, as well as the **University of Lausanne (UNIL)** and its Faculty of Biology and Medicine. These are closely linked to the university hospital CHUV and create an inspiring environment for applied life sciences and especially medical device start-ups. Switzerland also hosts the HQs of most sports organisations (International Olympic Committee, FIFA, UEFA etc.), luxury goods companies as well as major corporations such as **Nestlé** that are early adopters of VR/AR.

The Swiss VR start-up scene is mostly focused on the advancement of hardware and software for VR. But there is also an interesting community of gaming developers especially around Zurich and Lausanne. Already in 2014 **OZWE Games** launched the first multiplayer game in the world to be played with the Samsung Gear VR helmet – Anshar War. The Geneva-based research institute **Artanim** specialises in the development of cutting-edge immersive and interactive systems around motion capture and VR and is behind Dreamscape Immersive space in Los Angeles. Primary researchers are also keen first adopters of VR and use it as a tool for their studies and they collaborate with start-ups such as **MindMaze** – a successful VR med tech company.

Switzerland has advanced research facilities especially in the fields of technology, life sciences and medicine, these are **ETH, EPFL, Unil, University of Geneva, University of Zurich**, but also hosts international research centres such as **CERN**, the

Human Brain project and other. Public research organisations (and especially the polytechnic schools) play a major role in the Swiss innovation landscape.

The **Swiss Commission for Technologies and Innovation (CTI)** closely collaborates with universities and helps research to move into the commercialisation phase by fostering collaborative projects and knowledge transfers. Research is very well funded as Switzerland is among the countries with the highest spending on R&D in relation to their GDP (currently 3% of GDP, or around 16 billion CHF). Together with a well-structured access to early finance, expertise and other support provided by the state, the Swiss have a successful model for generating viable research spinoffs. The cantons (regions) have a considerable freedom and negotiating power to attract new companies by offering them regional tax cuts and other benefits.

4.2.8 REST OF EUROPE

WHERE

Finland • Denmark • Italy • Greece • Belgium • Poland • The Czech Republic • Estonia

KEY PLAYERS

ESTABLISHED COMPANIES

Nokia (FI) • Unity (DK/US) • The farm 51 (PL) • BARCO (BE)
Rovio (FI) • Labster (DK)
Armanda (FI) • VR Visio (PL)
Makropol (DK) • Anshar (PL)
Another reality (IT)

START-UPS

The Yondr (BE) • Mimesys (BE) • Futureplay (FI) • orilax (CZ) • Wolfprint 3D (EE)
Khora-VR (DK) • Invsion (IT)
Mindfield games (FI) • Arilyn (FI) • Epic VR (PL)

UNIVERSITIES

ICCS (GR) • Athens school of Arts (GR) • ITIA (IT) • Aalto University (FI) • University of Tallinn (EE) • University of Milan (IT)



Apart from the described front-runner countries a number of other cities spread all over Europe stand out for their research activities, start-up environments or strong focus on specific VR application areas.

In **Finland**, Helsinki and the nearby city of Espoo, a very technologically advanced region, are becoming a boiling hub of VR activity with new start-ups entering the game. The existence of a colossal tech company like Nokia which shifts towards VR by producing OZO (a 360-degree camera), as well as successful scale-ups in the mobile gaming industry, such as Rovio (Espoo) and Supercell (Helsinki) show that the ecosystem is ideal for the expansion of VR activities, especially gaming. The acquisition of Applifier (Helsinki), the cross-promotion network for

social games, by Unity in 2014 and the successful crowdfunding of Arilyn (Helsinki) show the investment opportunities and interest in the region's activity. There are various events that are especially important to start-ups like Futureplay (Helsinki) and Mindfield Games (Helsinki). These events include Slush in Helsinki, which brings together 2,300 start-ups and venture capitalists, journalists and 17,500 attendees, and other video game-focused happenings and meet-ups. They provide more opportunities to the regions' already privileged ecosystem.

Estonia is also a tech-savvy country, where e-residence, e-voting, e-signing and other digital public services are established showing not only Estonia's interest in digital technologies but also the high ease of doing business in the country. Estonia's government has also recognised the potential of VR as they are preparing a massive VR campaign for promotion purposes. This ecosystem is ideal for companies like Criffin (Tallinn, London), which has placed its R&D department in **Tallinn**, as well as innovative start-ups such as Wolfprint 3D (Tallinn) which works on making avatars in VR more realistic and closer to the actual player. Virtual Reality Lab, part of World Trade Center, offers organisations the possibility of renting the lab to get their employees accustomed to one of the pioneering technologies of the future.

Denmark's VR activity is centred in Copenhagen. VR companies there focus on a wide spectrum of areas and applications. The ecosystem started with the creation of Unity, the most popular VR engine. Even though the company is now located in the US, its research department remains in Copenhagen. The VR production house and innovators hub Khora Virtual Reality (Copenhagen) focuses on various areas including healthcare, games and education, Makropol (Copenhagen) explores VR's artistic possibilities of expression, Labster (Copenhagen) creates immersive lab simulations with gamification elements, and the start-up Absolute Zero (Copenhagen) manufactures 360-degree cameras.

Italy is a receiver of a large portion of EU funds related to VR research. VR activity seems to be spread all over the country but many companies are located in **Milan** to benefit from the raised demand thanks to the industrial and business activity in the region. For instance Another Reality (Milan) offers business VR and AR solutions and trainings and inVRsion (Milan) creates realistic VR applications for industries. Italy is in the second place in received funds for VR and AR projects under the H2020 scheme. The significant research activity is done by well-known universities such as the University of Milan and research centres like ITIA-CNR, which also supports companies and promotes the VR and AR application for industries.

Greece has a strong focus on VR research with several universities and research institutes taking part, most of which being located in **Athens**. The ICCS department within the National Technical University of Athens focuses on user interaction within Virtual Environments. Greece is also the sixth EU country in number of projects and amount of funds received for VR-related research through Horizon 2020. The Athens School of Arts in cooperation with the University of Paris 8 are running a master's degree in Art, Virtual Reality & Multi-User Systems. Despite the solid research activity and highly qualified workforce apart from few start-ups not many private companies engage with VR activities in Greece.

Neighbouring with the major European VR hubs, **Belgium** also has a significant VR activity. Without having developed a cluster focusing on specific VR applications or located in a specific city, established players in Belgium include BARCO (Kortrijk), which has a long experience in manufacturing VR projection systems, as well as smaller companies, like the media and advertising agency Yondr (Antwerp) and innovative start-ups like Mimesys (Hasselt). ScreenBrussels which is the audiovisual cluster of **Brussels** starts engaging in VR image and sound and sponsors the organisation of BE. Brussels also hosts different VR meet-ups. This promising ecosystem could host an audiovisual VR cluster at the heart of Europe. A media cluster TWIST from Liege in southern Belgium promotes VR media creation.

Poland has many VR companies that are spread in different regions all over the country a large portion of which focus on VR gaming. Farm51 (Gliwice) is a great example, as apart from gaming they also develop VR solutions for the army; Anshar (Katowice) and Setapp (Poznan) also develop VR games; apart from games, VR Visio (Gdynia) provides business VR solutions and produces 360-degree videos; and EPICVR (Krakow) works on VR content production for big companies in Poland and other European countries. Polish Immersion tries to integrate VR into business and guides their clients, stemming from the automotive or medical industries, through the whole VR app creation process.

Lastly, similar to Poland in a number of other **European countries** start-ups or more established companies perform their VR activities but are not in organised clusters. For instance in **Austria** there are a few VR companies and start-ups but they do not focus on a particular area of activities. Also, in many countries and regions there are ideal conditions for hub development and unexploited potential – for instance in the **Czech Republic**. Facilities such as the South Moravian Innovation Centre (Brno) are supporting the activities of entrepreneurs and businesses at any stage of development. Prague is also a regional hub for big software companies such as DELL, CISCO and Amazon and has a sophisticated software development scene and film industry that is starting to engage in VR and AR. Automotive industry Volkswagen Škoda Auto as well as some innovative start-ups like Sorilax (Prague) which develops a user-friendly VR engine where the user can create their own VR environment or Lifeliqe, focused on education, have managed to attract investment from big players in the VR industry. The existence of highly qualified workforce, passionate entrepreneurs and lower costs compared to other European countries create ideal conditions for a hub creation in the Czech Republic. **Bulgaria's** VR scene is also slowly coming up with companies such as Escape Reality, with the first local VR escape room, or VRCity production studio, with its first Bulgarian VR film festival taking place in late 2016.

Portugal and Lisbon in particular has a high start-up activity that is built around one of the major tech events – the Web Summit. Another potential future hub of VR activity could also be **Ireland**. Hosting the European headquarters of many innovative global businesses, including IT giants such as Google and Facebook, and thereby attracting investment from abroad. The cities of Dublin and Cork tick the boxes for the development of a dynamic VR community. Companies such as Immersive VR Education exemplify this potential.

05

THE APPLICATION OF VR AND AR

VR and AR are powerful technologies that can impact our everyday working and personal lives. So far, VR has proved that it is creating changes in various **application areas** from industry to healthcare, from training and education to gaming and entertainment. Continuously new application areas are arising making use of the advantages and strengths of VR and AR technologies.

Technological advancement by **technology providers**, both private companies and universities, enable and inspire practical **applications of VR**. In turn the need for

applications of VR drive further technology advancement, by expressing their needs for a better customer experience and for concrete practical solutions. Comfortable and advanced hardware, from headsets to haptic devices are needed, as well as powerful software to allow for fast image processing for a realistic immersive experience.

This section further elaborates on the major current application domains. It is preceded by a description of the technology providers driving these applications.

