

## Abstract

Recent advancements in virtual reality (VR) head-mounted displays (HMD) have resulted in some new police simulation training products utilizing HMDs rather than projectors and screens. The new VR displays have image quality that is close to matching the human eye. However, when it comes to professional training careful attention must be paid to determining if a new HMD or screen-based simulator provides negative training or ineffective training. Companies selling these HMD-based products often promise low-cost, high portability and quality training – but how can we be sure that critical training quality is not compromised. The public and those sworn to protect the public fully expect agencies to effectively evaluate training systems prior to any purchase decision, especially new methods of training. This white paper focuses on practical methods for law enforcement agencies to objectively evaluate current and new HMD-based training systems to help ensure proper officer and public safety. The paper also explores pragmatic and legal consequences of deciding between traditional simulation training versus HMD-based training.

## About the Authors



**Lon Bartel**, became a peace officer in 1997 and has been a certified law enforcement trainer for over 18 years. Recognized by AZPOST as an expert in the areas of Defensive Tactics and Firearms he was also a TASER Master Instructor for over 12 years. He served as his Department's Rangemaster from 2005-2017 where he managed the Firearms Instructional Team. In 2008 he wrote the Department's 'Use of Force Policy/Response Options Policy' and in 2015 the 'Non-sworn Use of Force Policy.' As a member of his departments SWAT team, he was a Senior Operator and was instrumental in creating the 'Explosive Breaching Program' for his department in 2008. He served on numerous review boards to include reviewing and evaluating 300+ police cases involving the use of force and deadly force. A guest firearms instructor for SHOTS Ranch, and IALEFI North Carolina ATC. Lon is certified by the Force Science Institute as a certified Use of Force analyst and is a certified Advanced Specialist. He is an IADLEST Nationally Certified Instructor. In 2019, Lon Bartel received the prestigious IADLEST Training Innovation Award. He is the Director of Training and Curriculum for VirTra and has a B.S. in Exercise and Sports Science (Magna Cum Laude) from Arizona State University.



**Bob Ferris**, started an immersive virtual reality and simulation company in 1993. He is considered one of the most experienced professionals on products based on Virtual Reality (VR) head-mounted display (HMD) technology having begun work with one of the earliest digital head-mounted displays at the start of VR. He performed VR research at the University of Arizona and his company operated HMDs for commercial use by over 1.5 million people. For over 26 years, he has helped invent a host of groundbreaking simulation products highlighted in magazines such as TIME, WIRED, Popular Science and MS&T. Bob has been awarded multiple patents in the field of simulation, written articles, spoken at numerous conferences and his company's simulation training products are used extensively in 32 countries in thousands of locations for judgment and firearms training that impacts millions. Bob Ferris is CEO and chairman of VirTra and has a B.S. in Systems Engineering from the University of Arizona.

## Introduction

Lon Bartel will never forget the first time he was facing down a deadly threat. Late at night, Lon and his partner were called behind a business. A group of young men in a drainage ditch were lighting items on fire with a flare in one hand and a beer in the other. Lon and partner were severely outnumbered and when they called to the subjects, they were met with hostility. As they tried to interact with these young men from the position on top of the ditch, two more young men came out of the shadows to their right. One of these two was carrying a firearm in his right hand. Lon drew his weapon and shouted commands to drop the weapon, which the subject ignored. These two continued toward Lon and his partner as the crowd below got louder. In the dim light provided by fire and flare, Lon was able to make out the faint color of orange on the tip of

the gun combined with a single voice from the crowd shouting, “it’s a toy!” Lon believes his training was a major reason this event did not end tragically.

Bob Ferris will never forget that feeling of immersion into a virtual world when, in 1993, he connected one of the first commercially available head-mounted displays (HMD) to a Pentium-90 computer. He was hooked. From that day forward his career has revolved around researching and deploying the latest simulation products. In fact, he’s attended over 185 AR/VR/Simulation tradeshow throughout 26 years and may well have personally experienced the largest variety of HMDs of anyone in the industry. Many are surprised to learn that during the first 11 years in the simulation business his products exclusively used HMDs. Today, VirTra is a display platform agnostic company meaning they use the best technology for the task, whether HMD, screens or something else. VirTra has had more than 1.5 million people use their HMDs since 1993, yet their most popular training simulators currently use projectors.

