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Virtual Reality and Digital Twin Technology: The Future of Expatriate Pre-Deployment Training and Assessment

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Abstract

Staffing expatriate (expat) assignments is a high-stakes venture given the complexity and cost of the process, especially when a high degree of cultural distance exists between the home and host countries. Ongoing developments in virtual reality (VR) technology present a unique opportunity for immersive training experiences which can double as a candidate assessment tool for Human Resource (HR) professionals. This paper will address the following items: 1) Introduction/Objective: The main objective of this paper is to examine the current state of virtual reality (VR) training technologies and assess the technology's potential for use in expat pre-deployment training. Additional emphasis will be placed on the integration of digital twin technology to improve the training's accuracy and effectiveness. 2) Methods: This paper will examine academic literature, business publications, and professional social media channels to analyze the opportunities, challenges, and alternative approaches to the use of VR and digital twin technology for immersive expat training. 3) Result: The findings highlighted an increasing use of these technologies across a variety of sectors and provide introductory guidelines for best practices for strategic decision makers. 4) Conclusion: The outcomes of these analyses provide insights for business leaders and HR professionals who hope to improve their expat program outcomes by introducing VR and digital twin technologies into their development and strategic management plans.

Keywords: *Expatriate, Training, Development, Virtual Reality, Extended Reality, Digital Twin, Technology*

1.0 Introduction

The future of learning, training, working, and engaging with others is here! That is the message which is repeated on a daily basis. However, that message is confounded by the vast number of fronts in which progress into the "future" is being made and to which ones learning and development (L&D) professionals should attend. The options seem endless: artificial intelligence (AI), extended reality (XR), podcast format, microlearning, gamification, personalized learning paths, and more. The list goes on. Each of these approaches certainly has its use cases, benefits, and limitations. One use case of

particular interest in today's increasingly globalized world is that of expatriate (expat) training and assessment, for which XR appears to hold immense potential. As such, the aim of this paper is to examine the existing literature regarding the current applications of XR in the workplace and discuss the implications of expanding those applications to expat programs. Since there is limited literature discussing the use of VR as a training and assessment tool for expatriate assignments, the literature review will approach the technology and concepts in a generalized manner and the results and discussion section will explore the application to expatriate assignments.

2.0 Literature Review

Before delving into the existing literature, it is of importance to clarify the terms which will be discussed going forward. Bothwell (2024) defines extended reality (XR) as "an overarching term for a spectrum of technologies that includes augmented reality (AR), mixed reality (MR), and virtual reality (VR)" (p. 4). Virtual reality (VR) will be the main focus of this paper, and can be described as "innovations in hardware, networking, and AI" (Barbour, 2022, p. 20) which "creates an entirely virtual environment" (Caddy, 2023, p. 10) in which the user is fully immersed as opposed to augmented reality (AR), which superimposes information from the digital world over the physical world (Barbour, 2022). All of these technologies fall under the umbrella of immersive technologies, which Bothwell (2024) explains to mean "any technology that integrates the physical environment with digital content to support user engagement…often includes hardware (such as a phone or head-mounted display), software (such as an app or software engine), and user interaction to and from the physical or virtual environment" (p. 4). Finally, this paper will explore the technology of digital twins, which Barbour (2022) defines as "a virtual representation of a physical environment, asset, or process" (p. 22) which can be accessed by the user via immersive technology and which reflects the real world status of the physical "twin." With these definitions in mind, the following subsections will explore the corresponding literature.

2.1 Critical Characteristics of Immersive Technologies

Immersive technologies are classed based on three distinct characteristics: immersion, presence, and interaction. Immersion is the level at which the user is immersed, for lack of a better word, in the digital world over the physical world due to the interaction between the digital environment and the user's senses (Bothwell, 2024). Presence refers to the user's perceptual acceptance of the digital environment as a lived experience rather than compartmentalizing it as a digital experience outside of their true reality (Bothwell, 2024). Interaction is the level at which the user can perform actions within the digital experience and receive feedback from the program (Bothwell, 2024). Perhaps a more representative explanation is that the intersection of these characteristics creates the level of realism within the immersive experience, given that high levels of immersion, presence, and interaction allow the user to lose track of their physical surroundings and begin to perceive the digital world as if it were their reality.

