Increasing XR Technology's Return on Investment through Media Analysis

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ABSTRACT

New developments in Extended Reality (XR) technologies, which includes virtual reality, augmented reality, and mixed reality, promise to transform how we train. Research results in manufacturing support this promise and innovative ideas are generating a multitude of new projects. How do we ensure we are getting the best return on investment (ROI) when using XR before we commit significant resources? What do we need to account for in advance before we invest in XR training solutions? What are the limitations in developing sound competencies and proficiencies in learners using XR technology during training?

Whenever industry introduces disruptive technologies, there exists the challenge of adoption and integration. Questions concerning its effectiveness and ROI are warranted and healthy. We intend to empower the military training industry with proven tools and processes, which can guide the adoption of and refine how we employ XR technology.

In this paper, we examine research on the effectiveness of XR training solutions and compare competency and proficiency results against traditional training methods. This paper includes a media analysis model, comparing new and traditional training methods that recommends the best approach for learners in a training environment, based on cost, schedule, and quality of training. It identifies changes both in project management and in acquisition that will increase ROI. Finally, we will recommend how and when to employ new tech to maximize training effectiveness and increase customers' ROI.

ABOUT THE AUTHORS

Martin Bogan is a training solutions expert for CAE USA's Instructional Systems Group. For more than 11 years, Martin led a diverse team of designers, 3D artists, and programmers in courseware design and production. He now functions as a research and development coordinator and scrums several innovation projects in the areas of extended reality, adaptive learning, data analytics, and use of xAPI in data collection. Martin contributed to the xAPI specification in 2018 with a new xAPI profile titled, *Department of Defense Instructional Systems Design Verb Profile*, which consists of over 400 verbs and metadata for tracking competencies and proficiencies in any U.S. military training application.

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TAKING THE PLUNGE INTO XR

XR or Extended Reality are technologies that create immersive experiences in which users interact with digital content in a digital or virtual reality (VR), that augment reality (AR) allowing users to interact with digital content in the real world, or create various blends where users interact with real or digital content within a mixed reality (MR). The technology is not new and dates back to the 1950s to filmmaker Mort Heilig (Robertson & Zelenko, 2019). However, we still consider XR as an emerging technology. A technology that continues to promise big returns in a broad range of industries such as manufacturing, design, and education. Early adopters eagerly embraced XR technology with huge investments in the 90s and again in 2014 when the Facebook purchase of Oculus for $2 billion created an avalanche of start-ups.

In truth, while most of us are enthusiastic about the idea of XR in its various and ever evolving forms, there is still a lot of disappointment. The technology is expensive and thus out-of-reach for most consumers. There are safety and health concerns, privacy woes, performance issues, and a lack of engaging content. No wonder investments for augmented and virtual reality dropped by 46 percent in 2018. Consumer adoption never materialized to the level the industry expected. Only 5 percent of North Americans currently own an XR headset – the highest rate globally (William, 2017). Based on marketing stories, organizations should expect a solid return on investment (ROI) when using XR. Nevertheless, with all the start-up failures, it is hard to trust claims that XR technology will result in 96% reduction in inspection times (Porter & Heppelmann, 2017).

It is no wonder that organizations interested in deploying XR technology are hesitant and cautious. Much is at risk when implementing XR solutions into training. XR hardware can be expensive and upgrades to hardware will be frequent for early adopters. Software content development that requires highly specialized skills can easily cause costs to get out of control. Unplanned costs associated with frequent content updates means content can quickly become obsolete. Poorly executed content can easily create a negative training environment for learners and cause abandonment of these expensive programs long before the organization realizes any ROI. Although these risks paint a bleak picture, it does not mean that we bypass the benefits of XR technology.

In this paper, we examine the use of XR technology in training solutions. What do training organizations need to know before committing significant resources? What limitations exist in developing learner competencies and proficiencies when using XR technology? How do we implement XR in training that fosters adoption and integration? Questions raised concerning effectiveness and ROI are warranted and healthy. In addressing these questions, we intend to empower the training industry with proven tools and processes. These tools can guide the adoption and refine how we employ XR technology. We will examine research on the effectiveness of XR training solutions and provide a media analysis model that will capitalize on that effectiveness. Finally, we will identify changes both in project management and in acquisition that will increase ROI.