We certainly do not propose that simulation, whether VR or screen-based, is the ‘magic bullet’ for training. In fact, live fire and force on force training methods should be used in conjunction with simulation training since each method has particular advantages and limitations. Furthermore, there are tremendous differences between manufacturers, so even similar looking simulators can provide radically different levels of training quality and capability.

This white paper describes an objective approach to evaluating training simulators, particularly helpful for those agencies considering new HMD-based or VR training products. Additional detail and background are provided to explain the “why” behind the suggestions advanced in this white paper. It makes sense that just because a new technology is in the headlines, surrounded by excitement and considered “state-of-the-art” doesn’t necessarily mean it provides effective and constructive professional training. The importance and legal considerations of training tool selection are also explored. We will start by describing a few myths.

## Myth #1: Simulation Training is All About the Same

When it comes to training validity there are two critical and related issues: skill acquisition and skill transfer (Goldstein, 1993). Skill acquisition is defined as learning the knowledge and skills necessary for effective performance. Skill transfer is defined as the transportability of trained knowledge and skills from the training context to the performance environment. This focuses on issues of retention, maintenance, and generalization (Baldwin & Ford, 1988). While both of these issues have importance, skill transfer is the more challenging issue (Barnett & Ceci, 2002).

There are two main approaches for resolving the transfer problem through simulation training design. One approach addresses physical fidelity, whereas the other approach addresses psychological fidelity. The physical fidelity approach focuses on the use of high-fidelity simulation for skill acquisition to minimize or eliminate skill degradation during transfer. High fidelity simulation is achieved when the training simulator reproduces or is a close approximation of the actual performance environment. The essence of this training strategy is that the emphasis on realism (such as training with a simulated weapon that nearly perfectly matches your real weapon) will minimize differences between the training and performance contexts, thus enhancing the potential for effective knowledge and skill transfer (Kozlowski & DeShon, 2002). If you’ll have stress in the performance environment then you want stress in the training environment. This concept is rooted in the idea of the transfer of learning depending on the proportion to which the learning task and the transfer task are similar (i.e., identical elements theory: Thorndike & Woodworth, 1901). The research results indicate that the most effective training is that which closely resembles the performance environment so as to maximize skill transfer (Druckman & Bjork, 1991).

*If the human doesn't look real, doesn't act real and doesn't appear real, then the psychological processes are not simulated for the trainee.*

The psychological fidelity approach is focused on the extent to which the training environment prompts the essential underlying psychological processes relevant to key performance characteristics in the real-world setting. In other words, it is an effort to evoke the central psychological constructs and mechanisms responsible for the on-the-job performance as closely as possible (Kozlowski & DeShon, 2002). For training to de-escalate a situation focused on another human being, the simulated human being needs to be lifelike in order to achieve psychological validity and for effective skill acquisition and skill transfer. For example, if a trainee is presented a CGI (computer generated image) human, it might look more like a video game character than a realistic human being the trainee might face in a real-world situation. If the human doesn’t look real,

doesn't act real and doesn't appear real then the psychological processes are not simulated for the trainee.

The two approaches, physical fidelity and psychological fidelity are not competing alternatives, but rather are complementary. Both physical and psychological validity are required for overall validity of the training system (Kozlowski & DeShon, 2002).

## **Myth #2: Video & CGI Humans Are About the Same**

When developing new training scenarios, the ability to quickly and affordably capture footage of humans using standard video equipment, with high-fidelity in both look and movement, cannot be matched by any other current technology or approach. While the level of fidelity of humans in simulation is of critical importance, the cost required to obtain these high-fidelity human characters is of great concern. Surprisingly, even though video far surpasses the realism of CGI, the average cost of creating a new human character in video is far less, often a tiny fraction of the cost and time to create a similar human character in CGI.

It should be noted that there is a wide variety of video camera technology currently available, with new advances occurring regularly. Since video is designed to capture whatever is within the camera's view and humans can be easily positioned in front of the camera and told to perform various natural movements, it is apparent that video confers far more realism at a very low cost as compared to a similar fidelity CGI approach.

