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Market Study of New Sound Technology for Simulation Training Solutions and Control Rooms

PREPARED FOR



BY OVG CONSULTING INC.

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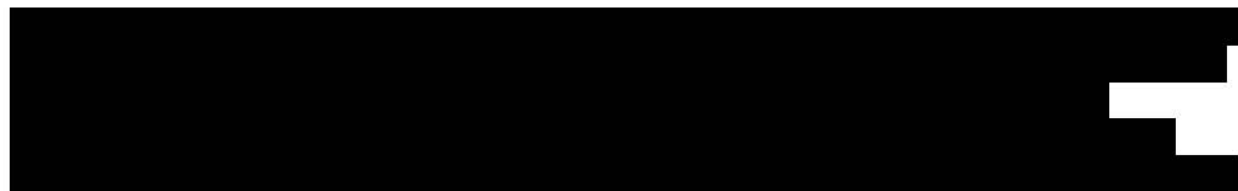
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Introduction



The Client is a creator of a new media display format, [REDACTED], which co-locates sounds and images within display areas so that sounds come from the location of the represented visual objects in the medium. This technology adds a new perceptual layer to the technology of synchronized sound by adding its spatial complement so that sound can be in place with its image, in addition to being in time with it. In contrast to surround sound arrays, which envelop listeners in an enveloping sound field, [REDACTED] draws attention to areas of screen-based imagery, so that sounds are attached to their visual sources within the display just as they are in natural perception.

[REDACTED] consists of wall panels which emit sound in co-location to objects and events in the virtual environment relative to the users' position in real space. [REDACTED] co-locates audio and visuals through attaching a 2D array of audio exciters to the back side of a visual display— which may be either projection-based or ultrathin OLED and MicroLED video screens, or wall panels— connected to signal distribution and software. The visual display or enclosure itself becomes the sound emitter. With [REDACTED], the screen or surrounding surface becomes the source of the sound, not only is audio tied to the general screen and surface area. [REDACTED] creates immersive experiences with interactive media since it emulates the way we actually experience objects and events in everyday life.

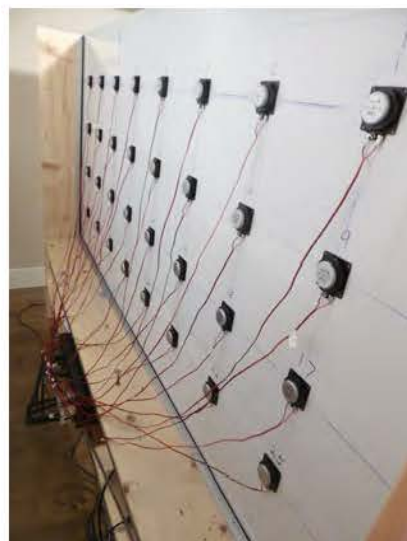


Figure 1: [REDACTED] Technology, Sample of its Application

Presently, the Clients is focused on developing the new generation prototypes for simulation-based training, large immersive exhibition displays, control rooms and video conferencing.

The Consultant was engaged by the Client to conduct market research to identify the current and projected future market for [REDACTED] technology in simulation-based training and control rooms with the specific focus on military, police, emergency response and industrial applications, as well as their pricing.

Study Approach and Major Assumptions

The Consultant followed the standard research approach, which consists of the following steps:

1. Review the Client's product, interview the Client to identify the project's objectives, requirements, and expectations in regard to the following:
 - a) Details of the product, its features, and applications;
 - b) Potential target market segments: industries, applications and customers who will benefit from this product.
2. Identify target market segments:
 - a) Develop the set of qualifiers based on the product's basic features, which help to match it with potential markets;
 - b) Identify markets that apply simulated (virtual reality) training technologies;
 - c) Assess, for each identified market, whether training is required or can benefit from the features that are offered by the Client's product;
 - d) Conclude on the target market segments, which are best suited for the Client's product.
3. Identify manufacturers of simulated training technologies that can benefit from the technology.
4. Conduct research and analysis of each target market segment to calculate the current and future demand for the Client's product:
 - a) Historical and future industry performance;
 - b) Existing usage of the simulation technology by the industry. Examples.
 - c) Trends affecting the current and future market development.
 - d) Estimation of the market potential. Calculation of the market demand varies for each segment depending on the publicly available data. Forecast extends until 2030.
5. Research and locate all publicly available data on detailed pricing of virtual simulation training systems.