VR & AR ECOSYSTEM MAP BY APPLICATION AREAS AND TECHNOLOGY PROVIDERS



The entities presented in this scheme are randomly selected examples only.

+ Other areas of VR & AR application
Sports • Adult industry • Education for kids
Visualization of big & complex data

5.1 Technology providers enabling the application of VR

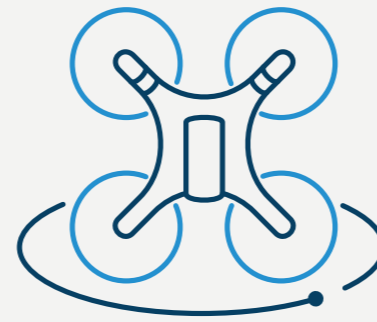
VR & AR TECHNOLOGY

EXAMPLES OF VR & AR TECHNOLOGY

Headset • 3D audio system • Lenses • 360-degree camera
360 drone • Haptic device • VR engine • Postproduction software

WHO NEEDS IT

Companies and suppliers across all
VR & AR application areas



SUPPLIERS

ESTABLISHED COMPANIES

Fraunhofer (DE) • Nokia (FI)
Zeiss (DE) • Tobii (SE) • Star VR
(SE) • Haption (FR) • Unity (DK)

START-UPS

Crytech (DE) • Pixyz (CH)
Wonda (FR) • Solirax (CZ)
Olorama (ES) • Wizdish (UK)
Sphere (DE) • Hololamp (FR)

RESEARCH

Paris Tech (FR) • Technical
University of Munich (DE)
Polytechnic University of Lausanne
(CH) • Clarte (FR) • ITIA-CNR (IT)

Many European innovative start-ups, companies and also universities, are working on the development of general **VR technologies and software** that enable the use of VR in different application areas.

In terms of **hardware** it is worth mentioning **StarVR (SE)** which produces a high-end “wide screen” headset, **VideoStitch (FR)** with its Orah camera, or **Sphere (DE)** with its 360-degree drone. It is also important to note established tech firms such as **Nokia (FI)**, with Sony Pictures using Nokia’s OZO 360-degree camera platform to produce VR content, **Fraunhofer (DE)** which works on 3D audio systems, and **Zeiss (DE)** with optics for headsets. Brand new technologies made in Europe attempt to make the virtual world even more immersive by enabling its visitors to walk around in it (the treadmill ROVR from **WizDish (UK)**), or smell their surroundings (a service offered by **Olorama (ES)**). **Haption (FR/DE)** is the world leader in synchronising movement in the virtual world with physical response in the real world. It is common that besides internal R&D, companies also cooperate with universities such as **ParisTech (Mines, ENSAM – FR)**, **Technical University of Munich (DE)** and **Polytechnic University of Lausanne (CH)** or dedicated research centres such as **CLARTE (FR)** or **ITIA-CNR (IT)**.

Basic research also benefits from the progress on hardware and software. For example neuroscience basic research, taking place for example at **Max Plank Institute (DE)** or **Humboldt University of Berlin (DE)** uses powerful game engines and technology solutions for VR headsets to advance their exploration of the brain. New VR solutions, enabled by general technology advancement allow to perform complicated brain exploration on mice instead of monkeys, and activate specific parts of the brain. Basic research spin-off companies such as **Winterlab (DE)** work on a further advancement of the technology to perform safe brain exploration on humans.

Software is often developed for a particular area of use and is taken over by other sectors. This is for example the case of **Unity (DK/US)**, **The Foundry (UK)** or **CryEngine (DE)**, that were principally developed as processing engines for gaming and entertainment, but currently generate VR content in the medical field, industrial design and training. **Pixyz (FR)** or **Lumiscaphe (FR)** initially focused on industrial design and are now finding their way to marketing and commerce. Other interesting software producing companies include **Improbable (UK)**, producing SpatialOS which offers a new way of building virtual worlds. Improbable has been also experimenting with AI and developed powerful technologies that can simulate entire game worlds, but also predict the development of natural disasters. Another example of a VR & AI company is **Blippar (UK)**, which provides powerful object and face recognition software – this technology is key for realistic interactions with 3D virtual spaces. **Wonda (FR)**, which offers a more user-friendly and simple alternative to Unity especially for movie makers, **Solirax (CZ)**, with its VR environment builder for everyone, and **SGO (ES/UK)** which will soon launch an ultra-fast VR post-production software.

5.2 Areas of VR application

VR can be used in various application domains. Some of the most relevant domains in Europe are further elaborated below.

5.2.1 ENGINEERING AND MANUFACTURING INDUSTRY

MEANS OF USAGE

Industrial design • Prototyping
Interdisciplinary dialogue
Trainings

ADVANTAGES OF USING VR

Eco-friendly • Cost saving
Reducing risk of injuries • Enhancing
communication and efficiency

WHO DEMANDS

All industries with a production
or design process

KEY PLAYERS

ESTABLISHED COMPANIES

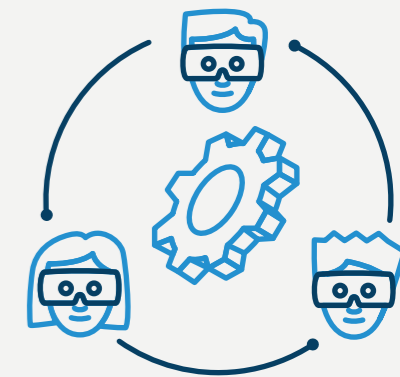
Fraunhofer (DE) • Lumiscaphe (FR)
Techviz (FR) • Immersion (FR) • Light and
Shadows (FR) • Barco (BE) • Jungle VR (FR)
Clarte (FR) • OPTIS (FR) • ZEISS (DE)
Dassault Systemes (FR)

START-UPS

Passer VR (NL)
Apizee (FR)

UNIVERSITIES / INSTITUTES

Arts et Metiers – Paris tech (FR)
Mines – Paris tech (FR)
Clarte (FR)



VR applications can be used for **industrial purposes** to improve product development processes, train staff and enhance communication. Driven by the needs of major European industries, VR applications are either developed in-house or are outsourced to VR/AR dedicated companies. Early adopting companies that already use VR solutions come from: the automotive industry (**Groupe PSA (FR)**, **Renault (FR)**, **Jaguar Land Rover (UK)**, **BMW (DE)**, **Volkswagen (DE)**) the aeronautical industry (**Dassault aviation (FR)**, **Airbus (FR)**) the transport sector in general (**SNCF (FR)**, **Alstom (FR)**) the energy industry (**EDF (FR)**), and other industries where industrial design is expensive and elaborate (**Bosch (DE)**, **Siemens (DE)**). The large list of companies that have integrated VR solutions in their design and production processes is continuously expanding as new companies want to benefit from this new technology. The European internal market has helped boost the growth of industrial VR as it is a common practice for companies to demand VR solutions from suppliers abroad. French companies are especially in high demand as they seem to be the most advanced in this sector. European companies are responding to the global demand from big companies like Tesla.

The **visualisation** of 3D models, CADs and other content in VR applications give the possibility for different people to access them from any location, to analyse and interact with them in a virtual environment. This can improve the manufacturing process, firstly during the **conception** phase for the **design and development** of components or the final product, and secondly for the creation of **prototypes** and experimentation once the final product has been developed. Both applications are radically reducing meeting costs and possible errors, as distant communication can be just as efficient as meetings in person. VR prototypes help improve the understanding of the final product between colleagues from different disciplines, enables clients to have more realistic

expectations and investigate alternative options (different colours, sizes or material). According to **OPTIS (FR)** one of their clients in the automotive industry reduced the physical prototypes from 30 to 7 real prototypes complemented by VR 3D models, thus having a significant effect on cost reduction. A number of established companies are active in 3D visualisation with VR, offering solutions with different methods (photography, virtual imaging), functions (level of interactivity with the content), quality and costs. Some big companies actively offer such solutions for engineering and manufacturing, such as **Fraunhofer (DE)**, **Lumiscaphe (FR)**, **ZeroLight (UK)**, **TechViz (FR)**, **Immersion (FR)**, **PS-Tech (NL)** and **Light & Shadows (FR)**. These

companies either offer their services on demand or by providing their software to the client. Also, there are hardware producing companies that also focus on the sector: **Barco (BE)** constructs VR showrooms, from simple screens and projectors to virtual “cubes” for industrial uses, **ZEISS (DE)** also focuses on VR hardware for manufacturing and produces VR lenses, **Dassault Systèmes (FR)** enhances the VR experience by allowing users to see and interact with their surroundings with a normal VR headset.

Trainings are yet another area where VR applications can support the engineering and manufacturing sectors by immersing staff in a simulation of a real-life situation. VR trainings are eco-friendly and cost saving, as no real resources are used, there are no safety hazards

and they can be easily repeated. The benefits of VR trainings are bigger where expensive or specialised machinery is used in real-life or where there is an unnecessary exposure to danger. For example, according to EON Reality’s department in France, the maintenance time of an energy plant’s facilities which requires the interruption of production can be reduced by 50% with the help of VR trainings. **Jungle VR (FR)**, **CLARTE (FR)**, **Saint-Gobain (FR)** and **Antycip Simulation (UK)** create such trainings and simulations. EON Reality’s departments in Europe (France, the UK and Sweden) also work on creating trainings. Specialised trainings often require specific complementary to the headset hardware, **Light & Shadows (FR)** produces on-demand, specialised hardware for industrial trainings, such as shoes with sensors.