## **Myth #3: Realistic CGI Humans are Just Around the Corner**

There is no doubt that computer technology and CGI fidelity continues to advance. Some might argue that in the near future CGI will be able to equal the photorealism of video. This argument usually begins with an enthusiast reminder of how far CGI has advanced in recent years and ends with an assumption that CGI will solve any remaining limitations in short order. However, some experts suggest that CGI has long solved the easier tasks and the remaining problems with humans looking/acting real are the most challenging, in some cases, by orders of magnitude.

One obstacle is the technological limitations to perfectly replicate the look and feel of a human and render this in real-time. Computer software takes many shortcuts in order to render scenes as quickly as possible. Yet, when it comes to humans, we are all experts at noticing the smallest details that do not look "normal," therefore, many of the CGI shortcuts are not possible when it comes to CGI human realism.

In fact, the limitation is not just computational capability; it is also dependent on graphic art and animation refinements. The most talented graphic artists, working long hours with non-real-time rendering are just now starting to equal the quality of video. The distance between today and a point in time when CGI humans can match video humans is difficult to predict, but the computing power required might be orders of magnitude beyond our fastest computers. The larger concern is if the industry has empirically translated computing power advances into more realistic CGI humans for real-time interaction? If the relationship were linear between computing power and CGI human realism for simulation, then CGI humans in simulation today would be twice as realistic as those displayed 18 months ago, which is not the case, so there must be other factors at work than just computing power.

## **Myth #4: You Can Easily Make Any Scenario You Want with VR & CGI Humans**

Training can't involve just a few human suspects, so a major obstacle is the time and cost of the creation of additional CGI humans that appear realistic. The amount of time and skill level of professional artists needed to create a photorealistic and natural behaving human is incredible. In fact, very few computer graphic artists even have the necessary skills to create a photorealistic human in CGI. This means that even if given unlimited time and resources, many graphic artists could never deliver a photorealistic human.

Obviously, it is not enough to create just one photorealistic human. Training scenarios need a variety of different looking humans with the ability to support all types of scenarios and to do new behaviors in the future. Ideally, the customer would have the ability to easily add new characters with new movements in the future. A photorealistic CGI human needs natural body movement, correct eye movement, normal facial appearance with hundreds of muscle movements that correspond to speech and emotions, just to name a few elements needed to replicate a normal human. The skill needed by the team of graphic artists and animation specialists to accomplish just a single natural looking human that moves normally is extreme. Still tremendous challenges exist to providing an easy to use, CGI-based, authoring environment usable by a non-technical person with real-time output that matches video of a real human.

## Myth #5: If CGI Humans Aren't Realistic, We Just Need to Spend More Money on Them

In 1970, Masahiro Mori realized that when a simulated human becomes 99 percent lifelike—so close that it's almost real—we focus on the missing 1 percent. We notice the slightly slack skin, the absence of a truly human glitter in the eyes. The once-cute simulated human now looks like an animated corpse. Our warm feelings, which had been rising the more realistic the simulated human became, abruptly plunge downward. Mori called this plunge 'the Uncanny Valley', the paradoxical point at which a simulation of a person becomes so good it's bad (Thompson, 2004). These missing components trigger innate aversion in the trainee towards the CGI simulated humans.

Unfortunately, the task to obtain CGI realism equivalent to video realism for people is not only arduous, but often developers land in the tragic Uncanny Valley, spending increasingly amounts of time and money in an unsuccessful attempt to exit the Uncanny Valley. Like quicksand, the more they struggle to exit the Uncanny Valley, the more they are firmly stuck. It is impressive to note that video jumps entirely over the Uncanny Valley, providing human realism with today's video technology – so long as the content creator's actors give a convincing performance.

