WHITE PAPER: ENTERPRISE TRAINING WITH AUGMENTED REALITY

THE WORKPLACE OF THE FUTURE
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AR TRAINING FOR THE WORKPLACE OF THE FUTURE

ABSTRACT
This white paper outlines the ‘how and why’ of Enterprise Training with Augmented and Mixed Reality. It will explain the environments and tasks AR training can support as well as concise benefits of doing so. Finally, this paper will categorize the best devices and software that can be used to incorporate AR training into business scenarios at a low cost with high impact.

BOX FACTS:

40% of employees who receive poor job training leave their positions within the first year.

In 2016: 68% of workers say training and development is the most important workplace policy.

Comprehensive training programs yield:

218% higher revenue per employee

24% higher profit margins

6% higher shareholder returns

AUGMENTED REALITY merges the digital world with the real and allows you to place digital information into the world around you. Augmented Reality applications can be used for visual guidance on smartphones, tablets and smart glasses to simplify production, training, maintenance and repair.

MIXED REALITY solutions utilize the latest smart glasses technology to place interactive digital objects into your environment. Enhance sales efforts by digitalizing showrooms, empower technicians with hands free maintenance information anywhere or increase information retention with state-of-the-art training.
INTRO
Augmented and Mixed Reality are emerging technologies gaining swift traction amongst many business leaders. A 2016 survey not only discovered that 39% of respondents were already using AR in their organization, but a staggering 67% of those not using AR were considering its implementation. In this survey alone, 20% of enterprise AR usage was for training and simulation purposes.

39% ALREADY USING AR
67% CONSIDERING IMPLEMENTATION
20% AR TRAINING AND SIMULATION

Each day companies are faced with the challenge of upgrading existing employee skills to increase production performance and to train new hires to be ‘production ready’ with the basic technical, safety and quality skills. More than 80% of managers believe that effective training is critical to project success (skill levels linked to business value and can lead to a 10% increase in productivity when teams are well trained). It is not uncommon for companies such as BMW to invest around 352 million Euro a year on employee training. In fact, US Manufacturers alone invest $3000 in training for each new hire. That is $4.6 million annually! To keep those same employees up to scratch throughout their career, manufacturers invest a further $1500 per employee each year – $2.3 million annually.

Huge sums of money are being invested in trainings across the globe, yet in many cases the training procedures are not only outdated, but do not clearly outline the complexity of the technical tasks they propose to teach. Longer training times, employees under-performing and safety risks have a huge knock-on effect to the industrial employer. Augmented Reality technology can not only close the gap between outdated training methods, but also increase worker production, efficiency and overall task performance rates in the long run – when compared to training with traditional methods.

AR MARKET
Even though most people think of PokemonGo or social media face filters when mentioning Augmented Reality technology, 8 of the top 10 tech companies are investing heavily into AR and it is not for social media gimmicks nor computer games. In 2016, both Microsoft and Google had over 850 employees working on Augmented Reality. These tech firms are investing into enterprise solutions and are expecting huge ROIs as they role out. As the technology improves industrial markets are quickly adopting the technology.

COMPARISON OF THOSE WHO ARE CONSIDERING ADOPTION OF AR TECHNOLOGY VS. VR TECHNOLOGY

AR TRAINING AND SIMULATION

VR
AR

61% don’t use any AR technology
19% as part of the products they make
12% in simulation exercises
8% in employee testing/training
8% in computer modelling activities
8% in the sales process
8% in GPS and GIS applications
7% in other applications
5% in computer analytics

No. of respondents: 165
Source: zdnet.com
There are countless cases of AR being used in manufacturing and Google even just re-released the Glass to meet the demand and to catch up with the popularity of the HoloLens for enterprise cases. A Godmansachs study estimated 6 million users of AR in the field of engineering at a value of $4.7 billion. One of the first instances where this technology will come into play is industrial training.

Meanwhile, in 2016 IDC found that there are already around 111,000 AR headsets in operation in the commercial segment and projected more than 20 million by 2021 - that’s a 184% Compound Annual Growth Rate, giving an 83% AR headset market share in 2021 in commercial segment.