5.2.2 ARCHITECTURE, REAL ESTATE AND CONSTRUCTION

MEANS OF USAGE Design • Visualisations • Sales Remote visits	ADVANTAGES OF USING VR Saving money Saving time	WHO DEMANDS Architects, interior designers, property developers, real estate agents, and clients of all of the above
KEY PLAYERS		
ESTABLISHED COMPANIES Bouygues Group (FR) • IKEA (SE)	START-UPS INOD (FR) • VMI (UK) • Kaouenn Studio (FR) • TruVisionVR (UK) • Cityscape VR (UK) • Neutral Digital (UK) • OpusVR (DE)	UNIVERSITIES / INSTITUTES ITIA-CNR (IT)



From streamlining the design process to facilitating property sales, virtual reality is revolutionising the **construction, architecture, and real estate industries**. **Cityscape VR (UK)**, **opusVR (DE)**, **Neutral Digital (UK)**, **TruVision VR (UK)**, **VMI Studio (UK)**, and **Kaouenn Studio (FR)** are just some of the companies enabling architects, interior designers, property developers and their clients to immerse themselves in creations throughout different stages of the design process, and so allowing them to get a better feel of what the model could look like once finished. This can be done effectively by, for example, translating Building Information Modelling (BIM) into virtual experiences, providing everyone from designers to clients with beautiful and interactive walkthroughs.

Not only does this eradicate the need for building physical mock-ups at each step of the process, but it also allows to properly experience the newly designed urban space or building before it is actually built. That way everyone involved has the opportunity to spot errors more easily and correct them more quickly. This drastically reduces the likelihood of an ill-designed finished

product that does not fit well in its environment or does not suit the needs of those living in or using the space. **ITIA-CNR (IT)**, for example, studies human psychological and emotional states and creates VR to test whether certain spaces fit the requirements for ambient assisted living.

The Industrial group **Bouygues (FR)** uses immersive technologies to transform and upgrade construction processes, but also to view real estate property. **Dreamplex (PL)** combines VR with 3D printing to truly emerge a client into their real estate or architecture presentation. **INOD (FR)** and **DIAKRIT (SE)** are further examples of companies enabling their clients to visit real estate in virtual reality, improving their experience of buying and renting, reducing their insecurity to do so and, perhaps above all, saving them a lot of time. Based on a live poll at a recent event on VR and real estate at London’s Realities Centre, people would be more than willing to pay for the convenience of making a collection of virtual visits before visiting a select few in person.

In terms of interior design, **IKEA (SE)** has launched a virtual reality showroom, designed by the digital agency **Demodern (DE)**, that uses the immersive power of VR to enable customers to bring IKEA rooms to life. IKEA has also created the “IKEA virtual reality kitchen experience”, made in collaboration with **Allegorithmic (FR)**. Through the app, customers could explore a virtual IKEA kitchen in real size. They can change the colours of cabinets with a simple click, or view the kitchen from different perspectives and sizes. For example, by shrinking to the size of a child, hidden dangers and/or possible design solutions could be uncovered.

5.2.3 EDUCATION AND CULTURE

MEANS OF USAGE Visiting places around the world and museums • Historical events • Cultural heritage	ADVANTAGES OF USING VR Being there factor in travelling Learning and exploring culture Low cost travelling Enhanced cultural experience	WHO DEMANDS Schools • Museums • Tourist destinations • Galleries
KEY PLAYERS		
ESTABLISHED COMPANIES The Virtual Dutch Men (NL) Parthenon (GR) Thomas Cook (UK)	START-UPS Art of Corner (FR) • Yondr (BE) • Lifeliqe (CZ) Labster (DK) • Immersive Education (IR)	



VR allows people to visit places that are difficult to reach or visit more spots virtually in a short period of time at lower cost. This can be for example used in **education**: pupils and students, or anyone interested in learning, can visit for example Jerusalem or a festival in ancient Rome in a 360-degree video. VR is capable of bringing knowledge closer to a student who wouldn’t be able to access it otherwise – for example due to disability or unavailability of quality education in her or his country. Education and training applications can be accessed by anyone owning a pair of VR glasses or a smartphone with VR cardboard device. In terms of learning, special apps are being created in VR that serve as a unique interactive platform. For teenagers, educational apps in VR are already coming up, like for example the traffic rules learning experience by **WeMakeVR (NL)**. School and universities have been experimenting with adding VR as a teaching tool or making VR lectures a part of the curricula. Companies such as **Labster (DK)**, which created virtual labs for experiments, **Immersive Education (IE)** and **Lifeliqe (CZ)** take the concept of VR education even further by providing a whole new interface for learning and exploring.

Another place where education takes place are **museums and galleries**. **The Virtual Dutch Men (NL)** have created a fictional virtual museum for the **Europeana Foundation (NL)** gathering masterpieces from different museums and exhibitions such as the works of Rembrandt and Vermeer. Other

galleries such as **Serpentine Galleries (UK)** and **Zabludowicz Collection (UK)** are also collecting pieces in VR. **Art Graphique & Patrimoine (FR)** also specialises in digitalisation of art work and creation of VR experiences for the **Louvre (FR)** and other museums and landmarks in France and abroad.

VR and AR can also enhance this visiting experience. From the world famous Parthenon in Athens, Greece or the Colosseum in Rome, Italy to less known historical sites such as la Bastille in Grenoble, France or Spilberk Castle in Brno, Czech republic, VR & AR help to tell better stories of monuments' long history. Virtual reality can also be used in **tourism**. Regions and cities create VR experiences to promote themselves to potential visitors, travel agencies such as **Thomas Cook (UK)** offer virtual mini-trips to promote sales of their travel services. The start-up **Yondr (BE)** is building a virtual travel agency with VR travel tours around the world that can be used both for virtual

fund and a teaser for real exploring. **Destinations VR (PL)** offers a VR application enabling tourists to visit hotels and resorts prior to booking them, so as to better be able to choose their place to stay for their next holidays.

Software such as Holostoria by **Oculuscope (FR)** uses 3D content for the creation of VR experiences and can also be useful for the design and scenography of museums and exhibitions. Companies such as **Timescope (FR)** and **Realtime Robotics (FR)**, create hardware for exploring cultural content in VR.

5.2.4 MEDICAL FIELD

MEANS OF USAGE	ADVANTAGES OF USING VR	WHO DEMANDS
Treatment • Training and collaboration of professionals	Less medical errors • Better interdisciplinary and patient-doctor understanding • More efficient treatment and rehabilitation	Patients Healthcare professionals Hospitals
KEY PLAYERS		
ESTABLISHED COMPANIES Philips (NL) • MindMaze (CH) • Medical Realities (UK) • Sim for health (FR) • C2Care (FR) • Royal Hospital (UK) • South General Hospital (SE) • HRV Simulation (FR)	START-UPS ScioVR (SE) L'effet papillon (FR) Immersive rehab (UK) MD linking (NL)	UNIVERSITIES King's College (UK) University of Portsmouth (UK) Ecole Polytechnique Federale de Lausanne (EPFL)



Many VR companies and research institutes aim to enhance the **medical sector**. Already a number of medical trainings are available and are widely adopted by universities and hospitals. Apart from trainings, VR can also be used to enhance interdisciplinary communication as well as directly for the treatment of patients.

VR has great potential for health professionals and hospitals, ranging from **trainings** to **better collaboration and mutual understanding**. **Philips's (NL)** healthcare department has developed the first augmented-reality surgical navigation technology that helps surgeons perform image-guided open and minimally-invasive spine surgery. Amongst other companies, **HRV simulation (FR)**, **SimForHealth (FR)**, **VirtaMed (CH)** and the start-up **ScioVR (SE)** in cooperation with the **South General Hospital (SE)** in Stockholm develop trainings varying from simple consultation simulations to performing surgeries on virtual patients using special input devices. In this way students and professionals in the medical sector have the opportunity to perform a realistic surgery on a virtual patient, test their knowledge and

learn new methods and tips, without any risk for the patient. Another special element in VR trainings is that they can realistically simulate real-life situations by bringing together professionals or students from different disciplines and promoting cooperation. Simulating and preparing for crisis situations such as working in a hospital after a major accident (e.g. terrorist attack) is another additional possibility offered by VR. The communication and visualisation possibilities that VR offers can enhance the efficient interdisciplinary dialogue in the medical sector as well as the better understanding and empathy between doctors and patients. Doctors from any location and any seniority can access VR videos of real surgery procedures provided by **Medical Realities (UK)**, a company that collaborates with the **Royal Hospital**

(UK) in London. Their first live VR surgery was watched by 150,000 people in 130 countries around the world and their training is becoming incorporated into many university curricula. **MDlinking (NL)** is also using VR to enhance the dialogue and knowledge sharing between healthcare professionals for free.

VR is also being applied to the **treatment of psychological disorders** such as phobias, addictions, eating disorders and stress. **C2Care (FR)** has developed applications for treating these conditions since 2012, **King's College (UK)** in London and **Hôpital de la conception (FR)** in Marseille have been using VR for this purpose for years. Another VR application helping patients is the Bliss project developed by **L'effet papillon (FR)**, which immerses patients before and after medical operations into

paradisiac VR experiences, having positive results on **pain and stress relief**. The third area where VR can be very beneficial for patients is **rehabilitation**. For instance **MindMaze (CH)**, a spinoff from the **École Polytechnique Fédérale de Lausanne (EPFL)**, which is one of the global pioneers in the medical use of VR, uses VR for rehabilitation of stroke patients and its VR solution is fully certified as a medical product. Rehabilitation VR applications can be also useful to patients with moving impairment or phantom limb syndrome and **Immersive Rehab (UK)** and **University of Portsmouth (UK)** are active in this area. Lastly, the awareness-raising and fitness applications of VR that are elaborated in the sections below can contribute to the purposes of preventive medicine.