Data for the study was acquired via online research; some information was collected by means of interviewing the businesses operating in the target market segments (Defense).

The following assumptions were identified for the purpose of the study:

1. The target markets are global; however due to the data limitations, included into the study were nations and industries publicly reporting the data required for analysis.
2. The gaming and interactive arts industries are excluded from the study.
3. The study is limited in its scope and excludes any consideration given to the Client's internal capacity in operational, HR and financial stance.

Qualification of Target Market Segments

Qualification of Simulated Training Applications

The use of simulated training technology is wide-spread and keeps expanding. As computing capabilities and technology become more affordable and advanced, simulated training continues offering greater, farther-reaching benefits. Some of the industries that were early adopters of this technology, and have been using the simulated training extensively, are healthcare and aviation.

Meanwhile, not all industries, even those who use simulation training, represent target markets for the Client as not all of them rely on sound as an important element of training. Moreover, even within audio-reliant professions and specialties, not all of them require identification of the exact location of the sound. This is seen especially in cases when the sound comes from the expected location (e.g., headphones). Accordingly, the industry or its application, which training exercises can benefit from the Client's technology, has to respond positively to the following test questions:

- 1) Is the sound important for the process?
- 2) Does the sound timing matter for the process?
- 3) Is the precise identification of the sound emittance location critical?

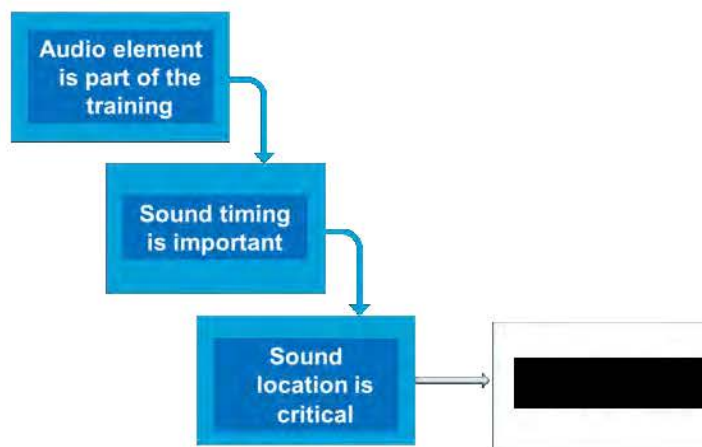


Figure 2: Simulation Training Features Relevant to [REDACTED] Technology

The Consultant then analyzed each industry within the simulation training industry to qualify it for [REDACTED] technology.

Healthcare

Simulated medical procedures, especially surgeries, constitute a large portion of the simulation market. Surgical education without the use of human or animal bodies helps reduce costs, eliminates ethical and humanitarian concerns, and reduces the number of medical mistakes and fatalities. By training medical professionals prior to performing high-risk or uncommon procedures, performance improves. The cost of health care decreases in correlation with a

decrease in the odds of a poor performance by a medical professional. The modern simulation allows for introduction of an accurate visual and behavioral representation of tissue in real time giving it the dynamic properties of real tissue. Examples of that can be internal organs moving, bleeding, and twitching, just as they do during a real operation. Meanwhile, any surgery or other medical intervention requires zero to limited verbal interaction, making the audio element in the training process insignificant.



WHILE HEALTHCARE REPRESENTS ONE OF THE MOST ATTRACTIVE MARKETS FOR SIMULATED TRAINING, ITS LOW RELIANCE ON AUDIO ASPECT MAKES IT IRRELEVANT TO THE CLIENT.

Safety, O&M

Simulation and virtual training are quickly becoming more of a standard approach to train new specialists, introduce new processes and procedures, and provide recurring skills upgrade in the majority of industries. The main focus for such training systems is safety, whether it is for heavy duty equipment operators or construction. The main objectives of this simulated training are reduction of cost of damaged equipment, number of errors and accidents. Some examples of the O&M and safety training are the following¹:

- Familiarization/Inspection – system overview, identify parts & components, and display required data;
- Procedural – guide students through a procedure step by step, assembly & dis-assembly;
- Troubleshooting – diagnosing and isolating the problem, leading to remedial action;
- Informational – explaining concepts (e.g., how a jet engine or diesel engine works);
- Checklists – real-time guidance in the field.