XR INCREASES TRAINING EFFECTIVENESS

The overwhelming consensus is that XR is here to stay. Many studies (some of which are mentioned below) provide evidence that XR technologies have shown to be effective; however there are many variables that can influence the outcome. We took a step back from the research results to see what the field of Learning Science has to say about the trends. If it really is an effective solution, is there any empirical scientific evidence that supports it? Cognitive psychology provides valuable insight into the workings of the human brain, and this directly influences the methods and media that enable effective learning. Dr. Todd Maddox, Ph.D., Brain and Life Science Consultant, has written and lectured on the learning science of how the brain consolidates information (Maddox, 2018). The principles discovered from his research indicate that XR media used for training should be extremely effective.

"Learning is an experience. Everything else is just information," said Albert Einstein, describing the value of experiences in learning. The use of XR in learning is effective because it provides an immersive experience that traditional distributive media does not provide. It does so by engaging multiple learning systems in the brain. Learning science shows that distinct brain systems and psychological processes mediate different types of learning tasks. The three types of learning are described here:

1. **Behavioral** (the "how") – It is one thing to know *what* to do, but it is another to know *how* to do it. Behavioral Learning develops the technical skills required for completing performance-related tasks.
2. **Cognitive** (the "what") – The knowledge and facts needed to perform tasks, usually learned through mental repetition. Cognitive Learning relies heavily on working memory and attention.
3. **Emotional** (the "feel") – The ability to perform under variable conditions and the ability to anticipate outcomes. The emotional learning system in the brain facilitates the development of an understanding of situations and people that is critical to success. Emotional Learning is the core of situational awareness.

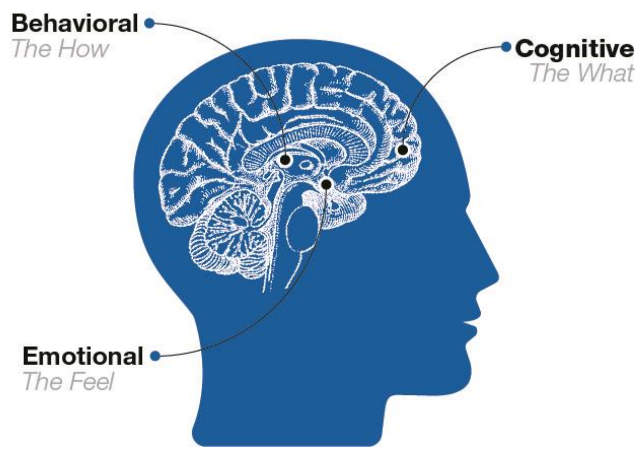

Figure 1. The Three Learning Systems in the Brain

These three learning systems can work in relative isolation or in tandem, depending on the instructional strategies deployed. When the Behavioral or Cognitive systems are combined with the Emotional system, learning is improved. Figure 1 illustrates the location of the three learning systems in the human brain.

For cognitive skills training, XR has the ability to generate 3D dynamic images, rather than 2D static images (normally included with traditional teaching methods) and, therefore, provides a more realistic model. In addition, when a learner has to make a conversion of 2D static images to 3D dynamic images, the demand on working memory and attention load is dramatically increased. XR naturally reduces the load by providing 3D images that do not require a conversion. AR media can reduce the cognitive load on the learner even more by supplying information within the learner's real-world environment.

Several studies have shown that a reduction of time and errors, as well as a decrease of cognitive work, occur with XR technology, which leads to an increase in working memory capacity (Jetter, Eimecke & Rese, 2018).

In a VR study, John L. Salmon discovered that learners felt more engaged and focused when practicing assembly tasks in a hands-on environment. Learning content was easier to comprehend when learners could watch the assembly steps performed by a human-like virtual trainer from multiple viewpoints while following along at their own pace. Learners also preferred having the ability to visualize the content in 3D imagery from multiple perspectives as though they were seeing them in real life (Smith & Salmon, 2017).

People learn behavioral skills through rewards and punishment and do not rely on working memory and attention. This type of learning optimizes when behavior is interactive and includes real-time corrective feedback. Behavioral skills may require extensive practice to become proficient. XR technologies, when implemented correctly, can speed up this process by providing hands-on practice in a realistic setting. Traditional models are less immersive and tend to be more passive.

In another recent study, a game was used as a training medium and compared to reading a printed manual. The results show that the Training Game was more effective for learning behavioral (procedural) knowledge and learners were more motivated as indicated by increased levels of engagement. Participants in the Training Game were more confident and engaged, based on the results of an attitudinal survey (Li, Hall, Bermell-Garcia, Alcock, Tiwari, & González-Franco, December 2017).