5.2.5 AWARENESS-RAISING AND REPORTING

MEANS OF USAGE	ADVANTAGES OF USING VR	WHO DEMANDS
Journalism • Awareness-raising Humanitarian efforts	Empathy-inducing qualities of VR	Broadcasters • News & journalism NGOs • Public authorities
KEY PLAYERS		
ESTABLISHED COMPANIES The Guardian (UK) The BBC (UK) Euronews (FR) Amnesty International (UK)	START-UPS Aardman Animations (UK) Vragments (DE) Sweden Virtual Reality (SE)	UNIVERSITIES Deutsche Welle Akademie (DE) Mediadesign Hochschule (DE)



Many broadcasters and companies active in **news and journalism**, as well as organisations engaged in and/or **furthering humanitarian efforts**, are tapping into the unique potential of VR/AR technologies, in particular the empathy-inducing capabilities of VR. These can effectively educate and raise awareness about certain issues, and even elicit response and action among viewers. VR/AR can act as powerful tools for increasing compassion and influencing behaviour, tackling serious issues ranging from racism to climate change.

The **BBC (UK)** collaborated with Oscar-winning **Aardman Animations (UK)** in order to dramatise the story of a Syrian family about to embark on a boat to Greece, publishing this alongside other VR experimentations on its Taster website. In a similar vein, **Sky News (UK)** collaborated with Jaunt (with offices also in the UK) to create the VR experience "Migrant Crisis", where one can experience in VR how boats, packed with refugees, land on a beach in Greece, together with the fear and struggle of families fighting to stay alive. **The Guardian (UK)** has developed a series of immersive, educational

experiences that emotionally engage viewers in, for example, the problem of solitary confinement in prisons, called "6 x 9". This VR experience puts viewers in the shoes of inmates that live alone in their tiny cells - sometimes for decades at a time - so they can learn first-hand about the dangers of psychological damage that can occur from prolonged periods of extreme isolation.

Euronews (FR), aims to become the first European newsroom to fully adopt VR journalism and regularly publish 360-degree news videos. Since February 2016 they have published over 30 such videos on their site, and are undergoing training by **WAN-IFRA (FR)**. In September 2016 Europe's first VR Journalism Hackathon took place in Berlin, organized by the 360-degree immersive story-telling company **Vragments (DE)** in collaboration with the **Deutsche Welle Akademie (DE)**, **Mediadesign Hochschule (DE)** and the **Center of Investigative Reporting (US)**.

Organisations furthering humanitarian efforts and/or engaged in public services are making use of these technologies for similar reasons and in similar ways. Charities seeking to incite empathy among the public have been among the early adopters, including the **National Autistic Society (UK)**, that in 2016 created in collaboration with **Happy Finish (UK)** a film showing people what it was like to live with autism. Similarly, **Alzheimer's Research**

(UK) created the VR experience "A Walk Through Dementia", which put viewers in the shoes of someone with the condition. **Nokia (FI)** and **Humanitarian Cooperative (UK)** made a VR film about Syrian child refugee and **Amnesty International (UK)** created a VR experience showing the devastation in Syria, in order to incite humanitarian relief response and charitable contributions for the cause.

VR/AR technologies are also used to educate and spur action from viewers concerning issues that can feel far-removed yet have a direct impact on humanity, such as climate change. For example, **Sweden Virtual Reality (SE)** is a VR development community arranging an international VR competition with the theme of sustainability. The aim of the competition is to encourage developers to create immersive experiences to facilitate sustainable development. These may range from 360-degree videos showing how glaciers have retreated over time, to fully immersive VR experiences, where one may swim through the deteriorating coral reef.

(FR) allows users to build in a simple way their own VR environment, decorate it as they want, insert the content they wish and invite their friends and family for a VR hangout, e.g. to watch a film or a live football match together. Also, **Mimesys's (BE)** hologram meetings can be used for social purposes, for example playing a game of chess or tennis with friends and family from abroad. An

alternative to holograms is provided by **Wolfprint 3D (EE)**, which focuses on affordable 3D scanning of humans that can be used as VR avatars. **Splash (DE)** aims to make 360-degree videos easy to record and share through smartphones, thus promote their creation and distribution and tone up the public's interest for VR.

5.2.6 COMMUNICATION AND SOCIAL INTERACTION

MEANS OF USAGE
Business meetings
Social interactions

ADVANTAGES OF USING VR
Bridging distances between people
Enabling close interactions without the need for physical travel

WHO DEMANDS
Companies
Individuals

KEY PLAYERS

START-UPS
Teemew (FR) • VRbnb (FR) • Splashapp (DE) • Vrtuoz (FR) • Beloola (FR) • Mimesys (FR) • Wolfprint 3D (EE)



VR has the potential to change the way we **communicate and interact** with each other. The added value of VR in comparison to other distance-based communication tools, is the interactivity and visualisation possibilities (data, documents, 3D models). In this respect, VR can offer new opportunities for efficient distant business meetings as well as fun social interactions.

Business meetings in VR can provide remote users with efficient ways to collaborate by using a set of tools and allowing them to visualise any type of files. **Teemew (FR)** enables users to take advantage of such an opportunity and **Mimesys (BE)** takes it one step further by allowing users to participate in the virtual meeting as holograms, making these meetings more personal and similar to real-life ones. **VRbnb (FR)** is a platform linking businesses in need of VR equipment and

communication tools with providers of such equipment. In this way they aim to facilitate doing business with VR by tackling the high cost issue.

Social VR is another sector where VR aims to reach out to the mass consumers. An example of social VR is **VRTUOZ (FR)**, which brings avatars of people from all over the globe together in a virtual environment allowing them to interact with each other as well as with the surroundings. **Beloola**

5.2.7 ART AND STORY-TELLING

MEANS OF USAGE
Cinematic entertainment
Art distribution

ADVANTAGES OF USING VR
Empathy creation • New form of expression and storytelling

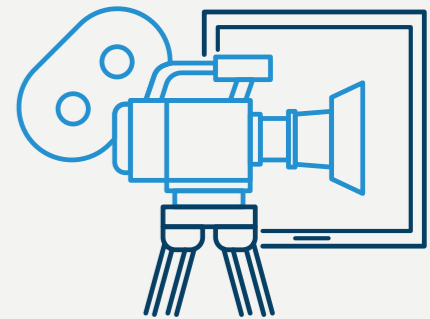
WHO DEMANDS
Mass market

KEY PLAYERS

ESTABLISHED COMPANIES
ARTE (FR-DE) • BBC (UK)

START-UPS
Backlight (FR) • Novelab (FR)
Okio studio (FR) • Gengiskhan
Production (FR) • Virtelio (LU)
Makropol (DK)

UNIVERSITIES
Master's degree in Art, Virtual
Reality & Multi-user Systems
(GR - FR)



VR does not only bring art to users' doorsteps, it is also a new form of **expression and storytelling**. VR film production possibilities are being explored in order to take full advantage of its potential to tell the stories in fresh and creative ways. Europe has a rich heritage and cultural diversity that have always been a great source of inspiration for film production and artistic expression, and this competitive advantage is also true for VR cinematic film making.

Production studios already create **360-degree film experiences**, the **BBC (UK)** has launched a tester website including several VR films and experiences such as "We wait" produced with the help of **Aardman (UK)** studio. Similarly, **ARTE (FR-DE)** is co-producing VR films such as "I Philip" with **OKIO-STUDIO (FR)** or "Notes on blightness" with **Novelab (FR)** which can be found in ARTE's 360-degree content library. These short films immerse the viewer into the main characters' perspective, inciting empathy. Another example is "Les Falaises de V." by **Gengiskhan Production (FR)**, co-funded by the **National Centre for Cinema and Animated Image (FR)**. **Virtelio (LU)** is a start-up that enables filmmakers to create different scenario depending on viewer's attitude thus influencing the story.

Artists have the opportunity to express themselves in new creative ways through VR, this leads to new pieces of **art**. **Protrait (é)mouvant (FR)** by Joséphine Derobe is an example of such an artistic VR experience. A collaboration between two universities has led to the creation of a **master's degree in Art, Virtual Reality & Multi-User Systems (GR - FR)**, which led to the creation of the project Enter the Game. Enter the Game offers an artistic experience that combines real urban environment with the virtual world. Another example is **Makropol (DK)** which brings live art performances to the audience in innovative ways.



5.2.8 COMMERCE AND BRANDED EXPERIENCES

MEANS OF USAGE

New shopping experiences
Advertising • Showrooms

ADVANTAGES OF USING VR

Enhanced online shopping • The
'wow' factor of VR/AR for advertising

WHO DEMANDS

Big brands looking for innovative
ways to market/advertise and
boost sales



KEY PLAYERS

ESTABLISHED COMPANIES

Givenchy (FR) • Jean Paul Gaultier (FR) • Renault (FR)
Peugeot (FR) • Nestle (CH) • J&B (UK) • Beefeater (UK) • Volvo
(SE) • Audi (DE) • Rolls Royce (UK) • Jaguar Land Rover (UK)
Dior (FR) • Topshop (UK) • Balenciaga (ES)

START-UPS

OKIO-STUDIO (FR) • Future Lighthouse
(ES) • Polar Effect (NL) • Scopic (FR) •
Gardner Creative (UK) • Savvy (UK)

The 'wow' factor of VR/AR technologies enables companies to **engage with their customers** in new and innovative ways, as the immersive nature of VR/AR tends to leave a lasting impression on existing and new audiences. At the same time, customers are able to undertake more **interactive and enjoyable shopping experiences**. Thus, not only can VR/AR help put brands on the map in customers' minds, but these technologies can also significantly increase and enhance **e-commerce** activity.

