Augmented Reality Education & Training Applications: Challenges & Opportunities

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Abstract

This presentation will discuss the challenges and considerations that need to be resolved for the future delivery of industrial and consumer applications of Augmented Reality. AR is increasingly being viewed as a technology that will become ubiquitous, though additional development is needed-- and underway-- to fulfill AR's full potential. On the near term horizon, emerging applications increasingly include education and entertainment, medicine and science, military training, public safety, and transportation. Additionally, AR's applicability to e-commerce through pairing with mobile smartphones is showing early promise but has yet to be fully exploited. This presentation will touch on each of these topics.

Keywords

Augmented reality training & education, content creation & conversion, AR revenue & business model, AR training markets

Training & Educational Applications—Target Industries for AR Solutions

Augmented Reality has the capability to solve and enhance a variety of educational and process training

needs across a range of industries and applications, including the following:

Aviation & Aerospace
When aircraft develop mechanical problems during flight, they land at the nearest airport and await repair from personnel who are qualified and certified to perform such repairs, certifications specific to particular airframes, particular power plants, etc.

- Because it is simply not possible for every Airframe & Power Plant (A&P) mechanic to be proficient on every possible variant, aircraft typically experience extended downtimes, first because travel time is needed to bring in a qualified mechanic / technician, and then once qualified diagnosis has begun, additional time is needed for ordered parts to be delivered before repair can begin. This extended downtime has monumental lost-revenue and lost-productivity impact for commercial air carriers, whether in passenger or cargo service. Air carriers need to minimize their aircraft downtime as a result of delays.

- AR Training enables air carriers to leverage A&P "generalists" who can—at a moment's notice and wherever they may be—access the diagnostic knowledge and parts information needed to accurately diagnose and repair the failed system. And the customary training interval has thus been significantly reduced or avoided altogether.

Military Warfare Training
Military casualties are an increasingly unacceptable cost of war, covert operations, resistance movements, etc., both politically and in real life terms. However the need

for military men and women who are trained in the newest warfare techniques is a critical need. Field-tested techniques, however, typically lead to avoidable casualties. Members of the armed forces, therefore, need the ability to test a variety of combat and warfare scenarios and to be able to identify, review, and learn from mistakes rather than sustain casualties or fatalities.

- AR Training products provide the ideal solution. In a portable, instantly-updatable mobile device and eyewear solution, members of the armed forces may interact with a virtual environment and virtual combatants, testing warfare methods without the unacceptably high human costs of failure.

Industrial Heavy Equipment Maintenance & Repair
One core target market for AR training solutions is the industrial marketplace, specifically heavy equipment operation and maintenance in the mining and earth-moving industry. In this area, AR solutions can cover the entire operational life of mining machines, including the following processes:

- Installation of the machine in-situ or relocation to another area

- Planned replacement of selected assemblies or components

- Emergency repairs

- Servicing, lubrication, and routine maintenance

Generally performed on-site and underground, these processes occur in conditions far different from those

found in the factories where the equipment is manufactured. Environmental impediments to successful completion of these activities can include:

- Confined operational space, i.e. – in mineshafts, quarries, or makeshift repair/maintenance spaces

- Inclined and/or slippery floor

- Poor lighting conditions

- Limited hoisting equipment available for moving machinery coupled with minimal maneuvering space for the machinery resulting in awkward positioning and significant physical exertion.

Emergency Response
Following a natural (or man-made) disaster, first-responders typically must ingress into damaged areas with only (if at all) a one-dimensional map of the terrain, possibility assisted by GIS data. Lacking an understanding of what existed in the pre-disaster state, it is both very difficult to assess the extent of the damage, and it is difficult for emergency responders to minimize their own personal safety risks.

- AR solutions enable first responders to enter and access affected areas with a portable, up-to-date virtual landscape, including features, structures, infrastructure, etc., that can be used to quickly survey the extent of the damage and inventory the magnitude of restorative repair that will be needed.

Fire Fighting
Training for fire-fighters is typically a combination of class-room training, supplemented with practical experience, either from staged fires or from real fires. Fortunately, the occurrence of actual large scale blazes is an infrequent event, but leads to fewer training opportunities for fire-fighters. Unfortunately, staged fires are costly and also do not occur regularly. As a result, new fire-fighters may have little more than a "textbook" understanding for the behaviors of different types of fires, how different extinguishing materials affect different ignition sources and incendiary materials, etc.

- AR Training solutions allow new firefighters to be trained in a virtual environment, where it is possible to stage a variety of virtual fires, and allow the fire-fighters to learn by experimenting with a variety of techniques and extinguishing materials without human risk of injury or death.

Medical
In order to successfully perform surgery or complex medical procedures, there is no substitute for exacting training and repetition. Medical students typically "practice" on cadavers to gain experience in their field, but in many cases the availability of human bodies is limited. Videos of procedures can act as training aids but wielding the knife and actually going through the physical motions of the procedure is the optimal training event.

- AR training will work closely with medical teaching institutions to create virtual procedural training content that residents can use to "see" and practice a variety of procedures and surgical techniques using a combination of eyewear and medical training software.