Research shows that, using AR, learners exhibited better short-term memory and long-term memory, when tested one week later (Prinz, Schleyer, & Kurth, 2018). Many studies have shown that when users must train or perform a behavioral (physical) task, AR is more effective than using traditional media. Compared to the use of a non-AR system, users of the AR system showed significantly faster speed in locating important items and showed significantly fewer head movements. In addition, learners demonstrated higher enthusiasm and higher engagement.

XR technologies ability to enhance emotional development might be the biggest gain regarding the three learning systems. There has been significant research regarding situational awareness (emotion) learning. In many cases, the research has shown that XR technologies show great potential because we can combine the emotional, cognitive, and behavioral skills training together, thereby engaging all three learning systems simultaneously.

In a study about Augmented Reality, an AR tool was used to reduce the burden of fusing information displayed in two screens (Ruano, Cuevas, Gallego, & Garcia, 2017). The team tested the AR tool performance in an Airbus GCS (Ground Control Station), where it demonstrated how the enhancement of the video stream with virtual elements avoids the burden of fusing information displayed in separate screens and improves the situational awareness of the UAV operators.

In a non-military use case, one study evaluated the effectiveness of VR interventions to improve neurocognitive performance in individuals who have sustained a traumatic brain injury (TBI). In this study, cognitive measures included learning and memory, attention, executive function, community skills, problem solving, route learning, and attitudes about driving. The conclusions were that VR interventions hold significant potential for improving neurocognitive performance in patients with TBI (Manivannan, Al-Amri, Postans, Westacott, Gray, & Zaban, 2019).

Another study examined the effectiveness of VR exposure therapy in alleviating fear of flying in patients diagnosed with Aviophobia (Eslami, Hajebrahimi, & Manshaee, 2014). Results indicated that the virtual reality therapeutic method had a significant effect in alleviating fear of flying. Results of the follow-up examination showed that the effect still lasted after two months. The study suggests that a virtual reality exposure therapy can have significant, reliable, and sustaining effects on alleviating fear of flying.

In addition to the learning science evidence, another advantage of XR technology is its ability to collect actionable data. With these technologies, one can quickly obtain subjective ratings of confidence, satisfaction and engagement, and objective tests to determine whether learning has actually occurred. The granularity of details that can be tracked is limitless, providing for a rich set of data that can be used as feedback to the learner and instructor, as well as metrics to improve training content.

MEDIA ANALYSIS

Research suggests that there is great promise for XR technologies, and the growing body of studies continue to confirm the benefits of this technology in training programs. However, many studies demonstrate how badly things can go when launching a program without a solid foundation. It is essential that thoughtful instructional design and media analysis happen at the front-end of a project, which ensures that we fully capture and document training requirements.

In one study, the exploration of using VR training techniques to improve time use, reduce error rate, and enhance user experience found no significant difference in performance between the VR training platform and the other traditional methods (Smith & Salmon, 2017). Follow-up questioning revealed a potential negative impact on user performance because many of the virtual parts and tools did not fully represent their physical counterparts in the study. Ten of the 30 participants in this test study mentioned a discrepancy in visuals, both in photorealism and scale. The results of this study confirm the need to match the chosen technology with training task requirements. Another thing to consider is the design interface of the XR platform. Without an understanding of tasks and users, inappropriate virtual or augmented reality headsets could result in negative training and user sickness. There is a need for a human factors approach that capitalizes on sensory task analysis (Padron, Mishler, Fidopiastis, Stanney, & Fragomeni, 2018). XR training system design that is user-centered and maximizes [ROI] does not necessarily employ all of the latest technological capabilities nor the highest fidelity virtual imagery; in fact, overly interesting and overly realistic virtual environments can hinder training by distracting trainees from their goals, and virtualization of some system components could eliminate cues critical to task performance. Instead, user-centered training system design requires an up-front analysis that gives designers an understanding of users, their tasks, their training objectives, and the context/environment of use (Stone, 2008).

The Basic Media Analysis Model

Within the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), Media Analysis usually occurs toward the end of the Analysis phase and in the transition between analysis and design. It uses data gathered during prior analysis steps (target audience characteristics, number of trainees, and environmental requirements) to guide decisions in how to deliver the training to meet instructional objectives. Before the design process begins, managers and instructional developers must decide how the instruction will be delivered to learners and need to work closely with Subject Matter Experts (SMEs) to determine the best methods and media. During media analysis, instructional developers examine the demands of the instructional situation and then decide which medium (or combination of media) will best meet the identified instructional needs (FEMA, 2012). Growth in electronic technology has substantially increased the media options for delivery. The entire paradigm for how to deploy training is shifting. The “classroom without walls” is a concept attracting a lot of attention – providing training at the point of need and at the learner’s location at that time of need.