**Worldwide AR and VR Headset Shipments, Segment Share, and CAGR, 2016 - 2021**

<table>
<thead>
<tr>
<th>PRODUCT CATEGORY</th>
<th>SEGMENT GROUP</th>
<th>2016 UNITS</th>
<th>2016 SHARE</th>
<th>2021 UNITS</th>
<th>2021 SHARE</th>
<th>CAGR% (2016-2021)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUGMENTED REALITY</td>
<td>COMMERCIAL</td>
<td>110,512</td>
<td>68.0%</td>
<td>20,454,18</td>
<td>83.3%</td>
<td>184.1%</td>
</tr>
<tr>
<td>AUGMENTED REALITY</td>
<td>CONSUMER</td>
<td>51,946</td>
<td>32.0%</td>
<td>4,114,598</td>
<td>16.7%</td>
<td>139.7%</td>
</tr>
<tr>
<td>TOTAL AR HEADSETS</td>
<td></td>
<td>162,458</td>
<td>100.0%</td>
<td>24,568,76</td>
<td>100.0%</td>
<td>172.9%</td>
</tr>
<tr>
<td>VIRTUAL REALITY</td>
<td>COMMERCIAL</td>
<td>1,838.19</td>
<td>19.9%</td>
<td>18,141.76</td>
<td>27.0%</td>
<td>58.1%</td>
</tr>
<tr>
<td>VIRTUAL REALITY</td>
<td>CONSUMER</td>
<td>7,399.36</td>
<td>80.1%</td>
<td>48,963.87</td>
<td>73.0%</td>
<td>45.9%</td>
</tr>
<tr>
<td>TOTAL VR HEADSETS</td>
<td></td>
<td>9,237,434</td>
<td>100%</td>
<td>67,105.53</td>
<td>100%</td>
<td>48.7%</td>
</tr>
</tbody>
</table>

**WORKPLACE ENVIRONMENTS FOR AR TRAINING**

When incorporating Augmented or Mixed Reality solutions into your industry 4.0 environment, the first decision is the most vital for deployment and success: ‘Which smart device best suits my business needs and use case?’ The smart device market is a jungle of diverse consumer and niche products - but where to start? Here is an overview of what’s available, how varying work environments impact device selection, and, most importantly, which device best fits your industrial scenario.

**HEAVY DUTY AR** - Safety, durability and efficiency are key to heavy industry environments such as Agriculture, Construction, Mining, Oil & Gas, manufacturing & production and more. Technological solutions in these environments need to be scalable/survivable for rugged tests of wear and tear. Smart glasses such as the Epson Moverio, ODG R8 & R9 and Google Glass EE have been designed specifically to meet the needs (not to mention specialist protective cases that can be added to any AR ready Smartphone or Tablet).

In heavy industry, trainees can expect to be learning about safety procedures and operating complex machinery. Skipping a single step or applying the wrong procedure to the wrong machine can be potentially hazardous. AR intuitively solves these problems without the need for complex handbooks with complicated 2D instructions.
AR and MR technology is able to identify machinery and place training material exactly where it needs to be in 3D - visualizing instructions and training materials just like we see every other object in the real world. Safety instructions can appear at every step needed without fail. No unnecessary accidents for safe training in the field. When using one of the many smart glasses options, trainees can practice solving complex technical operations on real machines with smart visual guidance - all hands free.

**DAY-TO-DAY** - Efficiency, style and comfort are the key to day-to-day AR usage. AR is in many ways similar to the enterprise acceptance of the iPad. Upon its first release, the benefits of the tablet were not appreciated. As soon as companies began to see the benefits of powerful portable stylish computers providing quick on-the-spot information without having to find a workstation, they were quickly adopted. The same applies for portable AR training – a small device is capable of holding masses of information ready for consumption at any time for precise results. No need to have multiple handbooks or search for information to refresh your memory or train a college on a new procedure.

Whether in a hospital or factory floor: AR training solutions are being adopted for their compact and portable improvements to work efficiency. With information always at hand, time spent on work tasks drops by 30% as employees are able to train themselves on-the-spot when faced with new tasks. With stylish and comfortable options such as the Microsoft HoloLens, Google Glass or AR ready smartphones and tablets, workers are further encouraged to adopt the tech.

