SimLEARN

Excellence in Veterans' Healthcare

EHT

VIRTUAL REALITY TRAINING ANALYTICS AND ITS AI-ENHANCED FUTURE STATE

CLIN 0011

Monthly Report of EHT Opportunities 6.3

FEB 2021

LETTER FROM THE EDITOR

Dear Readers,

What a great time to be alive! I'm forever proud of the bold work and outcomes produced by the Office of Health Innovation and Learning (OHIL), its innovators, industry partners, and the Veterans we serve.

SimLEARN's Emerging Health Technology Initiatives (EHTI) Portfolio provides differentiated value as the only innovation portfolio at VHA focused on the integration of emerging health-care technology (EHT) into clinical care through (1) informing EHT training curriculum and resources and (2) conducting simulation and workflow analysis of EHT to optimize adoption.

In the December 2020 quarterly EHT opportunities report we explored "Virtual Reality: Training for the Real World," which provided a high-level overview that defined VR, explained the benefits of training in VR, and showed how VR is being used in clinical health training to support surgeons, providers, and patients to enhance education, democratize access, and improve patient outcomes.

The January 2021 monthly EHT opportunities report unraveled into "Data Capture: Tracking All Things VR," and provided a general overview of the metrics that can be collected by VR application software, VR base hardware, and additional equipment that provides body/object tracking and biometrics.

I'm delighted to present the February 2021 EHT opportunities report to you, "Virtual Reality Training Analytics and its AI-Enhanced Future State."

Sincerely,

Brian K. Stevenson
Brian.Stevenson@va.gov
Associate Director of EHTI, SimLEARN
Gulf War Veteran, USN

Table of Contents

EXECUTIVE SUMMARY

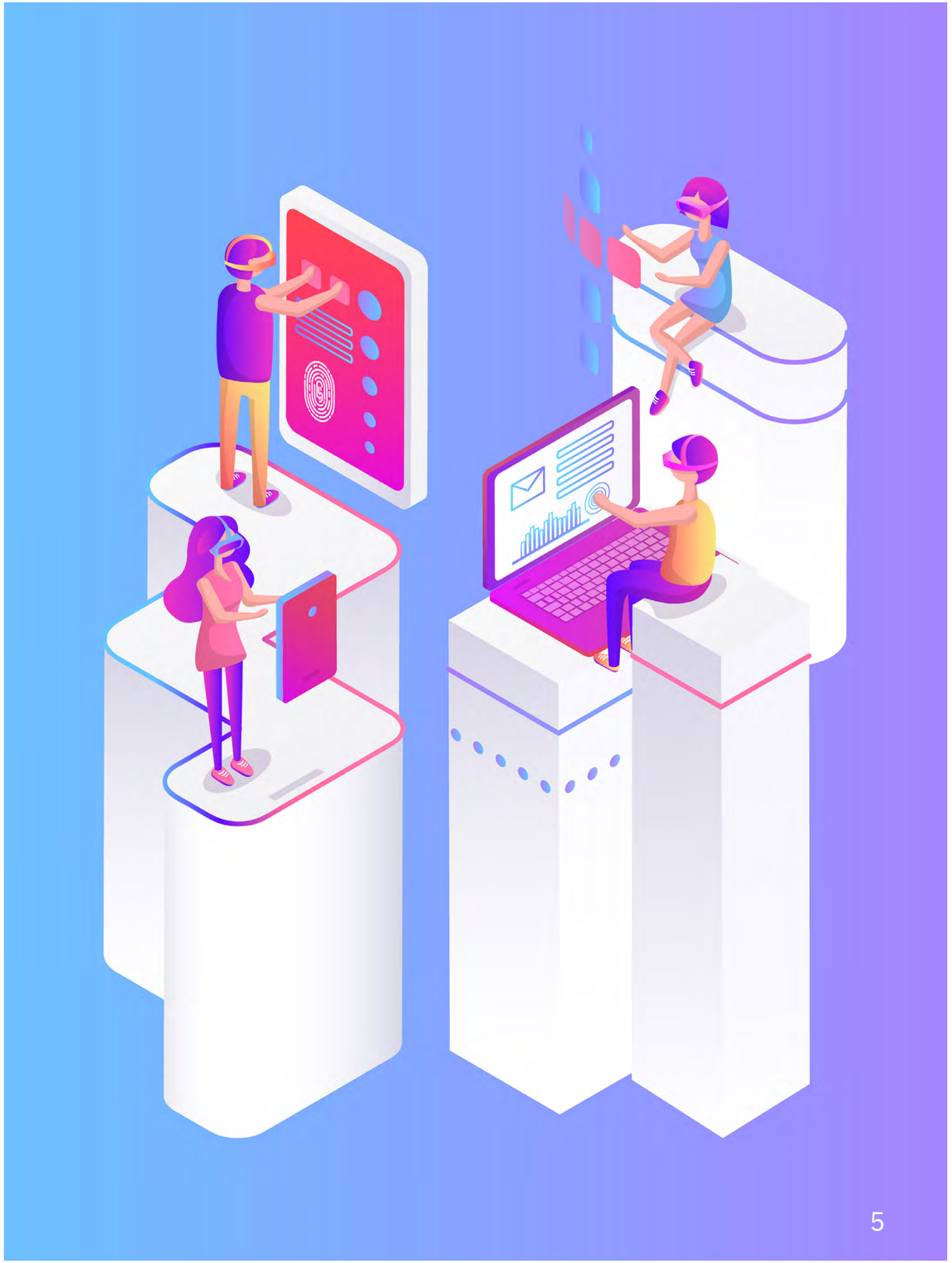
Virtual reality (VR) and artificial intelligence (AI) are emerging technologies that will transform training because their convergence will offer greater personalization, automation, and value.