Manufacturing

There are many manufacturing processes that are tightly controlled because of regulatory, safety, or security concerns. In fields such as pharmaceutical manufacturing, nuclear materials handling and fabrication, or bio-hazardous products, training operations and manufacturing personnel on correct procedures is paramount. Even after initial training, instant real time access to safety manuals, manufacturing checklists, and hazard containment procedures can mean the difference between a routine event and a major tragedy.

- AR will develop innovative approaches and visual content that can instantly combine the real world of spills, leaks, and security breaches with instantly available remedial procedures and manuals to quickly contain and secure a range of potentially damaging events.

Professional Certifications and Training

Many industries and professional services companies require that their customer-interface personnel become trained in specific actions or processes that lead to certification in order to perform their jobs. For instance, in the telemarketing and outsourcing industry, customer support operators (usually geographically located in Asia and India) require detailed training on

their customers' products, processes, and procedures in order to "go live" and receive incoming call traffic.

In the insurance industry, for example, claims adjusters work in the field and require immediate knowledge of both pre-accident states of property, and the proper methods and techniques to appropriately assess damaged property.

Challenges for the Creation and Adoption of AR Technologies

Augmented Reality is poised to gain rapid traction and improve performance, productivity and efficiency in a variety of industries and markets. It will also improve and eliminate unnecessary downtime and rework in industrial settings, and bring an enhanced sensory experience of reality before our eyes and fingers. As with so many other new technologies, advertising, merchandising and marketing are the leading adopters and tend to be among the first markets to adopt leading-edge solutions. The advertising industry is often drawn to the gimmicky allure of adopting something revolutionary and at the earliest stages of adoption.

In the industrial, governmental, and education worlds, however, the reality is that solving the challenges of just-in-time training delivery and the continuous improvement of human and practical skills are paramount. These ongoing needs imply and increasingly require the ability to learn and train on your own time, gaining whatever knowledge and whenever necessary to stay abreast of new products, technologies, and industries in the marketplace in real

time. There are certain challenges that the AR industry will need to overcome to smooth and accelerate the adoption of educational AR learning solutions.

Technology Challenges—Application Devices
The target markets and audiences for augmented reality products face challenges with their current technology solutions, challenges that if solved in AR applications would speed the adoption of AR solutions. For instance, navigation using Global Positioning System (GPS) is typically only accurate to within 9 to 10 meters outdoors (setting aside WAAS, the Wide-Area Augmentation System in the United States), and has some technological challenges connecting with transmitting satellites from within buildings. However, new and improved locational recognition technologies are under development as ingredients to AR solutions that show real promise in resolving these navigational challenges when a clear line-of-sight is not possible to multiple satellite GPS transmitters.

Another set of challenges come from the support devices for portable AR applications, particularly cell phones and even smartphones with their small display screens. Those small screens limit the amount of visual context and information that users can see at any given time, in addition to suffering from resolution and sharpness issues. This is the perfect opportunity and strategy for putting AR-enabled smart eyewear at the forefront of the solution, especially see-through eyewear that allows users both to see the real world around them and see the enhanced information from the augmented reality visual elements.

Technology Challenges—Eyewear
Sufficiently robust display technology is essential for success of mixed and augmented reality applications and content. In order to experience augmented reality properly, high-definition video display capability and technology is critical. Users of AR solutions must have high-definition, full-color, monocular AR displays that can display high-resolution, hand's-free training content for training and education in and out of classrooms.

The eyewear display also has to have the capability to be connected to a laptop or PC, with the ability to display high-quality digital video imagery to the user's eyes while allowing simultaneous viewing of complex machinery, manufacturing systems, military training, medicine, applied sciences, and emergency response.

In certain emergency or low-visibility conditions, the AR eyewear display technology may be the primary visual display for accurate, situational information. The AR eyewear of the future must be lightweight and relatively unintrusive in form factor, and be self-powered rather than drawing power from an otherwise wire-connected support device. In addition, the eyewear will need to be able to communicate wirelessly with the smartphone or web-enabled mobile device supporting it.

In terms of the smartphones and mobile devices that will be supporting and communicating with the latest in AR eyewear devices, key performance requirements include:

- High-quality and accurate location-tracking capabilities

- Sufficient battery power to play back video, 3D graphics and supporting audio

User Challenges—Privacy Concerns

There are also privacy concerns that will inevitably arise as a variety of AR-enabled applications gain access to each other. For instance, someone walking down a busy city street may be using AR eyewear with a live feed to the internet and certain data stores and applications. When this person observing and interacting with the world around them sees another person, the AR eyewear and connected applications may go to work to analyze and identify the approaching individual using facial recognition algorithms. While this capability has existed in the high-tech movies from Hollywood for many years (*Terminator*, *Iron Man*, etc.), it will certainly reach the real world sooner than many people many think.