DIAKSE (FR), a start-up active in **e-commerce**, believes that incorporating VR/AR technologies into the online shopping experience is currently the only way to remain competitive against big players in the industry (e.g. Amazon). The start-up creates virtual environments within which a customer can walk around, and which, thanks to Big Data technologies, reconfigure themselves for each individual so as to allow them to experience a unique and tailored visit. After introducing virtual reality elements to their customers, Diakse reports it has experienced a 400% increase in the time its customers spent on its site, as well as a 27% increase in consumer activity. Similarly **Savvy (UK)**, a retail and shopper marketing agency that has produced immersive content and campaigns for the likes of **Grolsch (NL)** and **Lipton (UK)**, is currently exploring how VR could transform and boost e-commerce for their clients, be it in grocery retail, travel, or fashion. Fashion brands such as **Topshop (UK)**, **Balenciaga (FR)**, and **Dior (FR)**, are already very active in the field, showing in-store customers their latest collections by offering them headsets with which to view 360-degree videos of their runway shows, live-streaming their fashion shows in virtual reality, or creating their own VR headset. Automobile manufacturers, such as **Jaguar Land Rover (UK)**, are also making use of VR/AR technologies directly in their showrooms, believing this to be particularly valuable as it allows visitors to experience the interiors and view various colour combinations on the spot.

Numerous big brands are also investing a lot into **advertising campaigns** incorporating VR/AR, and are therefore important contributors to the development of VR/AR. Currently the biggest clients of many start-ups focusing on immersive storytelling and filming are big brands. For example, fashion brands like **Givenchy (FR)** and **Jean-Paul Gaultier (FR)**, consumer brands like **Nestlé (CH)** and **J&B Whisky (UK)**, and automobile brands such as **Peugeot (FR)** and **Renault (FR)**, have collaborated with production house **OKIO-STUDIO (FR)** in order to expand the reach of their brands through elaborate immersive advertisements promoting their companies. This involves, for example, taking the ultimate, virtual test drive with the new Renault, filmed in 360-degree video. Advertising activities can range from simpler 360-degree videos to fully immersive experiences incorporating CGI, such as the recent branded VR campaign for **Beefeater (UK)** brought to life by VR studio **Future Lighthouse (ES)**. Some other examples of VR studios producing promotional content for established brands - which are often automotive brands - across Europe include **Scopic (NL)**, who have created the **Volvo (NL)** Ocean Race, **Ignyte (DE)**, who have produced 360-degree video content for **Audi (DE)**, and **Gardner Creative (UK)**, who have produced the **Rolls-Royce (UK)** Serenity campaign. According to immersive media lab **Polar Effect (NL)**, immersive means of advertising provide 100% viewer interaction, and can result in a 400% increase in returning views and 700% increase in sharing.

5.2.9 GAMING

MEANS OF USAGE

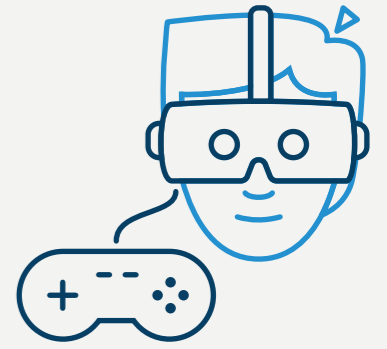
Immersive games • Mobile
games • Gamified training
Entertainment centres

ADVANTAGES OF USING VR

Immersive experience
Ability to move in the game
Strong feel of reality

WHO DEMANDS

Consumers • Gamers
Entertainment centres
Industries



KEY PLAYERS

ESTABLISHED COMPANIES

Force Field (NL) • Dice (SE) • Resolution
games (SE) • The Farm 51 (PL) • CryTek
(DE) • Rovio (FI) • Vertigo Games (NL)

START-UPS

Srvivive (SE) • Fast Travel
Games (SE) • Incarna (FR)
Neat Corporation (SE)

UNIVERSITIES

Hyper Island (SE)
Future Games (SE)

The **gaming industry** has been one of the key drivers of consumer adoption of VR headsets and advancement in software development and content production. Creation of VR games is a field for highly skilled developers and requires skills in 3D design, animation and software programming, but also needs creativity and innovative ideas.

Large established gaming companies often come from the Nordic countries - **Force Field (NL)**, **Rovio (FI)**, **Starbreeze Studios (SE)**, **Dice (SE)**, **CCP Games (IS)**. They started their activities already in the late 1990's and currently also develop VR games with their dedicated teams growing every year. The demand is driven on the one hand by the gamers and consumers themselves, and on the other hand by large hardware producers who are interested in quality VR content and who make large investments in supporting the development of VR content in Europe. The challenge for established gaming studios is the need to change their traditional gaming narrative and adjust it to the VR environment.

The blooming VR gaming scene also motivates new start-ups to develop new games and investors seem to see the high potential in some of them. The start-up **SVRVIVE (SE)** won a venture capital investment of 5 million EUR with their VR game prototype and has the ambition to become one of the global VR game leaders. Other interesting start-ups, such as **Neat Corporations (SE)** or **Fast Travel Games (SE)**, are popping up around Europe (especially in Northern Europe) and other smaller gaming players, for example **Warhorse (CZ)** with their VR horror game in development, are experimenting with gaming in fully virtual worlds. Smaller specialised players have the advantage of learning how to make VR experiences from scratch

and are less "burdened" by habits from traditional gaming. There is an interesting phenomenon of some gaming studios focusing exclusively on one hardware provider, such as **London Studio (UK)** that is developing virtual games for Sony. Other studios use their expertise to make **gamified trainings**, such as **The Farm 51 (PL)**, which makes training applications used by the Polish army. Introducing gaming elements to training programs in VR makes them more enjoyable for the participants.

VR games for mobile phones also exist and are likely to boom once smartphones are equipped with more powerful processors, better graphics, precise motion tracking and long-lasting batteries. However, already now, VR mobile games are an important VR sector. The games are more simple, with more "hexagonal" graphics, but they can currently reach a larger audience and can be easily downloaded. The VR fishing game Bite! by the current market leader **Resolution Games (SE)** has more than a million downloads and proves that mobile games have potential. Other interesting VR gaming-related areas are VR escape games, such as **Incarna (FR)** or **Vortex (CZ)**. There is also a rise of traditional games in virtual spaces, including games like **Casino VR Poker (CH)**, and VR cafes and entertainment centres where everyone can play VR games, paying for the time spent.

Content, software and hardware development for VR games is very fast-paced, driven by the desire to make games smoother, faster, more realistic and more immersive. This eventually also benefits other application areas as well as basic research.

5.2.10 LIVE ENTERTAINMENT AND EXPERIENCES

MEANS OF USAGE

Concerts • Theatre • Sport matches • Entertainment centres and team building • Escape games • Theme parks • Cinemas

ADVANTAGES OF USING VR

Bringing viewers closer to the action
Allowing large groups of people to take part in a fun activity together in real time.

WHO DEMANDS

Broadcasters
Sports/creative industries
Amusement parks

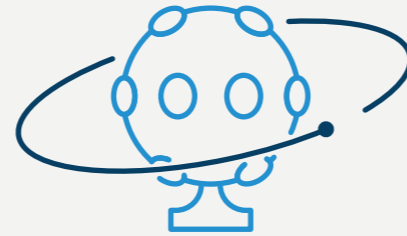
KEY PLAYERS

ESTABLISHED COMPANIES

Wowza • Orah • EON Reality • Enversed Center (NL)

START-UPS

Purple Pill VR (NL) • ENIGMA (CZ) • VORTEX VR (CZ) • Vroom (HU) • MystiqueRoom (HU) • AdventureRooms (IT) • Up The Game (event) (NL)



VR/AR technologies are creating new experiences and ways of **entertainment** that are immersive and in real time. This means being able to experience sport matches, concerts and theatrical performances as if you are there, despite actuality being miles away. An example of the huge appeal of this application is Manchester United, which globally has about 400 million fans, most of whom would probably never be able to experience a game live. With VR, however, fans may be ensured the best seats at every game. However, live streaming sports has certain requirements that VR has yet to fully meet. High definition TV already provides very good sports coverage, with an experienced director, a sharp picture, zoom as well as pause, rewind and replay - none of this is currently available with VR. Secondly, VR also creates mounds of data, making live-streaming with current broadband capacities difficult - 5G will therefore be very important.

Companies currently focusing on live streaming are largely headquartered in the US, however for example **Wowza** has its European HQ in Berlin, **Orah** created its European base in Paris, and **EON Reality** has offices in **Manchester, Gothenburg, Laval and Paris**. Nevertheless, European start-ups are beginning to pave their own way towards embracing and mastering live streaming services. In 2016, after being approached by MOMENTUMXR, **Purple Pill VR (NL)** was able to successfully display the live stream of the Grammys red carpet event in a 360-degree video in their app and web player. That same year, Europe had its first virtual reality concert, featuring a performance by Israeli-French singer, in the Euralille shopping centre. More recently, in February 2017, the concert of the Belgian DJ Netsky was streamed at the Sportpaleis in Antwerp. There are now also a few start-ups, such as **WeMakeVR (NL)**, that offer live streaming services.

Virtual reality theme parks and escape rooms, (live experiences that are enhanced with immersive technologies) are already well established all over Europe. For example, **Galactica** is a new virtual reality ride that opened at **Alton Towers in Staffordshire**. While the layout remains the same, passengers experience a completely different track depending on what they are viewing through their headset. **Alpenexpress Coastality** is another VR rollercoaster ride operating at **Europa-Park in Rust, Germany**. Providing unique team-building experiences, **Enversed** is a large virtual reality experience centre that opened up in an old Philips factory in **Eindhoven** late in 2016. At the Enversed Centre, the power of virtual reality can be experienced through unique games, escape rooms, team-building environments, workshops, and training sessions,. The centre is designed for general recreation as well as the corporate market. There are also many places all over Europe offering virtual escape games, including **ENIGMA**

and **VORTEX VR (CZ)**, **Vroom** and **MystiqueRoom (HU)**, and **AdventureRooms (IT)**. Meanwhile, Up The Game is the first real-life gaming and escape room conference in the world, having gathered more than 500 creators from all over the world in 2016 and 2017.