A VR experience mimics real-life, multi-sensory environments that elicit a user's natural responses to stimuli. AI can "think" like humans in recognizing patterns, processing information, drawing conclusions, and making recommendation. Separately and together, VR and AI have the capability to generate, capture, and consume volumes of data.

Within the noise of this collection of metrics, an analytics platform can identify and decipher the signals that provide actionable insights. With AI, training applications can be enhanced with models and programs of various complexity that can "learn" and enable dynamic adaptation, "smart" non-player characters, and predictive analytics.

This heightened level of interaction and engagement for training is relevant for industries like health care and public safety, where accuracy and effectiveness are paramount in life and death situations.

As VR training, VR analytics, and AI-enhanced VR training are focused on a workforce's human performance – which directly affects the business elements of time, money, and efficiency, we encourage you to explore today's solutions and those coming in the very near future.



VIRTUAL REALITY: TRAINING FOR THE REAL WORLD

Virtual reality (VR) is not just for gaming; VR has made the leap to directly addressing the next generation of training needs.

This advancement is especially relevant in the age of COVID-19. The long-term impact of the pandemic has resulted in an increasingly remote workforce that continues to require development and maintenance of a strong and reliable skills base.

VR training experiences tap into the synchrony of the brain and integrate these key concepts to fully engage the user.

- Presence
- Embodied Cognition
- Controlled Environment
- Simulation-Based
- Active Learning and Feedback
- Reduced Cognitive Load

This immersive learning recreates real-world scenarios and their challenges, allowing users to learn by doing. This is where VR has a significant advantage over traditional onsite and online learning.