“Ready, Relevant Learning is the Navy-wide initiative of providing the right training, at the right time, in the right way,” state the authors of this article (Hale, Welch, & Read, August 2017). The strategy is to modernize training content across the career-long continuum of learning for every Sailor. The content-modernization process includes analyzing and optimizing media types, media modes, and delivery methods of performance-centric training content and delivering it at the ideal time and in a location convenient to the Sailor, either at the waterfront or in the actual work environment. This process takes advantage of modern technologies to deliver training in the most effective way, based on key principles of the science of learning.

XR technologies have great potential to become supplements and (future state) replacements for simulators where they match the training need. XR solutions can be developed and deployed much more economically and can potentially provide better throughput compared to full-motion simulators. Media analysis and ongoing learner performance analysis are critical in determining which training tasks can effectively shift to XR.

Our approach to media analysis adheres to the ISD processes documented in the MIL-HDBK-29612-3A Series (August 2001). These processes include the following steps:

1. Identify the instructional concept, course strategy, and lesson strategy.
2. Identify sensory stimulus requirements for each learning objective (LO).
3. Identify sensory stimulus features for all available media.
4. Match sensory stimulus requirements of each LO to the sensory stimulus features of available media to identify viable options.
5. Select the delivery media based on resources, constraints, costs, time, and other relevant considerations.

We accomplished these steps by analyzing the core missions and operational tasks of our defense and security customers.

This process requires a strong collaboration with customers and subject matter experts, as well as a thorough understanding of the mission's needs to deliver a comprehensive training solution that achieves readiness.

Most types of complex skills involve multiple LOs from different domains of learning. Media Analysis can become very complex when it involves integrated learning activities. Selecting the right balance is not easy. Dozens of interrelated factors influence the decision; for example, which options are available; which activities are best suited for live training, synthetic training, or a mixture of the two; how much time, money, personnel, and resources would each of these options require; and where will the savings come from?

The first steps (1a and 1b in Figure 2) are to identify and list learning objectives and group them together based on similar learning outcomes and characteristics (knowledge, mental skills, psychomotor skills, software, and attitude).

Figure 2. Steps in Conducting Media Analysis

The second step is to identify viable delivery (media) options for each group of objectives. The media options depend on the following eight requirements:

1. Content – complexity of materials, desired proficiency levels, team vs. individual, etc.
2. Display – sensory cues necessary and how much fidelity the training should have compared to the real world scenario.
3. Design – instructional strategies, creativity, interactivity, location awareness, logistics and delivery methods, scalability, etc.
4. Activity – the methods to be employed (discussions, role plays, teaming exercises, tracking, fine and gross motor activities.
5. Environment – physical motion, acceleration, vibration, pitch/roll fidelity, connection to external devices, etc.
6. Safety – personal, safety of others, environmental, and equipment/data integrity.
7. Evaluation and Feedback – evaluations and testing methods, data types collected, question complexity and response analysis.
8. Limitations – resistance to change, instructor/SME availability, and job functions.

Steps 3 and 4 provide details regarding development time (based on industry standards) and overall costs, which include development costs as well as implementation, deployment, and maintenance costs. These details provide the ability to rate viable delivery options. In addition, there could be hidden costs (step 6) that are not obvious without further analysis—especially true with new technologies such as XR, because retraining and additional software/hardware purchases may be required to support the development effort.

The final output of media analysis is to determine the right blend of delivery options (step 7). Step 7 provides the source data for the final training plan that guides lesson design.

Figure 3 provides an example of the model, including the inputs and outputs of the seven steps listed in Figure 2.