In fact, we can learn much from the making of the recent movie Gemini Man starring Will Smith. In October 2019 Wired Magazine interviewed the highly accomplished crew who created this cutting-edge movie using the very latest tools. Realize making a CGI person for a movie that is just played back to an audience is far simpler than what is required for interactive simulation training. Movies have no real-time demands, no branches, no computer requirements for interaction, for framerate, for battery or heat or many other constraints. Even with the many advantages afforded a movie with over \$50 million budget, numerous experienced staff, and thousands of computers to render graphics, they still encountered major obstacles with presenting realistic CGI people. "With only a couple of months left for postproduction, [Ang] Lee isn't entirely satisfied with the scene we just saw; it's humbling, he says, to spend two years puzzling over why a one – second shot of a digital human just isn't jelling" (King, 95). "As sophisticated as motion capture is, and despite the massive trove of measurements taken of Smith's every gesture and movement, it still cannot record the full richness and depth of human behavior – the subcutaneous subtleties and minute movements, the micro-expressions, the difficult-to-pinpoint qualities that comprise humanness" (King, 92).

*When CGI humans aren't convincing, they aren't providing effective training.*

When CGI humans aren't convincing, they aren't providing effective training. This relationship between realistically simulated humans and effective human-to-human training is not setting too high of a standard but rather is acknowledging the reality that humans are extreme experts on, well, humans. It is even more critical since not properly showing realistic human interaction could lead to negative training.

## Myth #6: Low Quality Simulation Training Won't Harm Anyone

It is very possible for a simulator intended to help a trainee to actually harm a trainee. Therefore, before anything else, the very first step is to check the simulator for potential negative training. For example, some simulator companies have unique controllers, goggles or procedures used only during training. Trainees are told to only do this or that during training and NOT in real life, but the harsh reality is trainees will revert back to habits formed during training, especially when under crushing pressure during a real-world crisis. This 'negative training' can have disastrous consequences and therefore mustn't be allowed to occur in the first place.

Also, due to the liability involved of officers losing their lives and the liability of wrongful death lawsuits it is imperative to remove from consideration any simulator that lacks any of the three fundamental requirements needed to avoid negative training. These three fundamentals are:

1. **Weapon Realism / Accuracy:** only if the simulated weapon is accurate to form, fit, function and duplicates real-world ballistics will the trainee be able to practice real-world situations with confidence in applying what they learn in the real-world. This is required for physical validity.
2. **Judgmental Use of Force:** only if the simulated humans are accurate to real human behavior will the trainee be able to react to natural body language, human micro-expressions and subtle clues for what the human might do next. For now, CGI humans lack this realism needed for proper use of force decision making but high-definition video of good actors can achieve the needed fidelity. This is required for psychological validity.

3. **Stress During Training:** only if the trainee experiences real stress during training can they truly practice in the performance environment, since stress nearly always accompanies police encounters. This is required for both physical and psychological validity.

The best simulators on the market can provide all three of the above requirements. Whether it is VR-based or screen-based these fundamental capabilities are a must to avoid negative training habits. Further, if a simulator lacks even one of the fundamental three components then the trainee might think they are well trained, having no knowledge of the crucial flaw until revealed while trying to do a job they weren't properly trained to do. It's far better to push for a valid training simulator, using this article to help explain the 'why,' than to settle for a simulator that could do tragic harm until the next budget cycle.

Some may say, 'all simulators are about the same' and this is simply untrue. Some might just want a simulator to check a box and not care if the training is valid or effective – such an approach could be deemed culpable negligence. Other times there is pressure to make a purchase decision without actually testing and evaluating the simulation equipment which should always be avoided. Compromising on training equipment can lead to catastrophic results and life-long regrets.

One thing is obvious, to properly decide on training equipment requires someone experienced to personally evaluate it objectively. To do this you can score each simulation training product that is under consideration based on carefully selected criteria prior to deciding what product is worthy of training the fathers, mothers, sons and daughters who's training fall under your responsibility. Below is one approach that you might use as a template to rate the systems that pass the "first, do no harm" requirement. Of course, you could customize the importance (weight) on the various parameters to match to your own department/personal requirements as you see fit. Simply multiply the updated importance of the factor to the score.

## **An Objective-Based Training Simulator Comparison Guide**

VR-based and screen-based simulators are not simply equivalent to each other. Even a screen-based simulator created by two different companies can be drastically different and training effectiveness. Like shopping for any product, it takes some work to find the best fit. It's worth the effort considering the potentially tragic downside risk if money and time is invested in negative training. To ensure the best outcome, an objective criterion should be utilized when comparing various simulation training systems. One such objective criterion is provided below.