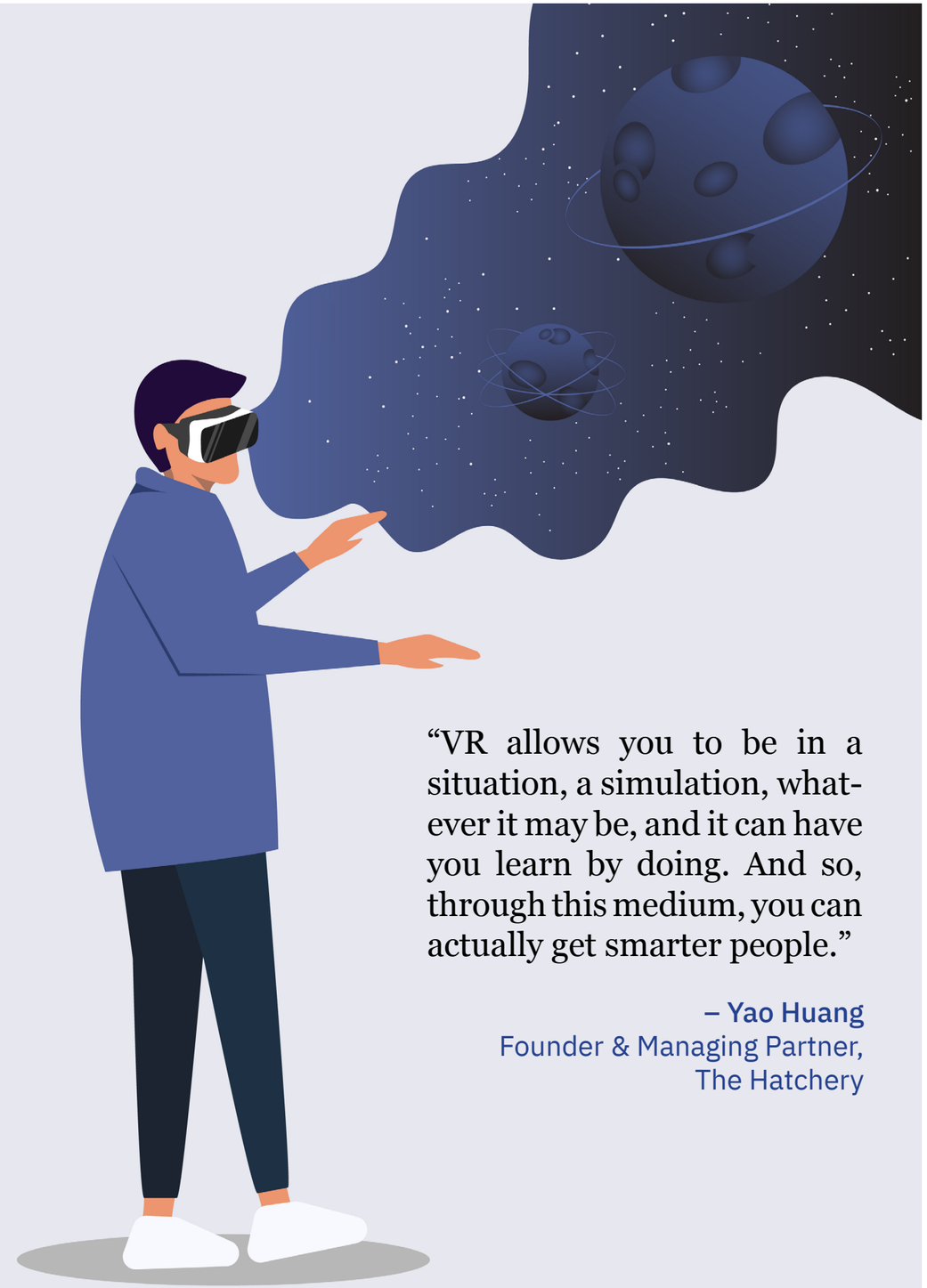
Users are also self-directed in a risk-free environment and have unlimited opportunities to reenact a precise set of circumstances and explore the consequences of different actions.

It becomes clear why VR training is an attractive proposition for replicating dangerous work, where high-risk skills can be learned safely. It is also a powerful tool for highly technical professions, such as surgeons, where crucial practice is important. VR training allows mistakes to be made and remediated without cost to life.

As for its effectiveness, according to a recent PwC report, users were four times faster to train in VR and 3.75 times more emotionally connected to content than in the classroom. In their survey, users were 275% more confident to apply skills learned after training and four times more focused than their e-learning peers.

VR training offers a deeper learning experience, increases retention, and promotes critical thinking.

For more information on this topic, please refer to EHTI's December 2020 Quarterly Report, "Virtual Reality Training in Clinical Health."



"VR allows you to be in a situation, a simulation, whatever it may be, and it can have you learn by doing. And so, through this medium, you can actually get smarter people."

– Yao Huang
Founder & Managing Partner,
The Hatchery

DATA CAPTURE: TRACKING ALL THINGS IN VR

VR training enables "learning by doing" for users through VR application software, VR base hardware, and if any, additional equipment providing body/object tracking and biometrics.

Each of these components can capture user data continuously and accurately throughout a session. The volume, types, and level of detail generated and collected from the user closely reflect their real-world responses.

Every hand gesture, eye movement, interaction, and response can be recorded and then analyzed to determine a user's successes and blockers. The findings can also inform a revision of current programs and development of new ones.