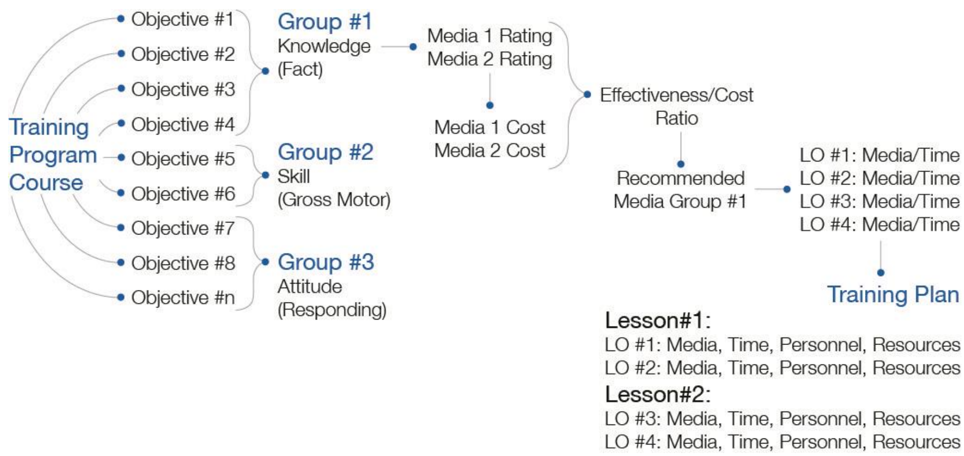

Figure 3. Media Analysis Example

There are endless possibilities for configuring XR or any type of simulation device for that matter. In order to ensure we are capturing the fidelity requirements for the training device, we may need to add an additional set of details. Failure to do so can result in ineffective training (or even negative training). This step is referred to as Fidelity Analysis and provides a step-by-step approach to assess the functional requirements of training devices, based on training needs and performance objectives. It identifies visual, tactile, olfactory, affective, and auditory sensory cues needed to practice tasks, within realistic environments and under preset conditions to attain the desired level of competency. Whether you are investigating the viability of off-the-shelf trainers/simulators or procuring/developing a custom-built trainer/simulator, you must clearly articulate critical requirements. With accurate, factual data in hand, you can maximize the benefits of your trainers/simulators investment by zeroing-in on requirements that offer the greatest value. Fidelity Analysis consists of three separate analysis procedures:

1. Synthetic Environment Analysis – Identify the terrain, environmental conditions and desired user controls.
2. Synthetic Elements Analysis – Identify elements within the synthetic environment and identify how users interact with each element.
3. Sensory Cues Analysis – Organize sensory cues in a repository under various categories (visual, tactile, olfactory, affective, and auditory) to assess the fidelity requirement of each objective.

Equipped with this level of detail, we can convey important requirements to internal development teams or vendors supplying the training devices.

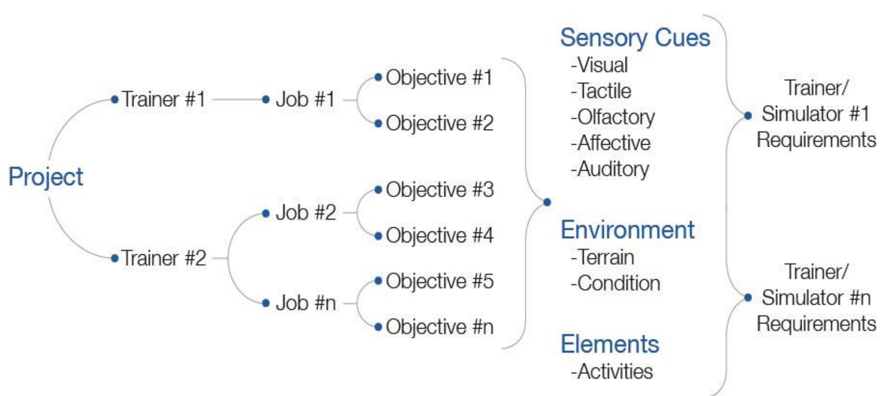

Figure 4. Fidelity Analysis

The Federal Aviation Administration (FAA) Code of Federal Regulations (CFR) defines a set of requirements regarding performance standards for all aircraft flight simulation training devices (FSTDs). *FAA 14 CFR 60* (2012) is a reference regarding performance, handling, motion, visual, and sound requirements of simulation devices. As we move into XR technologies as potential replacements, we should consider these requirements, ensuring that we know exactly what will and will not work as potential choices. The key point is that we should never try to force the media choice—it is fully dependent on sound instructional design.

Media Analysis Software/Documentation Sources

In this section, we examine ways that different organizations conduct ISD Media Analysis. We also review case studies that demonstrate gains achieved when using automated software. One of the complaints of traditional ISD is that it is too slow and clumsy, but providing the necessary details to make good decisions can be a laborious process. Spreadsheets have been popular to track granular details; however, managing this amount of data in a spreadsheet can also be overwhelming. The source list below describes some of the research about ISD methods, specifically about media analysis.