**IN YOUR POCKET** – Imagine empowering your entire workforce with AR training today with no major costs other than the training materials itself (which you probably already have in constant production anyway). In 2016, 88.1% of the US workforce owned a smartphone. Providing these phones have a camera and the latest software, your company could already integrate AR training for employees today.

In your pocket AR utilizes existing smartphone technology and allows for AR Training anywhere. This form of AR training adds the powerful benefits of AR training directly into existing infrastructures and is fully portable. Instead of searching for handbook materials or waiting for expert trainers, simply grab your smartphone and let it find all the information for you and guide you through the new task.
CHALLENGES, SOLUTION AND BENEFITS OF AR TRAINING

With the AR market on the rise and plenty of industrial companies already implementing AR technology to their training processes – the natural question to ask is... why? Why are companies investing their training budgets into AR technology and rolling it out to the workforce?

For business owners aiming to achieve a maximum yield, employee training is essential and never can be avoided. Training costs are also unavoidably high. AR training allows enterprises to streamline training costs and increase worker efficiency through more effective learning. The hands-on, interactive and visual learning style that AR training offers its students dramatically increases learning. This not only reduces the errors made by employee in the long run, but also saves time and money in the training process by allowing employees to learn quicker by themselves.

FOR EXAMPLE:

1. Researchers found that AR instructions overlaid in 3D resulted in a 82% reduction in the error rate for the assembly task

A study conducted by Tang et al. prompted users to assemble toy blocks into specific configurations using several different forms of instruction: traditional printed media, instructions displayed on an LCD monitor, static instructions displayed via a see-through Head-Mounted Display (HMD), and spatially-registered AR instructions also using a HMD™.

“Training is one of the original usages that researchers pursued in augmented reality”

Ronald Azuma
Principle Engineer/Research Manager, Intel Labs

AR TRAINING ALLOWS ENTERPRISES TO STREAMLINE TRAINING COSTS AND INCREASE WORKER EFFICIENCY THROUGH MORE EFFECTIVE LEARNING.

50% FASTER TASK PERFORMANCE

90% DECREASE IN MISTAKES

60% FASTER LEARNING

60% LESS MATERIALS USED
2. **50% faster task performance, 50% increase in concentration, 90% decrease in mistakes.**

A 2014 study discovered that when completing a task, mobile AR reduced the task performing time by 50%, and increased the employee’s concentration by 50%. In addition, AR decreased the amount of mistakes by 90%\textsuperscript{xiv}.

3. **60% increase in learning time, 60% decrease of consumable training materials**

The Augmented Arc™, an Augmented Reality Welding System for welding education, is being used to help students to complete their training faster and allow instructors to make more effective use of their time and resources. They discovered that quickly getting young people into the trade is more important than ever. According to the American Welding Society: manufacturers, who provide about 60% of all welding jobs will need almost 300,000 new and replacement welders, by the end of the decade. A Miller-supplied case study of the AR technology for welding training shows students have tripled the number of correct welds completed in the welding booth. Their workshop time required to achieve course objectives has dropped by more than 60%. Consumable usage (sticks, plates, etc.) has also been reduced by more than 60%\textsuperscript{xv}.

4. **Increased the motivation of students and shortened the total length of training**

In a Royal Netherlands Air Force project to improve F-35 aircraft maintenance training, trainees were divided into groups trained via traditional methods or via AR with the HoloLens. When compared, it was discovered that the modernised HoloLens training increased the motivation of students, eased the transition to real-life maintenance and shortened the total length of training\textsuperscript{xvi}. 