Significant metrics that can be collected during VR training include:

METRIC	DESCRIPTION
Play State	• Measure progress, tries, completions, and replays • Can indicate areas of improvement
Decision Making	• Gather key decision points • Analyze thought process and preferences
Voice Recognition and Analysis	• Track verbal interactions with interactive components • Record spontaneous utterances during training
Body Position and Movement	• Assess proper physical achievement • Evaluate user's communication, interactions, behavior, and body language
Eye Tracking	• Identify location and duration of gaze and fixation • Can inform moments of focus or distraction • Need to be supplemented with user interviews
Biometric Feedback	• Monitor heart rate, energy use, and brain activity • Describe stress levels during training moments

VR training data capture far surpasses what can be tracked and documented from traditional observation and assessment, resulting in a unique and robust starting point for analysis.

For more information on this topic, please refer to EHTI's January 2021 Monthly Report, "Capturing Human Data Stream Outputs with Virtual Reality."

VR TRAINING ANALYTICS: DATA IN; INSIGHTS OUT

Once user data is collected from VR training experiences and related equipment, the power of analytics is required to unify the various sources and derive meaning from them.

Whether hard-coding or integrating a third-party platform into a VR application, the best way to describe VR training analytics and how it can help with understanding user behavior, iterating training, and identifying areas of learning improvement is to look at a real solution.

Featured Application: Cognitive3D

Cognitive3D is a Canadian company that captures human interactions through VR and other immersive experiences and then records, aggregates, and analyzes the data through its analytics platform.

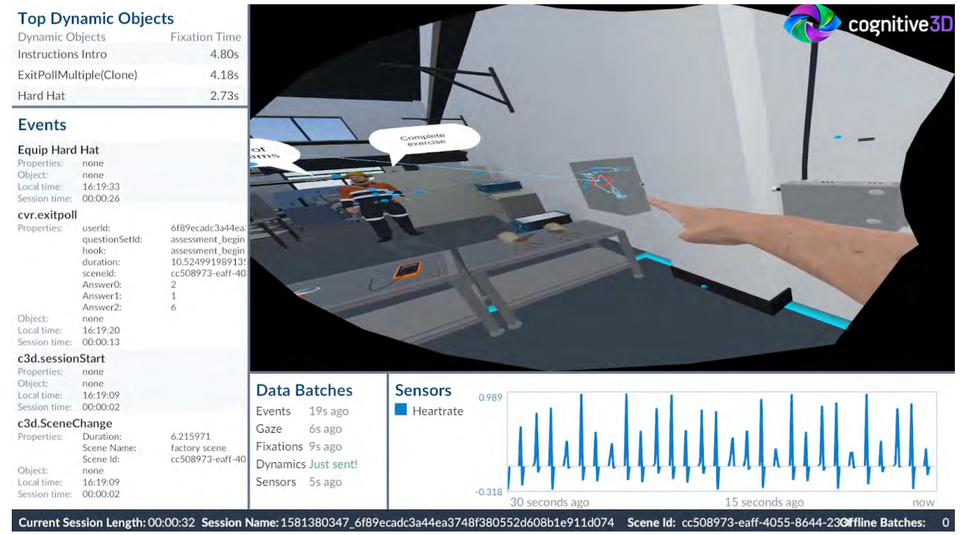
Working with clients who have started developing their training experiences, Cognitive3D supports them by assessing actual tasks to be done, determining how to efficiently measure them, and licensing assessment tools that can be integrated into the VR application.

Their platform can record all interactions from VR experiences, such as positional data, use of hands, eye movements, and biometric sensor readings. It then combines it all into a 3D-based visualization that can indicate exactly what happened when, where, and how.

Let's focus on the Scene Explorer and the Objectives System features.

SceneExplorer provides a one-to-one 3D replay of a session where all events are tagged on a timeline and in 3D space. This precise capture allows instructors and managers to conduct an After Action Review (AAR) for training or research anytime and anywhere.

SceneExplorer enables seeing events from multiple perspectives, monitoring interactions, and tracking paths – all of which offer a more holistic evaluation of human performance and a better understanding of how user behavior changes over time or session after session.



Images: Cognitive3D

Featured Application: Cognitive3D (continued)

Objectives System helps directly measure results from the VR experience. Completion can be qualified and user actions can be broken down based on sequential or non-sequential steps. The visualization can identify pain points and bottlenecks (see below).