## Effective Police Training Simulator Evaluation Criteria

The table below summarizes a sample comparison matrix between a generic VR-based simulator and a screen-based simulator from VirTra. Following this table is more in-depth information and a detailed description on how to evaluate each factor listed below.

	Item	VR-based	Screen-based	Importance (10=highest)	VR Total	Screen Total
Training Value	Avoiding Negative Training – Weapon Realism / Accuracy	4	9	10	40	90
	Avoiding Negative Training – Judgmental Use of Force	3	9	10	30	90
	Avoiding Negative Training – Stress During Training	1	9	10	10	90
	Quality of Training Content / Certifications	3	10	9	30	90
	Depth of Training Content	1	9	8	8	72
	Portability	10	8	3	30	24
Costs	Lack of Training - Wrongful Death Lawsuit(s)	1	9	10	10	90
	Lack of Training - Officer Injury or Death	4	9	10	40	90
	Recurring Costs (assuming outright purchase)	6	6	8	48	48
	Initial Costs (assuming outright purchase)	8	7	6	48	42
	<b>Total (Higher number is better)</b>				<b>294</b>	<b>726</b>

## Avoiding Negative Training - Weapon Realism / Accuracy

The first fundamental requirement for a simulator that involves firearms or less lethal weapons is that negative training is avoided at all costs. For example, if the trainee fires in the simulation and the simulated round is not tracked accurately, then the trainee naturally disregards the validity of the simulator itself, potentially reducing effectiveness to zero. Once a trainee feels the simulator has inaccuracies or errors, they will logically consider any simulated outcomes to be in error, especially if such outcome would show the trainee to be wrong. The key goal is for skill improvements gained in simulation to be valid in the real world. Therefore, correct simulation recreation to the real-world is critical to avoid wasting training time or even worse, the potential of negative training. Of course, a trainee that becomes excellent in the physical domain has a higher potential of success in handling their weapon to physically neutralize a threat with speed and accuracy without harm to bystanders. With enough practice these skills become honed to a level of automaticity. Unfortunately, even a very slight deviation from the real-world during simulation practice will result in tragic negative training. Consider that if the simulator ballistic profile is just 1-degree off from reality then the simulator could reinforce incorrect weapon aiming, showing the trainee hitting the hostage taker versus the hostage – whereas, in real-life, using the same movements practiced in the simulator yields the opposite outcome with horrific results. Even worse, if the simulator error is minor, the trainee might be unaware they have acquired slightly incorrect skills during training so when firing a weapon in a hostage situation they have false confidence based on thinking their success in the simulator warrants them taking the shot in real life, using what they ‘learned’ from the simulator experience.

It is clear as day that in real life, you can see your weapon sights, and in front of your weapon sights, you see the scenario. This natural optical path is exactly what you get with a screen-based system: scenario – your weapon – eye. A huge disadvantage for VR-based training is that the image is right in front of your eye and the VR developer must try to virtually recreate the natural optic path, a very daunting task when 1-degree errors are as unacceptable as shooting the hostage versus the hostage taker. Even the headset itself, unless the officer deploys with the headset, can create enough dissimilarity with reality to neutralize or create negative training. Since simulators don’t use real bullets, there is also some differences as compared to simulated weapons. The latest generation of drop-in kits, fit inside a standard weapon, have powerful recoil and even lock the slide back when out of ammunition or when simulated a malfunction. To achieve a top score in this category the simulated weapons must be nearly an identical match to a live firearm and not create training scars, like ejecting a magazine and then re-inserting it to magically obtain more rounds. A wrong habit formed in training is a land mine waiting for the unsuspecting trainee.

When evaluating training tools in this category consider the following criteria:

- Is handling the weapon in the simulator feel the same as handling the weapon in real-life?
- Is the placement of the impact extremely accurate every single time?
- Is the form, fit and function of the simulated weapon accurate to the real thing?
- Are there any system delays or malfunctions that detract from natural weapon handling?