HOLOLENS TRAINING INCREASED THE MOTIVATION OF STUDENTS, EASED THE TRANSITION TO REAL-LIFE MAINTENANCE AND SHORTENED THE TOTAL LENGTH OF TRAINING.
<table>
<thead>
<tr>
<th>Industry Training Challenges</th>
<th>AR as an Industry Training Solution</th>
<th>AR Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demotivated Learning</strong></td>
<td><strong>Motivate learners and enhance the learning experience</strong> New technology such as AR is fascinating and makes trainings more attractive</td>
<td><strong>Maximum Yield</strong> Motivated trainees become motivated employees with increased productivity for maximum yield rates</td>
</tr>
<tr>
<td>Classroom training and paper-based group learning methods often fail to motivate trainees to their full potential</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Training Safety</strong></td>
<td><strong>Create a safe environment</strong> AR makes it possible to explore and train troubleshooting scenarios without any risks</td>
<td><strong>Increased Safety</strong> AR enables employees or customers to safely perform interactive, hands-on training in environments and scenarios where safety was previously a concern</td>
</tr>
<tr>
<td>In many cases, paper or online trainings are the only option as it is not possible to train on real devices due to safety requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Damage and Destruction During Training</strong> Disassembling or destroying products for training purposes</td>
<td><strong>Eliminate damage and destruction for training purposes</strong> X-ray views and 3D visualizations let workers see inside and target key points in training scenarios to avoid unneeded damage or destruction of products</td>
<td><strong>Save on Training Material Costs</strong> Reduced damage or destruction of products and materials during training</td>
</tr>
<tr>
<td><strong>Demand for Expert Trainers</strong> Training new employees and customers usually requires either external experts or time taken from experienced colleagues</td>
<td><strong>Self Guided Training</strong> AR empowers employees and customers with self-guided training and enables ubiquitous, collaborative and situated learning</td>
<td><strong>Reduced Expert Training Costs</strong> AR offers self-guided training, similar to online e-learning</td>
</tr>
<tr>
<td><strong>Lack of Interactive Learning</strong> Employees want to be trained by doing, but this means that huge budgets need to be spent to offer this to each employee</td>
<td><strong>Interactive Learning</strong> AR trains employees by guiding them through real tasks in real scenarios with visual step-by-step instructions</td>
<td><strong>Increased Knowledge Retention</strong> Interactive and hands-on training increases training efficiency and knowledge retention allowing employees to outperform when commencing work</td>
</tr>
<tr>
<td><strong>The Training Data Jungle</strong> Huge handbooks, lost information, outdated versions or simply information too difficult to find and apply to training scenarios. Not to mention wasted costs on printing, materials and waste</td>
<td><strong>Organized Data Where It Needs to Be</strong> Training data appears exactly where it needs to be on real objects without having to search</td>
<td><strong>Save Time by 50%</strong> Training data appears exactly where it needs to be on real objects without having to search and training scenarios can be picked up and used immediately at any time to refresh memory in the field</td>
</tr>
<tr>
<td><strong>Outdated 2D Diagrams</strong> For complex training scenarios, 2D diagrams are unable to effectively display core learnings and be practically applied</td>
<td><strong>3D Instructions</strong> 3D AR visualizations on real world objects allow employees and customers to understand training processes by being able to see the information as we see it in the real world... in 3D</td>
<td><strong>Reduce Errors by 90%</strong> Precise visualizations of 3D data exactly in the correct position on real objects as well as training in any language ensures that employees and customers always understand their tasks</td>
</tr>
<tr>
<td><strong>Language Difficulties</strong> Global companies are faced with redistributing all training materials in multiple languages – thus increasing costs, efforts, waste and chances of outdated materials</td>
<td><strong>Multi Language</strong> AR can easily support variety of languages, keep it up to date and distribute globally without extra costs or effort</td>
<td><strong>Global Solution</strong> No more errors caused by language, common global solution with reduced production costs and less waste</td>
</tr>
</tbody>
</table>
USE CASE – AR TRAINING IN HEALTHCARE

Within the healthcare industry medical education plays an essential role. This is especially true for the medical device industry, which is faced with in-depth employee training on very specific and complex devices. What’s more, in most cases this knowledge also needs to be transferred to customers (mainly medical staff), to teach them the specific technologies and products. For these healthcare professionals, certified CME (Continuing Medical Education) is mandatory to maintain competence and remain informed about new and developing areas of their field. As a result, medical staff are constantly looking for possibilities to take part in certified CME courses.