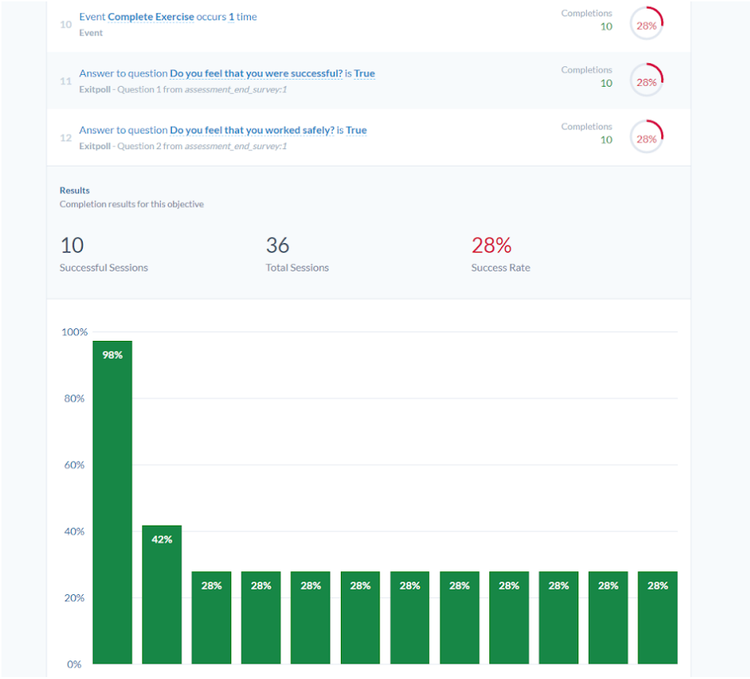
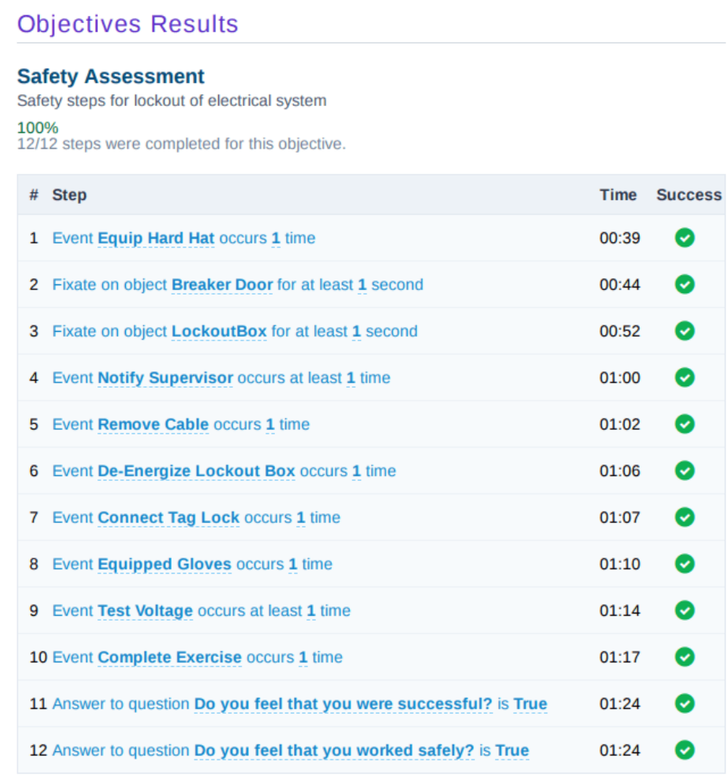


Image: Cognitive3D

"Cognitive3D's vision is to enhance human performance and measurement through the use of immersive technologies. We strive to help enterprises get actionable insights from VR by making sense of the data they collect."

- Tony Bevilacqua
Founder & CEO, Cognitive3D

Also, with a few clicks, instructors and managers can define the steps required for users to be successful.



Objectives Results

Safety Assessment
Safety steps for lockout of electrical system
100%
12/12 steps were completed for this objective.

#	Step	Time	Success
1	Event **Equip Hard Hat** occurs **1** time	00:39	✓
2	Fixate on object **Breaker Door** for at least **1** second	00:44	✓
3	Fixate on object **LockoutBox** for at least **1** second	00:52	✓
4	Event **Notify Supervisor** occurs at least **1** time	01:00	✓
5	Event **Remove Cable** occurs **1** time	01:02	✓
6	Event **De-Energize Lockout Box** occurs **1** time	01:06	✓
7	Event **Connect Tag Lock** occurs **1** time	01:07	✓
8	Event **Equipped Gloves** occurs **1** time	01:10	✓
9	Event **Test Voltage** occurs at least **1** time	01:14	✓
10	Event **Complete Exercise** occurs **1** time	01:17	✓
11	Answer to question **Do you feel that you were successful?** is **True**	01:24	✓
12	Answer to question **Do you feel that you worked safely?** is **True**	01:24	✓

Image: Cognitive3D

If a user's behaviors don't match expectations or fail to comprehend a particular scenario, the Objectives Systems allows after-action changes. Data can then be reassessed off different criteria. The reinforced feedback loop results in continual improvements for users and the VR training program.