Grodzicka et al. (2023) provide a detailed overview of the spectrum of immersive technologies. In terms of VR, the classification of non-immersive VR would be technology facilitated through a computer-generated environment controlled by a more traditional device, such as a mouse or joystick, in which the user remains completely aware of their physical environment (Grodzicka et al., 2023). A semi-immersive VR experience is one in which the user remains partially conscious of their physical surroundings but is able to engage to a higher degree with the digital environment, e.g., flight simulations (Grodzicka et al., 2023). Finally, a high-immersive VR experience is one in which the user

is fully engaged with the digital world, often losing awareness of their physical environment, e.g., the use of a VR headset (Grodzicka et al., 2023). The significance of creating a high-immersive experience can be seen in reports that increased frame rates and more realistic artwork within the digital experience reduce reports of motion sickness and other contraindications experienced by users (Grondstedt, 2024), with decreased cognitive dissonance between the two realities playing a significant role.

2.2 Virtual Reality

As previously established, VR is typically a fully immersive experience facilitated through the use of a headset and a robust digital environment. There are immense benefits to providing training through this medium, especially given that trainees can train on a range of scenarios with an option to complete them numerous times with a variety of decision paths which, in turn, provides a dynamic and memorable training experience (Barbour, 2022). Studies have shown that the trainees finish the training with a better understanding of the situations and possible outcomes which, paired with heightened engagement, can reduce training time by 40%, improve employee performance by 70%, and achieve up to a 75% training retention rate (Caddy, 2023). Additionally, VR training allows trainees to experience scenarios which are too dangerous, complex, or impossible to recreate, such as an environmental disaster response or a high-stakes medical procedure (Bothwell, 2024; Caddy, 2023). While there is a high initial investment into the hardware and software, the costs in the long-term tend to be much lower than those of traditional training costs for similar training needs given the scalability, reduced resource depletion, and capability to increase training frequency for better reinforcement (Barbour, 2024; Gronstedt, 2024). Furthermore, initial investment costs are decreasing as competition increases within the industry over time (Caddy, 2023).

Although all of the benefits may be appealing, it is critical to consider the technology's limitations. To start, the use cases in which VR training adoption is deemed desirable over traditional, or even less technologically advanced, training methods are limited to situations which are, according to Gronstedt (2024), "expensive to train, dangerous to train, or impossible to visualize." Such use cases include collaborative training for a globally dispersed team, maintenance training for high altitude or offshore machinery and equipment, or managerial training for facilitating difficult conversations or high-stakes negotiations (Caddy, 2023). Another limitation is the fact that not all employees are capable of utilizing the technology, whether that be due to familiarity and comfort levels, side effects, such as motion sickness, or medical exclusions, including seizure disorders, visual impairments, or mobility restrictions that negatively affect the user's ability to utilize the technology (Caddy, 2023; Grodzicka et al., 2023). These issues, among rapid changes in regulation, raise concerns about meeting training compliance requirements while utilizing VR training technology (Grodzicka et al., 2023). It is critical to the success of the training outcomes to ensure that the training need aligns with the benefits of VR training technology in such a way that the benefits outweigh the limitations and costs. If this is the case, then VR training is still limited in that the training should be supplemented with hands-on, real-world training that reinforces the VR training and provides additional opportunities for direct supervision and feedback (Selko, 2022).

2.3 Digital Twins

However, should VR be determined to be a desirable and viable option, it may be advantageous to consider the utilization of digital twin technologies. Digital twins, as outlined above, are digital

equivalents of physical counterparts. The creation of a digital twin relies on a variety of data sources, including historical data, digital streams (e.g., camera footage), external data (e.g., business cycle, supplier information), computer-aided drawings, and blueprints, which is processed by AI to create an AI-enabled digital twin model (Thomas et al., 2020). The resulting replica can be used in VR training to run simulations as they would occur within the exact processes, operations, and physical locations (Barbour, 2022; Hegy, 2018). Digital twins can compound many of the benefits of VR training, especially when the training need involves remote locations or complex operations (Barbour, 2022) and can be rendered on devices along the spectrum of immersive technologies, from a traditional desktop to a fully immersive VR, although actual capabilities and use cases may vary depending on the rendering device (Thomas et al., 2018).