5.2.11 OTHER AREAS OF VR & AR APPLICATION

Not all possible applications of VR technology have been further detailed above. This is mainly because they are either less visible or not yet fully developed even when they have a high future potential.

Sports can also be revolutionised by VR as we can, for example, instantly ski or cycle in the mountains thanks to a VR headset. Unfortunately, hardware does not seem to be comfortable enough to fully develop its potential for a sport experience in VR. For now, simulators such as **Birdy**, which allows flying, offer short term whole-body immersive experiences. **Holodia (FR)** has already developed fitness applications for VR and offers its customers a workout with a headset.

In the future, VR can revolutionise **child education**. However, current headsets are often not recommended for small kids apart from simple applications allowing city or museum visits for a short period of time. Start-ups such as **Kodama (FR)**, which creates an interface where physical objects managed by kids appear in a virtual world, try to solve the psychological development issue and give rise to learning apps for kids.

Potential also lies in **big and complex data visualisation** where extra dimension and virtual space can help capture flows in time and relations. This area is being explored by big players such as **SAP (DE)** and smaller companies such as **Outlier Collective (ES)**. Similarly, for example complex company processes and management processes flows can be better presented and understood in VR. **Spacesys (CR/US)** experiments with providing complex business processes visualisation in VR. Applications created by the **adult industry** are definitely less visible to the general public, but should not be forgotten as they are important drivers of the design of new technologies, similar to smartphones. Examples of VR adult entertainment companies such as **VR Girlz (UK)** or **VirtualReal Porn (ES)** are popping up quietly all around Europe, and gaining popularity.

More applications and ideas are to follow ranging from banking and defence to anything where the benefits of immersive VR technologies can add value or provide an additional experience.

06

SHAPING EUROPE'S VR AND AR FUTURE

Providing the right conditions to reap the full potential of VR and AR in Europe is essential for such an emerging industry. In addition to national policies and strategies, the EU environment determines to what extent and how the development of VR in Europe will unfold.

6.1 The EU policy environment

The European Commission supports European researchers and entrepreneurs to help scale up the ICT innovation ecosystem in Europe by reinforcing actions for ICT innovation through Horizon 2020 (the EU Research and Innovation programme) with nearly €80 billion of funding available for the time period 2014–2020. Horizon 2020 also supports SMEs through a new dedicated €2.8 billion SME Instrument, which is targeting innovative SMEs. Open Disruptive Innovation is a scheme under this SME Instrument, which aims to support fast-growing, innovative SMEs with close-to-market ideas bearing high disruptive potential. Additionally, other SME support initiatives are available through the European Commission.

In 2017 the EC introduced a new instrument in cooperation with the European Investment Fund (EIF). The market-driven Pan-European Venture Capital Funds-of-Funds has been designed to boost levels of investment in new generations of highly innovative European firms. VR companies focusing on content creation can also benefit from the Media Programme.

Broadband Europe and Wireless Europe are other initiatives which feed into the wider Digital Single Market strategy of the Commission and strive to ensure progress in internet access and connectivity. Important aims include offering gigabit connectivity in key economic nodes, the introduction of 5G networks, and internet access of at least 100 Mbps for all European households by 2025.

Next to a focus on strengthening the Digital Single Market, the European Commission initiated its Creative Europe programme in 2014, with a budget of €1.5 billion. The programme aims to support Europe's cultural and creative sectors to seize the opportunities of the digital age and globalisation.



6.2 Challenges to facilitate growth

Despite the many strengths of the VR and AR industry in Europe, there are certain issues that will need to be addressed in order for Europe to become a powerful player in the global VR and AR industry. Based on an extensive consultation with VR players in Europe, various challenges have been identified that have an **impact on the growth of the European VR landscape**. These include:

A lack of risk funding as well as a pro-risk and experimentation mentality in general.

Despite the availability of public research funding in general, research and development support for individual (start-up) companies rather than research consortia is not always equally accessible. Where it is available it is often highly result-oriented, allowing for little experimentation and failure on part of the start-up. As a result, start-ups tend to either become absorbed by larger, often foreign, companies, or they seek funding outside of Europe. Of the companies based in Europe that took part in our survey, most of them either self-funded their VR activities (21%) or were able to undertake them as part of other activities within the company (32%). Only 25% indicated to have benefitted from venture capital opportunities from within Europe, and almost half of the companies surveyed said they would have benefitted, or could benefit in the future, from better access to such opportunities.

Weak links between research and the market.

A considerable amount of public money goes into research institutions and universities across Europe, which are developing incredible technologies. These, however, often do not make it to the market. Based on our survey and interviews with public research institutions and universities, there is a much more pronounced focus on fundamental than applied research, and research outcomes often do not make it past the prototype stage. Only 29% of the companies surveyed actively cooperate with universities and research centres, while 61% of the companies carry out R&D internally, indicating a real need to improve the links between research and the market.

A lack of cooperation across the different countries in Europe.

Despite the high levels of cooperation observed within the various hubs and countries in Europe, cross-border collaboration could be improved further. Most supplier/customer relations are also either national or global, further hinting at limited European networks. Interviewees indicated that the VR landscape is currently so fragmented and fast-evolving that much time is spent by companies simply looking up contacts. One third of the companies surveyed indicated a need for more networking opportunities. Apart from collaboration across Europe, further collaboration should be encouraged between the three VR/AR global 'bubbles': of Europe, Silicon Valley and Asia. This will require additional attention when the UK leaves the EU, as currently London and Palo Alto form the strongest channel of transatlantic collaboration for VR/AR.

Current and expected needs for adequate infrastructure and resources.

An adequate infrastructure can strongly facilitate the uptake of VR, along with the spread of VR hardware among consumers and businesses. Furthermore, the education of technicians, designers and developers fluent in VR/AR technologies is essential for the future growth of the industry, with 36% of the companies surveyed saying they would greatly benefit from workers with the necessary technical skills.

6.3 Way forward

To stimulate growth in VR/AR and to address current bottlenecks, policymakers may take on board the following suggestions put forward by VR/AR stakeholders from different European countries, including academia, companies, incubators, associations and specific VR/AR industry experts:

- To make funding more accessible for companies and entrepreneurs in VR/AR, **funding schemes for start-ups could be re-addressed** so as to allow sufficient space for experimentation and (initial) failure.
- To accommodate the fast-evolving pace of the VR/AR sector, it would be useful if the **application processes to obtain funding could be shortened** for fast-growing, innovative start-ups, while a **stronger focus on supporting incubators and accelerators** would be especially valuable.
- To help deploy new technologies, it is suggested to fund more **applied research and demonstrators**, which are closer to market introduction and hence create a stronger bridge between research and innovation.
- To help boost cooperation between the technical, creative and business fields, as well as grow a skilled labour base, it would be useful to **support educational and training programmes with a practical orientation** that would lead students to design and produce novel VR/AR/360-degree film applications. If combined with training on **entrepreneurial skills**, this would allow students to take their projects further in the real world.
- To encourage and increase knowledge sharing, and thereby indirectly facilitate the development, standardisation and quality of VR/AR, it would be particularly useful to **support networking, with the priority of supporting much needed pan-European collaboration**. This could be done by funding and helping organise events, as well as supporting spaces for open source software and tools.
- To stimulate innovation and development within the VR/AR industries in Europe, it would be beneficial to help **showcase success stories across Europe**, inspiring budding entrepreneurs to realise their creative ideas.

Once the market surrounding these emerging technologies further develops, different policy issues will inevitably arise. For VR/AR these issues will concern in particular guidelines on VR/AR ethics because of the fact that, to provide as immersive and enjoyable an experience as possible, these technologies may aim to incorporate protected and/or personal data.

As the above areas of concern and emerging policy issues are addressed, and stakeholders across the region continue to innovate, the potential that may be unlocked across the VR/AR ecosystem in Europe is major. This study may be taken as a starting point for continuing to understand this growing sector, and to help ensure a favorable development thereof in the EU and across Europe.

ANNEXES

Virtual Reality (VR) is described as a 3D environment in which a person can become immersed, using a dedicated headset, powered by a computer, game console or smartphone.

The VR experience can be enhanced thanks to 3D audio sounds and by using haptic devices that use sensors to transfer body movement into the virtual space. VR is used within a wide array of areas, ranging from the gaming industry and entertainment, to training and simulation, including training in the medical field. Other areas of application include education and culture, sports, live broadcasting, real estate, advertising, architecture and arts. Other areas of application are still to come.

Augmented Reality (AR) refers to a real-world environment enhanced with computer-generated information such as sound, video or graphics.

The first generation of AR uses smart devices such as tablets or smartphones as a magic lens that adds an informational layer over our reality. **Upcoming devices in the form of glasses-like headsets** add holograms right in front of our eyes, creating a mix and interaction of virtual world and reality. AR has an almost limitless range of uses in a wide variety of areas, be it commerce, technical applications, work processes or education.

Although they are different, VR and AR share common processes and technologies, such as audio software and data processing. They also tend to concentrate in the same business and research worlds hence creating overlapping ecosystems. VR & AR serve both consumers and professional users that can be private and public. AR in its more advanced glasses-like version is currently available for businesses and developers only, while VR made its way to both consumers and businesses. VR products, and indeed also AR solutions for businesses build up a growing market for consumers and professional users, with dynamically developing business models.