DATA CAPTURE REVISITED:
VR MEETS ARTIFICIAL INTELLIGENCE

Until now, we explored how data capture from VR training can run through an analytics platform for insights on a user's operational performance and physiological state. The diagram on page 15 illustrates this concept in the dotted black box.

From this point, we will look at how data capture from VR training can also be enhanced by artificial intelligence (AI) to both improve the simulations and personalize the training. The diagram on page 15 illustrates this concept in the blue circles

Resulting from major advances in computing, VR and other immersive realities will converge with AI and create exponential change in the mainstream for both technologies.

"Training data is really the basis for AI. At the end of the day, machines need to learn how to speak, see, and hear. And they do so much like a human learns how to speak, see, and hear."

- Wendy Gonzalez
President and CEO, Samasource

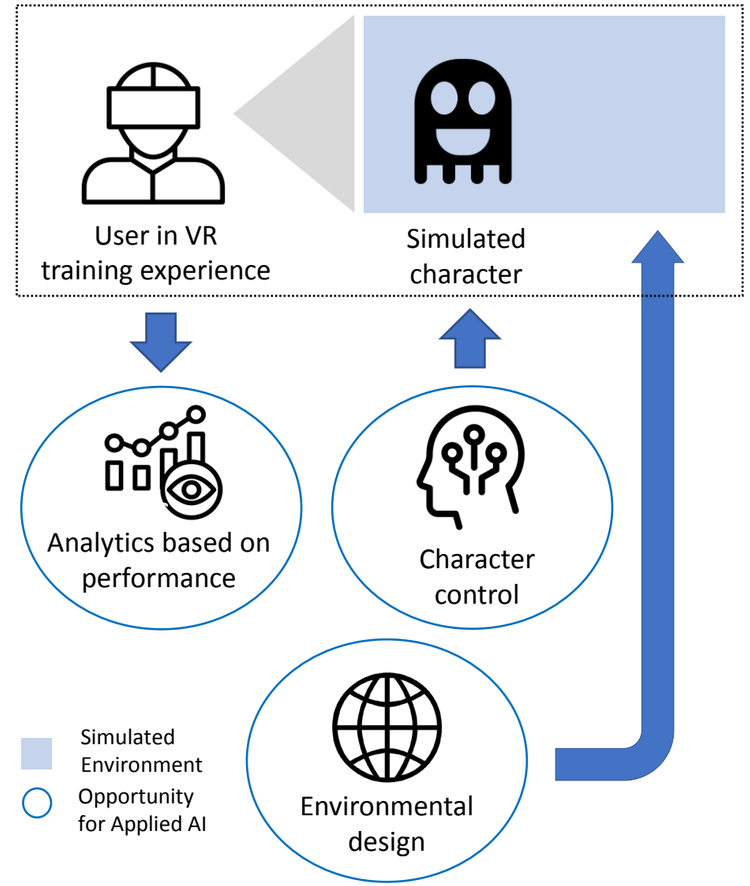


Image: Booz Allen Hamilton

VR HARDWARE TRACKERS

VR can create a simulated environment which can be interacted by a user for entertainment or serious games that promote learning, readiness, and behavior change.

AI is a machine or program that can perform and augment tasks, better inform decisions, and accomplish objectives that have traditionally required human intelligence, such as planning, reasoning from partial or uncertain information, and understanding.

AI-driven processes already exist on many platforms, especially smart phones. AI algorithms “learn” from the habits and tastes of users through data sets, which are transformed into suggestions through their applications – whether it be music or news feeds.

Just like in smart phones, AI can “learn” from new data streams captured in VR. Together, VR developed with AI can capitalize on this capability and revolutionize the entire learning lifecycle.

THE NEXT FRONTIER: AI-ENHANCED VR TRAINING

As one of the key factors driving the explosion and adoption of VR training, AI can improve a user's experience in the simulated environment as well as enhance the simulated environment itself.