According to O'Driscoll (2024), another capability of digital twin technology is the ability to create a digital twin of an actual person, which can then provide guidance, coaching, and feedback founded in that individual's perspective, knowledge base, and experiences. The creation of such a digital twin "expert" relies on a similar bounding technique that requires the input of the individual's historical data in the form of outputs, such as papers published, blogs, podcasts, lectures, and presentations, to name a few (O'Driscoll, 2024). This digital twin "expert" can then be enabled with AI to interact with others through processes similar to those of other Generative Pre-Trained Transformers, one such example being Chat-GPT (O'Driscoll, 2024). Such technology could add an additional layer of benefits to the investment into immersive training technologies.

At this point, it is imperative that the major concerns of immersive technologies be presented. The most cited concerns, as outlined by Bothwell (2024), include cybersecurity and privacy risks; excessive costs to maintain the technology given rapid technological advancements rendering current investments obsolete, the need for trainer and trainee training to smooth learning curves, and the reliance on specialized hardware, software, and data centers for continued operations. The technology requires high initial investment, especially in terms of accessing the skills and expertise to build the digital twin, which may be prohibitive to the majority of organizations, as some companies may not be in a position to high external trainers or purchase additional software, let alone fund digital twin technologies. The preceding literature review highlights the complexities of emerging training technologies and the ongoing need for critical analysis to align L&D strategies with those of the organization and the actual training needs.

3.0 Data and Methodology

The authors of this paper utilized a review methodology, performed through the examination of existing academic literature, business publications, and professional social media channels. Additionally, one of the authors currently teaches AI courses in several leading Master of Business Administration (MBA) programs and was able to provide an extra layer of insight into the exponential growth of related literature and use cases for such technologies, as well as the urgent need for instructors to embrace these technologies to keep their courses current and remain competitive as educators. The resulting analysis of the current body of literature surrounding VR and digital twin technology was then employed to facilitate the discussion of the potential use case of the technology as an immersive assessment and training tool for staffing expat assignments.

4.0 Results and Discussion

The process of recruitment, assessment, selection, and training of candidates for expat assignments is both a high stake and a complex undertaking. According to reports by Haile & White (2019), the average cost of a failed expat assignment, whether that be from poor performance outcomes or a request for early repatriation, is estimated to be between $40,000 and $1,000,000. Repeated assignment failures would compound those costs and may risk the venture in its entirety. Earlier research into this topic by Barrett & Miller (2024) found that, beyond the knowledge, skills, and abilities (KSAs) necessary to achieve the assignment's objectives, other key indicators of candidate success within an expat assignment include the candidate's "orientation towards international mobility, cultural intelligence (CQ) levels, and predicted ease of cross-cultural adjustment (CCA)." Each of these elements is mitigated by the candidate's level of cultural distance relative to the local culture in which they will operate, especially in terms of misalignment in values, convictions, needs, and preferences, as well as the candidate's perspective, knowledge, and expectations of the host culture, local business etiquette, laws, and current events (Barrett & Miller, 2024). There are a slew of assessments which can be used to determine the candidate's fit for the assignment, but the existing literature, for example, Grensing-Pophal, 2024; Gurchiek, 2016; Reddiar & Schultz, 2023; Salgado & Bastida, 2017, places emphasis on the importance of providing full disclosure of the realities of life within the local culture to both the candidate and their accompanying family, with further consideration recommended for an exploratory visit to the host country as an additional measure against culture shock, poor assignment fit, and requests for early repatriation.

4.1 Virtual Reality Applied to Expatriate Assignments

The suggested use cases for VR training included training that is expensive, dangerous, or impossible to visualize (Gronstedt, 2024). Candidate assessment and training for expat positions falls under these categories given the prohibitive expenses and potential safety and operational risks of performing exploratory visits and on-site training with each potential candidate and any accompanying family members prior to deployment. With VR technology, the host country can be brought to the candidate by way of an immersive digital environment, which may or may not include digital twins to replicate the processes, operations, and facilities of the assignment. Some specific training use cases may include scenario training for situational awareness while traveling, navigating high stakes negotiations with local business partners, decision-making under uncertainty or in ethical dilemmas pertinent to the position and host country, and virtually "in situ" procedural or operational training to achieve the assignment objectives. The candidate can also be assessed within the digital environment on their existing knowledge of the host culture, language, and local business etiquette in a way which is nearly impossible with traditional training methods. Beyond assessing the candidate's current KSAs, this approach can easily facilitate the creation of a training profile and needs assessment for the candidate.