Realistic and safe environments are a necessity for effective medical education. Achieving these two core criteria make it possible for doctors or nurses to learn daily medical scenarios, without affecting the patient’s safety. Currently, simulations with manikins are often used for hands-on medical trainings whereas online programs and virtual learning solutions are also available for realistic medical scenario simulation.

When considering the implementation of AR into these kind of trainings, it is important to consider that over 2,500 publications are already available that show examples of AR integration in medical learning. These examples can mainly be found in the area of surgery but also in other fields, like anatomy, cardiology or clinical life support. Despite such ranging application environments, the role of AR within these trainings can be broken down into two core fields: it can help to investigate user acceptance, and enhances learning performance. In both cases, AR decreases training costs by reducing the time for practice and increasing the success rate. AR can also be used as supplementary guidance or feedback tool, that filters meaningful information and simulates more realistic medical situations.

At the moment, the main challenges for AR in medical training are as follows:

• Adequate training experience must be ensured and approved
• Using AR or MR in medical training can craft well-trained specialists for specific tasks. Cross-over competencies must not be forgotten
• AR/MR is still not well-known and first applications are still in the prototype stage. To develop more AR/MR content more studies about the benefits are needed
An example of AR and MR implementation in medical training can be taken from PULSION Medical Systems (Getinge Group) in the field of advanced hemodynamic monitoring - where an AR learning app was created for the iPhone and iPad as well as a MR app for the Microsoft HoloLens. These applications explain the setup of the medical device and the meaning of the most important technologies. On one side the apps can be used as educational tool for new employees from sales, clinical application or to increase trainee’s subjective attractiveness and make the learning process easier. On the other side these AR apps can be used by the trained employees to better explain the technologies and product to the customers. Additionally, the medical staff can use the apps to get quick support without calling the company representative.

Clear benefits to use AR in medical education can be categorised as follows:

- In medical education, complex learning content occurs. This requires trainings that develop adaptive expertise and collaborative skills
- Medical trainings should be performed in real-life context. With AR, the physical training environment may be very similar, if not the same, as the professional work environment
- AR learning environments do not always require an expert or instructor to observe trainee performance
- AR technology can visualize the invisible and simulate relevant 3D, tactile and other aspects of the real world task
- AR provides immediate learner feedback which supports taking control over the learning process
- The patients’ safety is not affected if mistakes are made during skills training with AR.

To get an impression of the HoloLens app, you can watch this video:
SUMMARY
AR is mixed and enhanced reality technology with big potential and compelling features for training purposes. Within the field of training and education AR is still in at an early stage, resulting in limited evidence to support the projected long-term effects whilst most applications are still focusing on the development and usability of AR tools. As with multimedia or web-based trainings, this new technology still needs further studies to clearly indicate the technological characteristics that generate exclusive benefits to AR that are unfeasible with other media or concepts.

Despite this, the obvious benefits are easy to identify and AR solutions fit the mould for the modern challenges facing industrial training. This is especially true when considering the authenticity of training content as well as the engagement of the learners – both important aspects for training that come along with the implementation of AR.

Regarding our initial questions, we can definitely say that AR will really improve training processes for industrial trainings. It will be important to implement the technology within the right instructional approaches (role, location, task) and at the right time within the process. The ability of AR to cut training costs dramatically and increase training efficiency, is very difficult to show at this stage. Therefore, it is essential that companies show courage for this technological vision, and further support and drive AR content for their industrial trainings.
RE’FLEKT is an Augmented Reality ecosystem for enterprises, providing a powerful content creation platform and a remote expert solution to empower workers with flexible and customizable smart instructions on mobile devices and smart glasses - for increased efficiency and reduced errors. The content creation platform integrates into existing enterprise software and enables companies to easily convert existing CAD data and media content into Mixed Reality applications for maintenance, training and operations. The Remote Expert tool connects workers to immediate Augmented Reality support with dedicated experts in one simple click. RE’FLEKT creates the workplace of the future for global players such as Atlas Copco/Leybold, Bosch, Hyperloop and Mercedes Benz and is recommended by leading analysts including ABI Research and Gartner.

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