Some existing and anticipated benefits offered by AI include:

BENEFITS	EXPLANATION
Dynamic Adaptation	• Analyze data from user as well as environment • Provide real-time and post-experience feedback
"Smart" Non-Player Characters	• Engage user with more sophisticated intelligence • Improve realism when interacting with others
Predictive Analytics	• Assess user behavior against skill mapping • Evaluate how performance in VR applies to real life
Faster Development	• Auto-create variations in background environment • No longer write out each permutation in code
Modeling and Visualization	• Auto-create variations in background environment • No longer write out each permutation in code
Data Mining	• Identify plausible values from real-world data • Recreate expected and worst-case scenarios

In this section, we will explore how VR training data relates to:

- Dynamic Adaptation
- "Smart" Non-Player Characters
- Predictive Analytics

"AI combined with virtual reality is a strong combination that can be used as a tool for educating the next generation of pilots, surgeons, among others. [It] has the ability to improve simulated training by incorporating more data points, comparing as well as contrasting different techniques, and by personalizing the education."

- Magnimind Academy

DYNAMIC ADAPTATION

Most VR training applications are serious games that rely on traditional game development and design patterns and thus, are coded with models or programs.

The simplest is a rules-based software usually centered around “if-then” statements, whereas programs that can alter themselves vary in their degrees of ”learning” capabilities. The “if-then” structure can be enhanced with basic AI that can increase the possible outcomes from predefined “rule” values as it learns and adapts to user input.

Differentiated from rule-based adjustment, advanced AI can make the VR experience dynamically adapt to human skill levels by calibrating the difficulty autonomously while providing meaningful training. This frees the game designer from having to set parameters of what can change because the program itself will learn and decide on its own.

So, how VR training data capture is used in an application depends on the AI models. For example, user data can be used to modify a VR experience to achieve training goals and subsequently improve the user experience too. AI can be used against data collected by the VR application software to provide better feedback.

In this case, real-time data can be captured from a game engine, including what the user is looking at, response time, target accuracy, and so on. With this data, the experience itself would train an AI model to provide real-time feedback to the user while in the experience and further enhance it. A first responder use case may include a user being alerted that the angle of the hose in their hands needs to be adjusted.

When these capabilities mature, it is possible that tailored learning sessions can be created to be ever-changing with every attempt eliciting the responses of a novice player.

“SMART” NON-PLAYER CHARACTERS

When training in VR, you may interact with non-player characters (NPC). In general, an NPC is a character in a game which is not controlled by a player. With a “smart” NPC, the NPC is controlled by the game’s AI.

As noted earlier, VR applications follow game development and design, where AI control may use a complex series of “if-then” statements in which AI decisions will move through a flowchart that determines the matrix and conforms to a rigid set of rules in the code. The diagram on page 23 depicts a basic “if-then” example.

While this is a logical way of behaving, it is superficial in that it is unlike human intelligence and often too predictable. So, to train in a realistic manner, it is necessary to model real-world behavior using AI algorithms that shape behavior dynamically based on reactions and learning.

Advances in AI will create “smart” NPCs, improving realism when compared to the past as NPC actions had to be preprogrammed as reactions to predicted user behaviors. Complex algorithmic character controls that learn from user input can be done with sophisticated AI techniques. This allows NPCs to behave in less predictive, more human-like ways.

For instance, in case-by-case scenarios like a natural disaster or medical triage, the increased NPC interactivity will enhance the quality of engagement and users will end their training feeling like they truly experienced the uncertain immediacies of the incident.

With realistic NPCs, the user’s interactions and performance become even more accurate and specific to how they could likely act in real life and that is reflected in the data capture and analytics.

Looking ahead, the pinnacle would be a true AI-powered NPC that could change, grow, and react as a human would in the real world yet do so in the virtual one.

Another possibility is having a ”smart agent” tailored to the user who shadows the user, dynamically assessing training efficacy and administering guidance on where they should spend extra time to ensure mastery of content. Eventually, this “smart agent” would be a training partner customized to the user.