- The ASSURE Model, originally developed by Robert Heinich and Michael Molenda in 1999, is an instructional model for planning a lesson and the technology that will enhance it (Smaldino, 2019). The ASSURE model contains six steps: Analyze learners; State objectives; Select instructional methods, media and materials; Utilize media and materials; Require learner participation; and Evaluate and revise.

- Donald Clark's *Blended Learning* article (Clark, 2015) contains a useful Media Selection.

- The SECTIONS Model, developed by A. W. (Tony) Bates (Teaching in a Digital Age, 2015) is a framework for making effective choices regarding media for teaching and learning. This model contains eight interrelated components (Student, Ease of Use, Costs, Teaching Functions, Interaction, Organizational Issues, Networking, and Security and Privacy). Examining each component provides the criteria necessary for making practical media decisions.

- Authors such as Reiser and Gagné, Briggs, Durham, Romiszowski and Kemp, Reynolds and Anderson, and Cone, are a few of the names associated with media selection models. These model formats are presented in flowcharts, matrixes, and worksheets. In general, these models present similar factors to consider when selecting media. These common factors include "the instructional method, type of learning task (subject matter), learner characteristics, practical constraints, teacher preference, physical attributes of media (sensory channels), and physical environment. With so many models and questions to consider, how does one begin to approach such a complex task?" (Reiser & Gagné, 1982).

- ADVISOR Enterprise is a commercial off-the-shelf software tool (Bahlis, 2019). The Training Design module includes robust Media Analysis and Fidelity Analysis features. It automates media analysis using instructional design requirements and constraints to rank recommended media along with a list of requirements that the media under consideration does not meet. ADVISOR forecasts the estimated costs for each option based on users' input and allows the user to compare the costs of various options, calculate the projected ROI, and graphically display the results.

Case Studies

The following case study summaries, provided by BNH Expert Software, Inc., (BNH) demonstrate successes achieved with automated software to perform instructional design and media analysis.

- **Army Land Vehicle Crew Study:** Assessed the viability and financial impact of using XR and Trainers at various training levels [individual to combat team] for Driver, Gunner, Crew, and Troop Commander on LAV III, Closed Combat Vehicle, and Leopard 2. The analysis revealed reductions between 6% and 38% in budget, personnel, and resources for 7 of 12 courses, resulting in total direct and indirect savings of $49.3 million over 10 years.

- **Air Force Technical Training Study:** Assessed the viability of using alternate delivery options for field-ready aircraft technicians. In addition to identifying 140 Common Core hours and 135 Basic Electrical and Electronic training hours, the study revealed that blended, instructor-led, interactive multimedia and XR technology allowed the Air Force to reduce training time for ACS, AVN, AWS, and AVS between 4% and 17%, as well as reduce conversion costs while improving quality.

- **Forces College Study:** Assessed the impact of extending the nine-month instructor-led Command and Staff course from 88 to 390 officers. The study revealed that a blended residential with web-based delivery allowed the College to use existing facilities with minor modifications and, in turn, save $22 million in upfront costs for new school and residence extension, as well as save $6 million in annual recurring costs.

- **Arctic Offshore Patrol Ship Study:** Assessed individual and collective training requirements for various crewmembers. The study revealed that to overcome the limited access to the ship and its systems, a virtual reality model that allowed the crew to explore the ship and interact with various systems onboard would drastically reduce live training requirements.

A NEW APPROACH

Media analysis provides a solid foundation for any XR project and profoundly improves the odds of a healthy ROI. However, there are additional activities to consider that will improve those odds even more. Altering traditional approaches to how we structure contracts and manage projects will benefit any high-risk project and, therefore, should be included in any XR project. XR capabilities provide opportunities to deploy new features that promise to improve the quality of training and delight customers. Without becoming rigid, requirements that outline pathways to unlock these features will benefit the customer and provide a well-documented framework for production teams.

Project Requirements that Evolve with the Technology

Writing project requirements is a difficult task. Make them too rigid and the contractor is too restricted to advise the client on ways to benefit from their expertise. These type of projects will likely produce products that may meet the requirements as written but result in client dissatisfaction. Fixes to the product at this stage will only increase costs. Make the requirements too generic and the contractor will be confused and determined to set new priorities, which are not needed or provide little benefit to the training program.