In terms of assessing candidate performance and assisting in the creation of training plans, VR technology can automatically capture data that informs the overarching assessment, including nonverbal communication and decision paths, which can be fed directly into the learning management system and used as both an assessment for candidate competencies and as a baseline for personalized training going forward (Sanchez et al., 2022). Given that VR is a collaborative tool, trainers can enter the virtual environment with the trainees to observe their progress and provide immediate feedback, as well (Bothwell, 2024). The collaborative nature of VR may also facilitate meetings and interactions

between the candidate and the host location's team members to build working relationships prior to departure and to assess the candidate's fit amongst the team. Alternatively, the candidate and trainer can choose to meet with a local expert who can provide guidance and insights directly to the trainer/trainee team. These are only a few of the possible use cases with VR in expat assignment preparations.

Use of VR assessments and training may assist in the selection process in unexpected ways. A study performed by Sanchez et al. (2022) to assess the validity of VR as an assessment tool reported that their results were likely skewed due to participant attrition in response to a height aversion VR assessment session that asked them to balance on a plank in the physical environment while performing tasks in a digital environment at high altitudes. Sanchez et al. (2022) explained that the participants who left the study were more likely to have had aversion to heights, leading to the observation that experiences in the digital environment may cause similar emotional and visceral reactions to those experienced in the physical environment. Utilizing VR to allow candidates to experience the realities of the host location can be reasonably assumed to be a powerful tool for assessment and candidate self-selection if the outcome is the voluntary withdrawal of the candidate from the recruitment and selection process. This unexpected outcome can save the HR department valuable time and resources when staffing an expat position.

4.2 Key Considerations and Viable Alternatives

However, it is critical that the circumstances surrounding the training be taken into consideration prior to settling on VR as the medium for training delivery. Concerns related to trainee familiarity and comfort with the technology have already been discussed in the literature review and remain a top concern in the scope of expat assignments, along with cybersecurity, privacy requirements, and prohibitive costs. Another concern specific to international business and VR training is the concept of the virtuality trap in which the organization comes to rely on virtual channels and interactions as the main source of information on the target location (Kshetri & Dwivedi, 2024). This is a mistake which can reduce the robustness of the training and result in ineffective, outdated, or misinformed training. Depending on the host location, the necessary infrastructure required for ongoing VR collaboration and post-deployment training may not exist. In the long term, such a situation would drastically decrease the ROI of investment in VR training.

One viable alternative to VR training is augmented reality (AR) training technology. It is a less immersive experience and thus does not achieve the same benefits as a VR training experience. With that being said, AR is multimodal and can be displayed on a wider variety of devices. One common example of AR is the game "Pokémon GO" in which digital elements of the game are layered over the physical elements, although filters, such as those on Snapchat or Instagram, and videocall backgrounds, such as those on Zoom and Facebook Messenger, are also adequate examples. In terms of training, AR allows the trainee to access digital information, such as instructions, diagrams, explanations, and warnings, about the elements with which they interact in the physical environment (Caddy, 2023; Hegy, 2018). This technology is especially useful when the trainee is encountering new or challenging situations or attempting to troubleshoot complex problems (Hegy, 2018). Since AR also has a collaborative element, the trainer or a remote expert has the ability to connect with the trainee, see the physical element in question, and provide personalized guidance and feedback, should the situation call for such an intervention (Hegy, 2018). AR is a dynamic alternative to VR and tends to be more cost

effective in terms of initial investment, development, and maintenance, thus more accessible for organizations who may not have the budget or the need to invest into a highly immersive VR training experience (Selko, 2022). Given that the technology is less advanced than VR, it may also be the perfect alternative for host locations with technological, infrastructural, or budgetary constraints.