## Avoiding Negative Training - Judgmental Use of Force

Judgmental Use of Force includes the psychological process of deciding to engage another human with force. Human realism and high-fidelity simulation are of utmost importance. The use of human actors is an option but is often cost prohibitive, hard to coordinate, impossible to scale, and isn’t reproducible for all trainees – just to name a few problems. The most realistic method besides live actors is to capture live actors digitally, with branching options and then present this to trainees. Human use of force training is extremely challenging as the trainee tries to determine threats from non-threats from very subtle non-verbal cues in fractions of a second. If the trainee does not sense danger nor observes a threat, their physical skills have no power to assist. In addition, if the trainee makes a judgment error and engages non-threats, then the result of effective firearms skills could be disastrous. In all of these situations, CGI characters come up far short of the fidelity level required to provide the subtle verbal, para-verbal, human non-verbal cues and precise visual nuances necessary to recreate effective judgmental use of force training. This is reinforced by multiple research studies indicating that on average we place 55% importance on body language, 38% importance on tone of voice and 7% importance on the words spoken (Mehrabian & Wiener, 1967 and Mehrabian & Ferris, 1967). If over 50% of decision making is based on non-verbal communication, such as body language, then it would naturally follow that high-fidelity simulation should closely replicate human realism to most effectively improve skill acquisition and transfer in the trainees. This assertion is also backed up by research that indicates that using high-fidelity simulators leads to mastery learning, also known as “performance accomplishment,” which produces higher performance outcomes (Issenberg et al., 2005; Larew et al., 2006).

These task environments are characterized as dynamic decision making (DDM) situations and uniquely place incredible demands on the skills of operators, sometimes suddenly and with immediate lethal consequences. DDM tasks are dynamic, ambiguous, and emergent. They necessitate rapid assessment of the situation as it unfolds, diagnosis and prioritization of possible actions, and implementation of appropriate task strategies (Kozlowski & DeShon, 2002). DDM tasks require high levels of expertise. This higher level of expertise often depends on either experience already gained in the real-world or from practice with high-fidelity simulation capable of providing transferrable skills to the real-world. A top score here either requires a human actor or a digital equivalent of a human actor which looks and acts exactly as you'd expect to see in the real-world.

When evaluating training tools in this category consider the following criteria:

- Are the human movements and interactions realistic/natural enough to be convincing?
- Is the resolution and visual acuity sufficient to see threats/non-threats?
- Do I get a sense that I'm dealing with a person or does it feel like video game character?

## Avoiding Negative Training - Stress During Training

It's not just success in decision making, correct tactics, and handling a weapon with speed and accuracy without harm to bystanders – it is doing so under acute stress. The need for stress during training is often overlooked, but untrained people perform one way when calm and usually far worse when under stress. Obviously, removing nearly all stress during simulation of real-life but then having stress during a real-life encounter is a setup for psychological and physical mistakes with corresponding increased potential for the loss of life.

For training to be most effective, a trainee needs to experience some of the same physiological effects of a real incident such as stress and tension. In fact, with no fear of return fire during training, the trainee will efficiently ignore potential threats around them and thereby learn dangerous habits with each training session. Various technology has been developed to successfully bring this into LE training. Using impact reduction suits for arrest and control tactics as well as the use of the Simunition product line are examples of using training tools that bring stress into training. A unique device to fill this chasm is the Threat-Fire. It uses an electric impulse to safely apply stress during training and supply immediate negative consequences, if they are needed. This device can psychologically represent all threats to the officer's safety not just gunfire. This device completes the interaction loop: the trainee engages simulated suspects and simulated suspects engage the trainee (safely). With no return fire a simulator provides only 50% interaction, with return fire it reaches 100%. Live fire range training is unable to introduce sufficient stress and consequences due to safety limitations. A top score here requires a long track record of no injuries and a method for introducing stress and immediate consequences, should they be needed. Avoid projectile firing systems as they require eye-protection, clean-up, aiming and seem to eventually damage persons or property.

When evaluating training tools in this category consider the following criteria:

- Has the system been in use for many years by large numbers of agencies without inadvertent injuries?
- Does it distract the instructor from monitoring the trainees' performance?
- Does it create adequate stress during training and provide an immediate consequence?