Requirements should focus on the vision of the product along with features that provide a benefit to the end-user. Consider four key benefits of XR when determining project requirements:

1. XR technology dramatically increases learner interactivity.
2. XR technology can deliver solo, team, and instructor-guided content.
3. Learner interactivity, along with learner attitude, can be tracked, measured, and reported.
4. Knowledge and skill training can be combined and compressed.

These benefits should encourage projects where content is purposefully designed for high-level interactivity in a variety of learning environments. With increased interactivity, we can translate learner experiences into competency and efficiency statements. Using xAPI formatted data, learning experiences are tracked and stored in a Learning Record Store (LRS) at a level of detail not possible under the previous eLearning SCORM models.

Structured interoperable xAPI formatted data allows XR devices to communicate in real time with an LRS to provide adaptive learning branches back to the learner. Detailed data collection enables more accurate descriptive analysis and better enables prescriptive and predictive analysis. As instructional decisions are codified based on data analysis, these decisions can transfer from manual human interaction to automated AI interaction monitored by human instructors. This fundamentally shifts the instructor role away from instructing mundane tasks to a coach dedicated to provide more personalized time to a learner's individual needs.

Agile Production and Management

The need for flexibility when working with XR technology training solutions suggests that rigid management methods will increase costs and error. XR technology brings a level of complexity and risk that can overwhelm traditional management methods. Agile methodologies are better suited to maneuver around a design and production environment where new and complex technology introduces many unknown risks.

Dr. David Rico compared statistics from hundreds of research articles on the ROI of agile management. He concludes, "Agile project management is not just a fancy name for an old idea. It is a better way for managing high-risk, time-sensitive research and development oriented projects. Its lightweight structure leads to better productivity and efficient decision-making, while exceeding the quality characteristics of older paradigms. These alone result in lower costs and faster time-to-market." (Rico, 2010).

Changing our management approach to agile methods may introduce new risks and challenges, but studies have shown that agile methods ROI can exceed traditional methods by over 1,000% with some studies reporting as high as 2,341% difference in ROI gains (Rico, 2009).

The Agile Contract

It is reasonable to assert that if agile management methods are used, then the structure of program contracts should also be agile. Agile contracts provide structure without compromising the benefits of flexibility. They break down projects into smaller periods of performance that better align with agile sprints. They set expectations of increased communication and collaboration between the contractor and client, allowing both parties to benefit.

The guiding principles of an agile contract encourages incentives for both parties. Pay for output rather than effort helps vendors focus on creating good business values. In balance, offering money for nothing provides a fair way to end the contract once the key value has been delivered. The early completion does not penalize the contractor. Accepting changes for free allows program flexibility and enables reasonable scope changes without the stigma of scope creep. Collaboration, transparency, and increased communication through reviews and feedback loops are built in to increase trust and fairness during production. Client meetings are set to align with the contractor release plan and sprint cycles.

The agile contract makes product vision (not the process) the focal point to ensure that the client always gets what they need and expect and that the contractor does not experience cost overruns while remaining flexible during the period of performance. Continuous improvement is planned so that products can be delivered early with ongoing improvement releases that benefit both client and contractor.

Spotlight on Instructional Systems Design

The world of learning is changing fast. In recent years, we have seen the emergence of a host of new technologies that promise dramatic improvement in our ability to deliver learning outcomes. New learning technologies, from mobile to voice assistants, to Virtual, Augmented, and Mixed Realities, have all begun maturing to the point where the learning industry must learn to use them well. We are comfortable in our understanding of how to deliver learning using traditional mediums, however we have a long way to go in our understanding of how we deliver new learning technologies. Moreover, it will be an ongoing effort to keep up with the changes in the technological capabilities.

We now have an unprecedented opportunity to change how training is developed, designed, and delivered. There have been new models of instructional design proposed (ADDEDD and SAM) to take the place of ADDIE (Aquinas Learning, 2018). Regardless of the ISD model, there is an important point to address. We must take additional steps to determine the best technologies and tools needed to achieve our goals. In addition to the new technologies in training media, there are also new technologies that allow for tracking "experiences" a learner encounters along the learning path. xAPI provides a mechanism for tracking at a granular level that we haven't seen before. The new mediums of deployment align with the reporting technologies. In fact, the traditional way of tracking learning may not even be possible with the new technologies. Learning Management Systems (LMS) collecting SCORM data have limited to no ability to collect data from mobile devices, VR headsets, or other sources of training materials not launched from within the LMS domain. Therefore, a new method of tracking the learning events is required for XR content.