4.3 Calculating Return on Investment

The expected ROI is an essential metric to gaining support from upper management and accessing resources to implement VR training. Given the importance of the training program's ROI, it has been deemed suitable to provide some guidance on how to best calculate the expected ROI. According to Gronstedt (2024) a suggested return on investment (ROI) for assessing the use of VR training can be calculated using the following formula:

$$" \text{ROI} = \frac{\text{Cost Savings} + \text{Training Impact}}{\text{Investment}} "$$

- *Cost savings*: resources saved, i.e., travel time and costs, venue and trainer expenses, and the reduction in consumables spent during training
- *Training impact*: deliverables such as training outcomes, performance improvements, employee engagement, and safety improvements
- *Investment*: training development costs, labor hours, equipment, and other relevant investment costs.

As can be seen, achieving a greater ROI requires careful consideration of the "why" behind implementing the technology. The use case suggestions for expensive to train, dangerous to train, and impossible to visualize (Gronstedt, 2024) are those which carry enough cost savings and training impact to offset the investment costs. It is rational to place expat assessment and training within these categories for the reasons listed above: savings on travel expenses, internal resources (especially HR labor hours) saved with candidate self-selection, improved understanding of the host location, ability to build relationships prior to deployment, better training performance tracking and personalization capabilities, and more. All of these outcomes are expected to reduce assignment failure rates, which can result in an average cost savings of up to $1,000,000 per placement. If the organization is able to overcome the concerns and contraindications outlined throughout this paper, the use case and ROI potential is boundless as the technology continuously improves in quality and capabilities. The use cases presented throughout this paper highlight the variety of industries in which the technology is being utilized, namely, within the medical field, emergency and natural disaster response teams, high-risk maintenance tasks, and management of remote teams, although numerous other industries are adopting and utilizing the technology, including the academic, manufacturing, transportation, defense, and tourism industries (Bothwell, 2024; Kshetri & Dwivedi, 2024).

5.0 Conclusion

Extended reality (XR) encompasses virtual reality (VR), augmented reality (AR), and mixed reality (MR). The technology, although already quite advanced, continues to evolve at a rapid pace. XR tools are becoming increasingly common as a training technology across a variety of industries, and with good reason. Studies have shown that the improvements in training outcomes are well worth the

investment if the use case is compatible with the technology's capabilities. There is a growing interest in exploring the potential use case of XR applied to expatriate assessment and pre-deployment training. This enthusiasm is particularly geared towards the applications of VR, as a highly immersive technology that has the potential to transport the candidate to the host location to spend time "living" the realities of the assignment. Through such an experience, the HR department will have better insights into the "fit" between the candidate and the assignment, as well as the candidate's preparedness for such a high impact undertaking. The future of learning, training, working, and engaging with others, without a doubt, is here.

While the promise of innovative technologies is exhilarating, consideration must be given to the ways in which the technology is implemented. This is especially true given the context of the expat assignment application. Studies have shown that the digital environment can easily elicit emotional and visceral reactions similar to the ones experienced in the physical environment (Sanchez et al., 2022). It is with this in mind that L&D professionals must approach the VR use case of transporting the candidate to the host location. The focus must remain on providing educational and informational value to facilitate quality decision-making rather than aiming for shock value to maximize the candidate's reactions. Moreover, it would be beneficial for the L&D team to consider planning a pre-training tutorial session with the equipment to ensure that the candidate's experience, and the subsequent assessment, are as fair as possible. Some candidates will be more or less accustomed to the equipment, as well as to gamification as a whole, and may have additional confounding factors at play, such as test or interview anxiety. To build upon the topic of fairness and equity, L&D professionals are strongly encouraged to maintain multiple valid assessment techniques, keeping in mind that there are excluding medical conditions and VR side effects which may render the candidates unable to engage with the technology. The legality and regulatory compliance of these technologies must also be ensured across all global locations, as laws may change drastically from location to location.

As this technology continues to grow and evolve, there are a number of future research opportunities. Across the scope of XR, there exists a need for research into ensuring equitable training and advancement opportunities for those who are unable or unwilling to utilize the technology, with a potential future research implication being the beta testing and contingency planning for such occasions. The scope of this paper was limited to pre-deployment assessment and training for expat assignments, but over the course of researching this topic, it became evident that research on the intersection of XR and expatriate training is lacking, and additional opportunities exist in researching the use cases of XR during deployment and after repatriation.

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