In the case of law enforcement, this functionality may have very useful application to quickly identify the imminent threat level from a suspect or fugitive with a criminal history, and enable appropriate levels of protection or lead to a spontaneous capture. For regular citizens, however, this technological ability to take live, ubiquitous data and use it to quickly identify people can lead to an invasion of privacy—the private and otherwise unknown whereabouts and activities of regular people (to say nothing of celebrities, politicians, etc.) become ever more quickly and broadly known. And of course, the potential for this information to be automatically broadcast to and tracked by a variety of interested parties, such as creditors, spouses, employers, etc., has far-reaching consequences.

AR Business Model Challenges—Defining Value & Revenue Streams

To accelerate both the development (and conversion) of AR applications, as well as to attract new users and customers to AR application, a solid business model will need to be defined and implemented for appropriately valuing and monetizing AR training and learning solutions. Some possible revenue model examples for AR training applications can include:

- A *subscription-based* model, where users pre-pay for a limited (or unlimited) access to certain training content and/or courses for a specified period of time.

- A *pay-as-you-go* model, where users pay on-demand for each training module and/or course they wish to complete (Apple iTunes model). The question arises here whether users license content for a one-time use, as well as whether they pay per hour of training content, per course module, per learning objective, etc.

- A *community service* model, which may have application in the area of a public service and public benefit, where a charitable or governmental entity shoulders the development and distribution costs for AR training content, and makes it available free-of-charge to patrons and/or beneficiaries.

- A *bundled-cost* model, which may have application to colleges and universities, who will begin to create and distribute content to make available to their current matriculated students as an enhanced learning tool, included in the annual tuition.

- An *overhead-cost* model, which may have application to corporations and their human resources and training functions. These corporations already have employee and personnel training budgets that cover on-the-job training for some (or all) of their employees; the cost of AR training solutions goes into that budget line item.

Challenges Slowing the Adoption of AR Within Learning & Education

Many augmented reality projects and ideas are being developed for specific customers and custom-built hardware. Despite the falling total-solution costs for AR solutions, overall augmented reality projects can be very expensive to design, develop and maintain. Today's augmented reality development and projects are typically focused on research or individual users.

With regards to the implications of teaching and learning, augmented reality installations can be built to take advantage of existing, low-cost infrastructure. The use of nearly ubiquitous devices, such as smartphones, may or will permit rapid acceleration and experimentation of portable and enhanced applications in augmented reality education.

Because today's generation of students, young professionals and recent college graduates are so accustomed to experiencing so much of their lives through their smartphones and web-enabled devices (maintaining social relations and networks through Facebook, Googling new things to do, looking for jobs on LinkedIn, etc.), it is a very short and very natural

extension for them to bring the process of learning and education to smartphones and web-enabled mobile devices.

The challenge is for current educators and institutions of higher learning to anticipate this growing shift and evolve their education and teaching models to meet the changed reality and expectations of the students they teach. Converting existing content to "work" in the new model is one challenge, but the greater challenge—and opportunity—will be creating educational content that fully leverages the capabilities afforded by AR learning approaches.

Promoting and encouraging interactive visual learning is going to be proven to be a practical and effective education method in engaging students and employees to gain knowledge, be educated, and extend learning to research and share intelligently and quickly. Additionally, the capability of seeing interactively and being connected with the content in real time gives students a different experience, making the user experience richer and more real.

AR Training Development Challenges— Functionality, Content Creation & Conversion
To develop a finished AR curriculum or AR training product, you can either begin to develop that product from scratch, using an authoring system that enables you to build that content, or you would convert existing training content into an AR product. However, the tools do not presently exist that allow content authors to easily develop AR training applications. To develop such applications, you first must have the ability to convert the training course and/or modules onto AR platforms

from the typically MicroSoft Windows environment in which they typically presently reside.

Existing authoring solutions are tailored towards marketing and advertising applications, but they lack the functionality to support a learning management system, certification capabilities, managing students, and keeping track of performance across all types of training activities and initiatives. The current tools do not allow the instructor to design lesson plans, and perform all sorts of administrative tasks, including record-keeping and testing. Until easy, ready-to-use authoring tools come to market, it will remain challenging and costly to develop AR training applications.

To be effective, AR learning management systems will need to successfully and effectively deliver the following features:

- The ability to manage users

- The ability to manage roles

- A curriculum-based approach to delivering educational content

- Capability of testing and assessment, before-and-after (baseline knowledge testing capability)

- Capability of displaying and recording scores and grades for modules and courses

- The ability to deliver AR content on PCs and/or mobile devices and smartphones

- The capability to use a visual display in the form of eyewear

Future learning management systems will have to adopt AR standards and learning management methods. The industry will need to develop and adopt standards to enable widespread creation and adoption of AR training solutions.

Conclusion

With all the challenges that face the adoption of AR industry-wide, one thing is clear: there will be a significant global need for AR education and training information, as well as intelligent AR products and services for the global workforce over the next several years. By combining high-quality, well-designed curricula with smart eyewear, AR education and learning solutions will revolutionize the entire learning paradigm and model for many decades to come. Indeed, augmented reality will be an increasingly common part of everyone's lives.