As instructional designers, we have to think much more granularly than ever before. Following is a list of questions that ISD teams need to consider:

- What types of "experiences" do we want to track?
- What feedback do we provide to the learners based on the information received?
- What usable key events, "milestones" or core training tasks exist that provide adaptive branching?
- How do we build additional training content into the learning paths to ensure we are catering to the needs of all learners?
- How do we redefine training paths and schedules based on a personalized and adaptive learning path that each individual learner has available?
- How do we integrate data from multiple sources together (LMS, LRS, HRIS, etc.) to provide a holistic evaluation of the learner's performance?
- How do we incorporate lifelong experiences into the decisions regarding recommended learning paths?

CONCLUSION

Advances in XR technologies have been significant over the past few years. While many start-ups that provide XR hardware and software have failed, the dust is beginning to settle again, and a few products such as HoloLens, HTC VIVE, OCULUS, and Sony PlayStation VR remain viable solutions. Strategic deployment of XR technologies at this stage can benefit a training program with significant cost savings and training value and we encourage the training industry to invest in these technologies as recommended by media analysis.

We believe that customers interested in integrating XR technology into their training programs will find the highest ROI in three areas:

XR technology

1. Provides new training to fill an existing training gap.
2. Replaces expensive or ineffective training methods, including higher fidelity training devices.
3. Increases training throughput by reducing dependencies, transferring training tasks from limited devices and/or training staff.

When deploying XR, do not neglect its incredible ability to collect granular data on learner experiences using xAPI. Develop a data collection strategy that allows translation of your data into learner competency and efficiency statements. Your new ability to evaluate program performance compared to program cost as well as compare the long-term performance of different learner groups will increase your ROI even more.

We anticipate that strategic deployment of XR technologies will mirror similar ROI highlighted in our case studies. For large programs, this can equate to millions of dollars in savings. Programs that embrace agile methods into their contracts, management, and production can expect to see significant improvements in productivity, quality, and cost savings over traditional methods. Projects involving new technologies such as XR, where risk is inherently high, using an agile approach, will increase customer satisfaction and product quality, and the expected ROI can average 20:1.

Most importantly, XR technology only provides the opportunity for ROI gains. It is the purposeful media analysis and strategic deployment of that technology that will create these benefits. Improper deployment of XR may have significant negative effects if careful planning and user experience design is not part of the overall investment.

DEFINITIONS

The “working” definitions in this section are here to facilitate a common understanding.

ADDEDD: A new Instructional Systems Design model, intended to improve on ADDIE. This model includes a six-step process: Analyze, Determine, Design, Experience, Develop, and Deploy (Aquinas Learning, 2018). It focuses on agile methodologies to evaluate what is needed quickly, uses rapid prototyping to accelerate the process, and provides constant feedback for improvement.

Augmented Reality: A technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view.

Aviophobia: Fear of flying in an airplane or other aircraft.

Extended Reality: A term referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. It includes representative forms such as augmented reality (AR), augmented virtuality (AV), mixed reality (MR), and virtual reality (VR).

LRS (Learning Record Store): a cloud-based data storage and retrieval system serving as a repository for learning records collected from connected systems where learning activities are conducted (Berking, 2016). It is an essential component when using xAPI.

Mixed Reality: Sometimes referred to as polyplexity (PP), Mixed Reality is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time.

Nondigital Training: Any formal or informal training where the learning content is not in a digital format and the environment does not allow for digital capture of the learner experience; for example, reading a textbook and listening to a lecture.

SAM (Successive Approximation Model): Considered an agile approach to the traditional Instructional Systems Design ADDIE model, it uses only three steps: analyze, design, and develop. It is suitable for efforts with smaller cycle length that provide more opportunities for evaluation and client interaction.

SCORM (Shareable Content Object Reference Model): A collection of standards and specifications for web-based e-learning. The standard defines communications between client-side content and a host system called "the run-time environment," which is commonly supported by a learning management system. SCORM also defines how content may be packaged into a transferable ZIP file called "Package Interchange Format."

Virtual Reality: The computer-generated simulation of a 3D image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.

xAPI (Experience Application Programming Interface): An e-learning software specification that allows learning content and learning systems to speak to each other in a way that records and tracks all types of learning experiences. This enables nearly dynamic tracking of activities from any platform or software system—from traditional Learning Management Systems (LMSs) to mobile devices, simulations, wearables, physical beacons, and more.

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