VR for consumers is mainly referring to applications such as games, travel experiences, short movies or adult entertainment. Upcoming products include medical and training applications or educational application. Consumers also purchase hardware such as head-mounted displays (HMD), HMDs for smartphones, 360-degree cameras etc. or specific software (for example Tilt Brush).

The different distribution channels and business models adopted to reach out to consumers can be divided according to the type of VR product:

Hardware	Direct sales	Direct sale of consumer hardware via a website	HMD, cameras
	Intermediary	Using an online or physical retailer	HMD, cameras
	"Free gift"	Offer to a phone subscription or other services	Mobile HMD
Content, apps	Direct sale	Single purchase of an app/content	Travel, gaming
	Subscription	By paying a period fee, consumer can access an online library	Travel, education
	Freemium/demo	Basic content for free, more advanced content for a fee	Travel, gaming
	"Free"	Promotion purposes, consumer pays with attention or data	Advertising
VR experience	Pay for time	Pay for time spent enjoying experience	Cinema, arcades, VR café
	Rental	Rent VR gear with content for a period of time	VR rental
	"Free"	Promotion purposes, at fairs and public spaces	Advertising

VR for professional users includes applications and content, software, hardware or a combination of these. For example, in the medical field a training application for surgeons includes CGI (computer generated image) with haptic input so the surgeon can train in VR but on a real dummy mannequin. A professional solution can also be a high specs 360-degree camera or an external device rented to a VR production company which then uses it for its business.

For professional use distribution channels and business models depend on the consumer market. The table below gives a brief introduction to some of the most important mechanisms.

Professional solutions	Sell of IP/ rights	Sale of whole solution with rights to it	Industry, training, content
	Single sale	One or multiple solutions are sold, seller owns IP	HW, customised solution
	Rental models	Solution rented for a fee on a long or short-term basis	HW
	Royalties model	Resellers monetise and pay back royalties	Industry, HW
Professional content or software	Direct/licence sale	A single license or rights are sold, free or paid updates	Professional SW
	Subscription	Access to content or SW with updates for a periodic fee	Professional SW
	Freemium/demo	Basic version free, advanced for a fee	Medical, SW engine
VR experience	Pay for time	Pay for time spent enjoying experience	Cinema, arcades, VR café
	Rental	Rent VR gear with content for a period of time	VR rental
	"Free"	Promotion purposes, at fairs and public spaces	Advertising

Often products and technical solutions are not even developed with a direct revenue model in mind, but rather as a means to **"grow and get bought"**, aiming to be purchased by larger companies once the technical solution proves to be feasible.

Annex B: Quantitative assessment of the AR/VR market

The quantitative market development estimates are based upon a **VR & AR industry growth prediction model**, constructed specifically for this study. The model measuring the growth for the near future (2015-2020) is based upon both quantitative and qualitative information from different sources and growth assumptions.

The quantitative and qualitative inputs used for estimating VR & AR yearly growth rates, turnover and impacts on the economy and jobs include:

- Comparative assessment of growth rates from a set market reports listed in Annex D;
- Existing econometric analysis commissioned by Facebook modelling growth of sales of HMDs;
- Results of the survey of VR & AR companies run by Ecorys as a part of this study;
- Critical assessment of the future VR & AR market development by relevant academic and industry experts;
- Analysis of the VR & AR market based upon a detailed analysis of around 900 relevant entities;
- Qualitative assessment of development of different VR & AR applications based upon 70 interviews;
- Assessment of growth and economic impact of three hi-tech industries similar to different VR & AR applications.

Three high-tech industries were selected based on their similarities with different VR & AR application areas. Their development over time and direct contribution to the economy was then examined and used to estimate the effects of the VR & AR industries on the economy (in particular in terms of indirect employment and value added). These industries were:

1. The mobile apps industry representing VR and AR applications which are content intensive and aim at the **consumer mass market** (e.g. real estate, journalism, advertising, communication). The data for the size and contribution of the mobile apps industry was retrieved from the reports of Vision Mobile³ on the EU economy. Due to the price sensitivity and mass market nature of this VR market, it is only starting to take off now. However, much like in other comparable markets, this part of the VR market is expected to grow very fast.

2. The video games industry, representing the **maturing and high value mass market** of VR and AR (e.g. gaming, engineering and manufacturing applications, entertainment). The data for the size and contribution of the video games industry was retrieved from the reports of the Entertainment Software Association of Canada⁴ on the contribution of video games to the Canadian economy and the Association for UK Interactive Entertainment⁵ on the contribution of video games to the UK economy. This part of the VR market is estimated to be the most developed to this day. Having said that, there is still maturing and steady growth to be had as the potential of this VR market is fully explored.

3. The flight simulation industry for the **highly specialised VR market** which includes application areas characterised by a high degree of technical sophistication (e.g. security, specialised medical trainings). The data for the size and contribution of the flight simulation industry was retrieved from the published accounts of CAE⁶ which is one of the major players in the industry and a number of other public sources⁷. Due to the sophistication and high technological demands, this VR market is in its infancy. However, it is foreseeable that Europe will play a strong role in developing this sector, precisely due to its complexities and need for top quality and high price tag.

3. Vision Mobile (2015 & previous publications) <https://www.visionmobile.com/reports/european-app-economy-2015>
 4. The ESAC publications (2009-2015) <http://theesa.ca/resources/research/>
 5. Ukie factsheet http://ukie.org.uk/research#fact_sheet
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 7. Flight Global article <https://www.flightglobal.com/news/articles/in-focus-is-there-room-for-so-many-players-in-civil-387883/> & Halldale group (2015) <https://www.halldale.com/insidesnt/airline/rosy-picture-future-2015-world-civil-full-flight-simulator-census>

Unfortunately due to the early stage nature of the two industries, data gaps, at such a granular level, remained. It was therefore necessary to make several **growth assumptions** of the VR & AR market. These included:

- Market for VR & AR professional applications, such as in manufacturing industries, construction or healthcare is a maturing market with a steadily growing adoption rate;
- Consumer mass-market for VR & AR is still in need of a “killing-app” that would drive mass adoption, as well as access to affordable and comfortable hardware, to start a steep growth. Fulfilment of these conditions cannot be estimated quantitatively;
- In terms of professional applications, Europe is likely to be one of the global leaders in R&D and precise technology manufacturing;
- In terms of the global consumer mass-market, Europe is less likely to drive the growth in manufacturing but rather in content production and some software development;
- With the growth of the VR & AR market, higher proportion of population will be equipped with hardware every year. Once a significant part of the consumers and professional users are equipped by a hardware, the growth of the sector will be increasingly by creation of content and to some extent by software development;
- Europe will hold or slightly increase its global market share in VR & AR.

These two steps meant that we had our disposal a database of information on key data points (turnover, annual growth rates, share of the market, employment and value added) at granule level (geographical region, year, type of sector). Based on this data, two growth scenarios were constructed. These are:

- **The baseline scenario** counts on the steady growth of professional applications of VR, for example in industry and medical training, and on moderate growth of the mass market of consumer applications.
- **The optimistic scenario**, assumes that a technological breakthrough will lead to optimal conditions for the growth of the mass VR/AR market. For instance, more user-friendly and comfortable hardware will lead to further price decreases, software optimisation will allow minimal motion sickness, and consumer applications (like social VR) and new content will spur the purchase of headsets by a large number of consumers.

The results from the scenarios were discussed and validated with different industry and academic experts. The estimates for VR & AR development in the world and Europe are presented **on the next page**.

The scenario modelling also included calculations of value added and employment per each of the granular levels mentioned earlier. As well as the assessment of the size of the indirect supply chain impacts. To do this a rather conservative multiplier of 1.6 was used (based on other studies⁸). What has not been valued in the calculations are the induced employment and value added impacts, which occur from personnel working in VR and AR spending their earned salaries.

8. Olsberg, SPI & Nordcity (2015), Economic Contribution of the UK's Film, High-End TV, Video Game, and Animation Programming Sectors
<http://www.o-spi.co.uk/wp-content/uploads/2015/02/SPI-Economic-Contribution-Study-2015-02-24.pdf>

WORLD - BASELINE SCENARIO							
Growth rates	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	N/A	1,3	1,4	1,45	1,5	1,7
	SW	N/A	1,6	1,8	1,9	2	2,3
	Content	N/A	1,9	2	2,1	2,4	2,7
Proportion of sectors	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	73,00 %	67,00 %	60,00 %	52,00 %	42,00 %	33,00 %
	SW	14,00 %	15,00 %	18,00 %	20,00 %	22,00 %	23,00 %
	Content	13,00 %	17,00 %	22,00 %	28,00 %	36,00 %	45,00 %
Market size in million EUR	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	2.142	2.785	3.899	5.653	8.480	14.416
	SW	395	632	1.138	2.163	4.325	9.948
	Content	380	722	1.444	3.032	7.278	19.650
	Total	2.917	4.139	6.481	10.848	20.083	44.014

EUROPE - BASELINE SCENARIO							
Growth rates	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	N/A	1,2	1,3	1,45	1,7	1,7
	SW	N/A	1,6	1,8	1,9	2	2,2
	Content	N/A	2	2	2,2	2,3	2,6
Proportion of sectors	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	53,00 %	43,00 %	34,00 %	26,00 %	22,00 %	16,00 %
	SW	21,00 %	23,00 %	25,00 %	25,00 %	24,00 %	23,00 %
	Content	25,00 %	34,00 %	41,00 %	49,00 %	54,00 %	61,00 %
Market size in million EUR	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	359	431	560	812	1.380	2.346
	SW	142	228	410	779	1.557	3.425
	Content	171	342	684	1.505	3.461	8.999
	Total	672	1.000	1.654	3.095	6.398	14.770