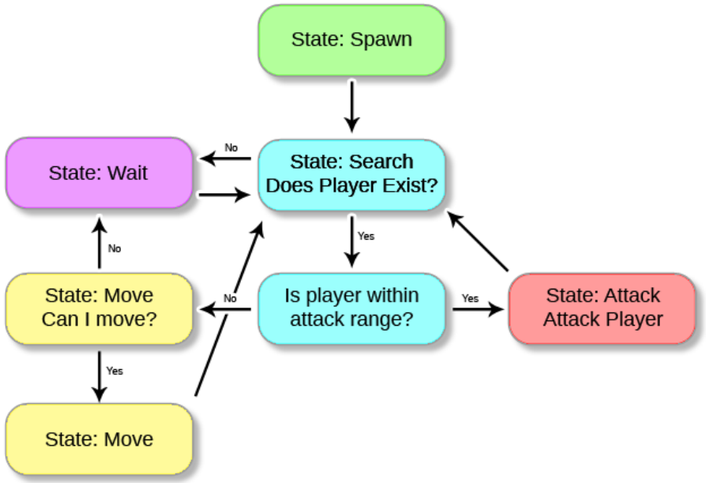


Image: u/PixelatedPope via Reddit

Image: Health Scholars

PREDICTIVE ANALYTICS

With user data captured in VR, predictive analytics can be run to extract insights and understand their true impact.

Predictive analytics includes performance and engagement data mapped to real-world data to create an AI-based predictive model from which you can precisely understand how interactions and behavior in the VR training will play out in actual circumstances.

The accuracy of the AI-based predictive model depends on the strength of the underlying relationship between the data and there needs to be enough data from the right users to ensure good values.

> "Today, immersive predictive analytics are in their infancy because most companies are not yet measuring data on employees' real-world performance. [As] more companies begin collecting real-world performance data at the employee level, this will allow better and more precise predictive models to be developed. Ultimately, immersive training can be used as a way to assess the workforce and immediately understand the type of real-world impact they will have."
>
> – STRIVR

USE CASE: CANDIDATE ASSESSMENT, STRIVR & WALMART

STRIVR is a California-based company that specializes in end-to-end immersive learning solutions that help enterprises implement engaging, effective, and impactful VR training at scale.

One of their recent achievements is reimagining the candidate assessment for new hires or existing employees transitioning within the company. Instead of answering questions related to imaginary scenarios, candidates will be able to put on a VR headset that they received onsite or via mail and show off their skills in realistic simulations that mimic what they will face on the job.

STRIVR's partnership with Walmart started in 2016, and since then, Walmart Academies have VR training covering everyday situations, like managing produce, to the rare, like Black Friday madness. They also have a skill management assessment for mid-level positions.

In VR, the Walmart candidates are placed in real-life situations, such as calming an angry shopper or giving new employees a store tour, that test their knowledge of store departments, decision-making, leadership capacities, and soft skills.

Behavioral data, such as verbal data (e.g., keyword and speech pattern) and nonverbal data (e.g., eye contact and gesturing), is being captured as well as decision and attention metrics, including how they prioritized different tasks and communicated with others

This VR assessment provides a powerful predictive analytics model that can clarify the relationship between a candidate's performance in VR and real life.

The findings are an information-rich data point that supplement traditional evaluations, but also offer virtually replicated and standardized sessions for hundreds of employees that eliminate bias and place candidates in positions that best fit their skill sets.

"We use VR to assess their listening and problem-solving skills to see if, for example, they're a good fit for a team leader role. It's just one data point, but what we're seeing is that VR can make the same, if not better, predictions for who will succeed in a role than a human."

– Heather Durtschi
Sr. Director
Content Design Development, Walmart

EXPONENTIAL IMPACT:
VR & AI FOR HEALTH CARE TRAINING

By bringing VR to heath care training, practitioners will learn new skills with effectiveness and about their behavior in detail. From gaining technical skills for surgery to learning empathy for the elderly, VR can also help prepare them for the emotional and physical trauma that may arise from the nature of their profession.

These VR experiences track and collect a wealth of data that then propels a data-driven practice by incorporating objective and automated data analysis. With analytics platforms and AI bringing more immersion and return on investment, VR will raise the bar for setting more accurate goals, achieving performance standards, and predicting operational readiness.

These capabilities benefit individuals as well as organizations. For example, a surgeon can follow a standardized protocol, yet their actual execution may involve reordering steps or extra actions unique to that person. Replicating their task flow so other surgeons learn and perfect it can be done with VR, as can creating AI models with other surgeons' captured patterns and performance data to generate new training simulations.

At the macro level, analysis of specific practitioner groups can help identify clinical training gaps to be improved at scale.

Ultimately, VR training with analytics platform and AI can help health care practitioners along their entire learning lifecycle, from preparing to performance through to recovery – all of which positively affects the industry as a whole.

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