## Quality of Training Content / Certifications

Not all training content is created equal. Furthermore, the axiom "Content is King" holds great truth since content is so central to the quality of training provided. Some companies take special care to insert multiple lessons that are hard or impossible to instruct any other way than through simulation. Other companies throw together lots of small training scenarios with few teachable moments and poor acting. One scenario might have enormous training value and another might be nearly zero. Never demo just a few scenarios, spend some time experiencing the quality (or lack of quality) throughout the entire library.

This is one reason why seeking out companies that offer certified training content makes sense. A simple question to ask is how much of the content being offered is IADLEST (International Association of Directors of Law Enforcement Standards and Training) certified? This is one of the few objective measures when it comes to content – either a company has met the training quality standards of IADLEST or not. Top scores in this category goes to IADLEST certified content and high-quality content that has clearly defined training objectives, such as a curriculum method versus just a list of various scenarios.

## Depth of Training Content

Of course, having three or four excellent pieces of training content is not adequate for covering all the various areas of expertise expected from a police officer. A real danger with VR-based simulation training is a very small library of training content that will quickly be experienced and then the system just sits in a closet for years. Don't just test one scenario and trust their whole library is fine. A trick used by some VR-based and screen-based is to show a few of their best scenarios and just hope the potential client doesn't test out lots of their library. Then, after delivery of the system, the training staff make the discovery that besides the scenarios they already demoed, the rest of the library has nearly no training value or is a disappointment for other reasons.

The other problem is that the scenarios that VR-based suppliers do have are very limited in effectiveness if they are using CGI human characters as discussed earlier. So even if you had access to 700 different scenarios, if they have nearly no training value it won't help trainees acquire or transfer skills. A lot of zeros still adds up to zero.

However, VR-based simulation providers are aware of these limitations and their common rebuttals to address these concerns fall into two main methods. The first method is to promise that many new (and 'amazing') scenarios are just around the corner. Be very suspicious of this promise that is seeking to make a sale now with little downside to the company if the promise is not kept. The second method is to say that the customer will have a powerful editing suite, through which they can create their own new scenarios. The military has invested millions and years of R&D and they still have yet to perfect such an authoring tool. Just because CGI affords so many possibilities it doesn't mean that creating convincing training content becomes trivial – the opposite is the case. In fact, we've found that few agencies have either the available personnel with the unique skills nor the time to create professionally produced training content libraries. You should ask for a reference of a couple departments who already have created scenarios using their authoring tool and then actually experience the scenario that they created and determine for yourself the training value and realism. In this case, an ounce of prevention is worth a pound of cure.

Top scores for this category go to products with a large library of quality training content that is either certified or is vetted by an experienced trainer.

## Portability

VR-based systems can be very portable, fitting within one case. However, keep in mind that some VR-based systems do require "optical tracking" which often involves setting up cameras on tripods and these are far less portable.

In recent years, projectors and computers have shrunk remarkably while improving in performance. In fact, some single-screen simulators are now as portable or more portable than VR-based systems. The largest item would be a screen, however, often you don't even need a screen since you can often project onto a wall and skip the screen altogether.

Furthermore, for many departments, portability is not their #1 concern. If pressed, their top concerns are often: keeping the public safe, keeping officers safe and avoiding multi-million-dollar wrongful death law suits. However, if portability is the chief requirement, then screen-based simulators should not be ruled out. Determine if the system must be portable enough for air travel or portable for vehicle travel. For example, it is possible to fit a portable 180-degree simulator in an SUV but air travel would demand a single-screen simulator or VR. Top scores should be based on which system best fits your specific use case, whether car or plane mobility.

## Lack of Training - Wrongful Death Lawsuit(s)

The last thing a department desires is to be found guilty of a failure to train an officer accused of causing the wrongful death of a law-abiding citizen. The result is not just millions of dollars but it can cause riots that can kill many more and lead to billions of dollars of damage. On top of this, an entire department's reputation can be tainted for years, impacting cooperation with the community and devastating recruiting efforts in a tight job market.