WORLD - OPTIMISTIC SCENARIO							
Growth rates	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	N/A	1,3	1,6	2,3	2,3	2,5
	SW	N/A	1,6	1,9	2,3	2,5	2,7
	Content	N/A	1,9	2,5	2,6	2,8	2,9
Proportion of sectors	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	73,00 %	67,00 %	60,00 %	58,00 %	54,00 %	51,00 %
	SW	14,00 %	15,00 %	16,00 %	16,00 %	16,00 %	16,00 %
	Content	13,00 %	17,00 %	24,00 %	27,00 %	30,00 %	33,00 %
Market size in million EUR	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	2.142	2.785	4.456	10.249	23.572	58.929
	SW	395	632	1.201	2.763	6.908	18.652
	Content	380	722	1.805	4.693	13.140	38.107
	Total	2.917	4.139	7.462	17.705	43.620	115.688

EUROPE - OPTIMISTIC SCENARIO							
Growth rates	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	N/A	1,2	1,6	1,8	1,9	2,2
	SW	N/A	1,6	2,2	2,3	2,5	2,7
	Content	N/A	2	2,6	2,85	2,9	2,9
Proportion of sectors	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	53,00 %	43,00 %	33,00 %	25,00 %	19,00 %	15,00 %
	SW	21,00 %	23,00 %	24,00 %	23,00 %	23,00 %	23,00 %
	Content	25,00 %	34,00 %	43,00 %	51,00 %	58,00 %	62,00 %
Market size in million EUR	Sector / Year	2015	2016	2017	2018	2019	2020
	HW	359	431	689	1.240	2.357	5.185
	SW	142	228	501	1.152	2.880	7.775
	Content	171	342	889	2.534	7.349	21.313
	Total	672	1.000	2.079	4.926	12.586	34.273

Annex C: List of interviewees and events visited

Name of the event	Place	Focus
Dutch VR days	Amsterdam, NL	VR & AR fair; talks and panels on VR & AR applications
VR Evolution	London, UK	Talks and panels on VR & AR applications
Virtuality	Paris, FR	VR & AR fair; short presentations on VR application areas
Laval Virtual	Laval, FR	VR & AR fair; round tables on industrial VR and Near future of VR; Investment forum; VR awards

Name of the interviewee	Place	Company/ institutions	Focus
Philippe Fuchs	Paris, FR	University ParisTech – Mines	VR theoretic research and industrial applications; VR academic publications
Stephane Imbert	Paris, FR	Light & Shadows; Pixyz	VR & AR applications in manufacturing industries; industrial design; visualisation
Philippe Gelin	Luxembourg, LU	European Commission, DG Connect	EC expert on VR & AR
Carl White	Berlin, DE	Berlin VR Meetup	German VR & AR scene overview; community building
David Bomphrey	London, UK	Jaunt	VR creative content and specialised hardware
Graham Thomas	London, UK	BBC	R&D activities in VR; immersive and interactive content
Fiona Kilkelly	London, UK	Knowledge Transfer Network (KTN)	UK VR & AR scene overview; community building
Thomas Gere	London, UK	Realities Centre	Accelerator/incubator; community building
Charles King	London, UK	Wizdish	VR & AR applications
Samir Garbaya	Paris, FR	VR & AR researcher	VR & AR theoretic research and industrial applications; VR & AR academic publications
Adriaan Rijkens	Amsterdam, NL	VRHeroes; Warp Industries	VR applications; community building
Jip Samhoud	Amsterdam, NL	Samhoud Media	VR content creation
Mart Maes	Amsterdam, NL	WeMakeVR	VR applications
Roger ter Heide	Amsterdam, NL	Improvive; Dutch Game Awards	NL VR & AR scene overview; VR gaming; community building
Antoine Cayrol	Paris, FR	OKIO-STUDIO	VR production studio
Rémi Rousseau	Paris, FR	Mimesys	VR applications
Laurent Chretien	Laval, FR	Laval Virtual	VR & AR event/cluster
Niels Julien-Saint-Amand	Bordeaux, FR	VRbnb	VR online platform
Marine Haverland	Brussels, FR	Impulse Brussels	Brussels' audiovisual cluster
Pierre-Julien Barraud	Laval, FR	EON Reality	VR and AR, R&D and applications
Frederic Blin	Lille, FR	Plain Images	Incubator
Nicolas Zuber	Laval, FR	Laval Virtual University	VR trainings
Jean-Baptiste Brucena	Paris, FR	Gengiskhan production	VR production studio
Noel Schepers	Charleroi, FR	CHU Charleroi	VR application in psychological treatment

Name of the interviewee	Place	Company/ institutions	Focus
Cecile Lupo	Troyes, FR	Aube en Champagne, Tourisme et Congres	Promotion with VR (content and cardboard)
Matthieu Paquet	Bordeaux, FR	OPTIS	VR applications for industries
Pierre-Marie Boye	Paris, FR	CNC	National agency (funding VR activities)
Dr Eric Malbos	Marseille	Hôpital de la conception	VR application in psychological treatment
Organisation member	Paris, FR	Action Contre la Faim	VR promotion video (Bangui L' Oubliee)
Alaa El Boudali	Paris, FR	DIAKSE	VR e-commerce solutions
Celine Carre	Normandie, FR	Normandie Region	Regional authority
Arnaud Dressen	Paris, FR	Wonda	VR software
Frederic Purgal	Paris, FR	Art of Corner	VR Art studio
Researcher	Laval, FR	Arts et Métiers ParisTech	VR research and study programs
Emma Genet	Paris, FR	Uni-VR	VR think tank
Nicole Laux	Liepzig, DE	Schenker	Tech software producer
Vladimir Kuts	Tallinn, EE	Tallinn Univesrity of Technology	University
Alexandre Bouchet	Laval, FR	CLARTE	VR research institute
Thibault Guillaumont	Tourcoing, FR	Holusion	Holographic gadgets
Jerome Perret	FR/DE	Haption / EuroVR	Haptic devices/ European VR research association
Niels Waem	Beveren, BE	The Yondr	VR creative agency/ community
Luca Greci	Milano, IT	ITIA CNR	Italian research institute active in VR
Johannes Crilly	Hamburg, DE	Spice VR	Digital VR production, VR drones
Marleen Miotke	Berlin, DE	Panono	360/ VR cameras
Stephan K. Schindler	Postdam, DE	Wonder Lamp	Holographic lamp/ AR
Herve Fontaine	Slough, UK	HTC Vive	VR headset manufacturing
Ludovic Clamens	FR	Realtime Robotics	Robotic VR synchronization
Laetitia Richez	Bordeaux, FR	Immersion	Multiple industrial VR solutions
Ton Kuper	Enschede, NL	Serious VR	VR training provider
Stephane Lienard	Massy, FR	Diota	VR and AR engineering and manufacturing solutions
Dag Eklund	Stockholm, SE	ScioVR	Medical training in VR
Thomas Van Els	Amsterdam, NL	Enliven 3D	Haptics and sensors for VR
Sander De Roeck	Brussels, BE	Soulmade	VR creative content
Eric Braux	Nanterre, FR	Barco	Cinematic equipment and VR
Sara Vogl	Berlin, DE	Berlin VRBase	VR hub and co-working space
Boris Goldshteyn	Berlin, DE	All VR	VR visualization
Emilio Laroocca Conte	Berlin, DE	Nilasphere	Creative VR solutions
Dominic Eskofier	Munich, DE	Nvidia	Software and engines, VR rendering
Philip Hausmeier	Berlin, DE	Berlin VR meetup	Berlin informal networking platform
Kay Thurley	Munich, DE	Ludwig-Maximilians-Universitaet Muenchen	University – basic research using VR
York Winter	Berlin, DE	Humboldt Universität zu Berlin/ WinterLab	University – basic research using VR/ company developing tools for neurology research
Pablo Corrales Sánchez	Madrid, ES	Abanlex	Legal firm focused on new technology legal issues
Steven Posner	Madrid, ES	Future Lighthouse	Creative VR content
Óscar Marín	Barcelona, ES	Outliers Collective/ Barcelona VR meetup	Big data visualization in VR/ informal networking platform

Name of the interviewee	Place	Company/ institutions	Focus
Pedro Diezma	Madrid, ES	Zerintia	VR and AR for manufacturing industry
Jose Luis Acha	Madrid, ES	SGO	Postproduction software
Joseph Michael	Stockholm, SE	Invest Stockholm	Innovation support public agency
Faviana Vangelius	Stockholm, SE	SVRVIVE	VR gaming studio
Jenny Nordenborg	Stockholm, SE	Neat Corporations	VR gaming studio
Tommy Palm	Stockholm, SE	Resolution Games	VR mobile gaming studio
Steve Dann	London, UK	Medical Realities	Medical training in VR
Lucia Valmaggia	London, UK	King's College	University – psychology and psychiatry VR research
MK2 VR	Paris, FR	Representative	VR entertainment
Emma Genet	Paris, FR	Uni-VR	VR think tank
Kathleen Schroter	Munich, DE	Fraunhofer	VR research and development, audio
Frederic Condolo	Laussane, CH	MindMaze	Medical devices and neurology
Anthony Hacques	Laval, FR	Inod	VR solutions for architecture, real estate
Benjamin de Wit	Amsterdam, NL	Dutch VR days	Leading Dutch VR event
Vincent Rieuf	Laval, FR	Orbital Views	VR simulator for space
Jawed Raifai	Bordeaux, FR	Lumiscaphe	Virtual realistic models and prototypes
Representative	Paris, FR	TechViz	Virtual prototyping
Representative	Prague, CZ	Solirax	VR engine and creation interface
Michiel Mol	Amsterdam, NL	Force Field	VR gaming studio
Pawel Surgiel	Warsaw, PL	Bivrost360	Camera producer

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