If a department must answer accusations of failure to train, the best approach is to actually be doing excellent training prior to the event. Being able to say that you are using certified curriculum with the most realistic simulator is also critical. The fact that VR-based training is so new, unproved and is less expensive is a major liability in the courtroom. The fact that VR is most closely associated with games that kids play is not helpful for the deadly serious business of police training. When a wrongful death suit is thrust upon an agency, they are not pleased if they reduced budget on training, instead they are

terrified by it. Of course, such a lawsuit can place a department and their training program under intense scrutiny. Even if a department bought VirTra's V-300® simulator, arguably the most effective police simulation training tool in the market currently, it is most useful if utilized correctly for all officers. Also, having records of all the work performed in just deciding what training simulator to buy could also be part of the overall defense that proves there was not a failure to train on the part of the department. Don't be fooled into thinking that 'check the box training' is 'good enough.' It's far better to train properly with effective tools and hopefully avoid the problem in the first place! Top scores in this category go to whichever simulator would standup the best in a court of law and under intense interrogation.

## Lack of Training - Officer Injury or Death

The costs of the loss of an officer due to avoidable injury or death go far beyond the financial and are hard to calculate. Adding up the numbers to recruit, hire and then train a replacement officer is easy math. Adding up payments to disability and death benefits are formulas. Calculating the negative impact resulting from a loss of an officer due to poor training is monumental. How do you calculate the effect of feelings of guilt for not providing quality training? How do you calculate the effect on the morale of the other officers? How do you calculate the loss of this officer in the lives of their spouses and their children?

"Check the box" training unfortunately exists. This is the training that is provided that technically meets the standard by the letter of the law, but fails the spirit of the law. Moreover, it fails people who trust us with their training. It may check a box and allow one to say, "Yup, we did training," but was it training that provided improvements and change in trainee's skills? Was the change lasting? If the training did not provide effective skill acquisition and transfer then the job was not done, the box wasn't really checked.

## Recurring Costs (Assuming Outright Purchase)

The recurring costs of VR-based or screen-based simulators are quite similar. Both products require new software updates and new content to be created and have hardware that can and will eventually break-down. One slight difference is that VR often has a trainee personally handling the HMD and/or computer – and this greatly increases the chance of damage to an expensive part of the overall system. Also, VR-based systems often require more instructor time as each trainee must adjust the headset to their own eyes and deal with those who wear glasses. It is case-by-case fitting to each trainee and takes additional time.

## Initial Costs (Assuming Outright Purchase)

The cost between vendors can vary wildly. Some VR-based simulators can cost more than screen-based simulators and vice-versus. Keep in mind that some screen-based simulators have a large library of training content and continually reinvest back into the product with a large team supporting your purchase. A simulator that sits in the closet broken or has very limited training value is not very useful, even if the simulator was purchased at a discount.

For agencies without funding to handle upfront costs, VirTra offers a 'pay as you go' subscription service that removes the need for a large upfront purchase, bringing the upfront cost actually below that of VR-based offerings.

## Conclusion

Just a few weeks ago a reporter experienced one of the very latest VR training simulators at a tradeshow. He reported, "the [VR] experience wasn't perfect. The red dot sight didn't operate like the real thing — you had to line up the red dot with the front sight to shoot accurately. Also, I couldn't go full-auto with the rifle during the simulation itself — kind of a bummer. Additionally, reloading the magazine was an awkward, clunky experience. The simulator was fun... As a training exercise, though, it's got its limitations. The mannequins don't shoot back, so shooting from cover like you would in a combat situation isn't required" (Read, 2019).

This description of a VR-based system further underscores why it is critical to employ an objective process when evaluating any training product, particularly a brand-new methodology. Moreover, this type of purchase is an investment in the officer's life and safety as well as the life and safety of the communities they serve. Costs are a factor but negative training or lack of training effectiveness can be far more costly.

Whether VR-based or screen-based, if the system does not train the right skills in the right way it can embarrassingly waste time and money – or worse. Putting on a VR headset and being immersed into another world is so new and amazing it is almost hypnotizing. Like a moth, we can be drawn towards a mesmerizing light that doesn't deliver what was promised. Without a track-record or evidence of effective change in performance and behavior - a shiny new product might deliver entertainment, not training.

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