SAFETY AND O&M TRAINING IS A MARKET WITH SOME OF THE HIGHEST GROWTH RATE GIVEN THE INCREASING CONCERN FOR SAFETY AND EFFICIENCY. MEANWHILE, THIS TYPE OF TRAINING DOES NOT REQUIRE SIGNIFICANT VERBAL INTERACTION THUS ELIMINATING IT AS A TARGET MARKET FOR THE CLIENT.

Energy & Utilities

The energy sector encompasses multiple subsectors such as oil&gas, mining, electricity, and utilities. Each one of them already uses and continues to expand the application of simulation training. Operating expensive and potentially dangerous equipment requires extensive specialized training, which is also expensive and requires periodical updates and upgrades. Some examples of simulation training for this industry are below:

- Power generation: routine operation, monitoring and controlling of turbines and control systems;
- Oil&gas: planning energy expeditions, geoscience exploration, drilling, marine operations, fire and gas systems, stability training in semi-sub stability, ballast control, moorings;
- Mining: driver and operator training;
- Utilities: monitoring and controlling of water, gas, power transmission and distribution systems.

TRAINING FOR ENERGY SECTOR AND UTILITIES IS VERY DEMANDING AND ENTAILS DEVELOPMENT OF VERY SPECIALIZED SKILLS AND KNOWLEDGE BASE, WHICH IS PREDOMINATELY TECHNICAL WITH LIMITED REFERENCE TO AUDIO INTERACTION AND VIRTUAL REALITY. IT MAKES THE CLIENT'S TECHNOLOGY NOT RELEVANT TO THIS SECTOR.



Military (Defense)

Military, a state-authorized and managed industry, traditionally consisting of three major branches: army, navy, air force. In some countries, marines and coast guards represent two additional branches. Such division also works for the purpose of this study since the mode of operation for each of these branches differs by its requirements for audio/video aspects and accordingly leads to varying need in the [REDACTED]-like technology for training.

Air force, as well as commercial aviation, has been using training simulators extensively for a very long time. In fact, training flight simulators may be the most well-known type of training simulation. Meanwhile, pilot's operations are centered primarily on the instrument panel with limited need for audio capacity.

SIMULATION TRAINING FOR AVIATION IS MAINLY CENTERED ON VISUAL FACTORS. AUDIO ELEMENT IS PRESENT BUT RESTRICTED PREDOMINATELY TO ONE SOURCE – HEADPHONES. GIVEN THESE CONDITIONS, THE CLIENT'S TECHNOLOGY WILL NOT PROVIDE ANY ADDITIONAL VALUE TO THIS SECTOR.



Military simulations come in three forms: live, virtual and constructive.

Live simulation involves real personnel training on ranges with actual assets. A live environment can be augmented with virtual scenes through “augmented reality”.

Virtual simulation calls for the use of simulators that enable an individual or team to perfect their skills in a virtual world, before confidently performing them in reality.

Constructive simulation is used to display groups of forces and vehicles on the battlefield and for training, analysis, planning and mission rehearsal exercises.

Training an army is very involved and requires engagement of a person’s full sensory capacity combined with critical thinking and quick physical reaction. Simulation training of army personnel stretches from arms training (from pistols to grenade launchers and guided weapons) to sophisticated campaign simulations (i.e., war games) to planning and refining battle strategies. Using virtual reality to train soldiers and other military personnel is a much safer and cheaper option for defence organisations.

Modern technology makes it feasible to model every geographic location and terrain; virtual cities can be created for specific campaigns. When integrated with high resolution physics models (e.g., blast, dispersion), the immersive environments become powerful training and exercise tools for both military commanders and soldiers. The construction of a knowledge base of different cultures and translation of this information into realistic, virtual humans, specific to a local culture, is the key in enabling soldier training in environments prior to deployment to these regions. The new synthetic training environment means creating lifelike representations of real

places. Should soldiers need to be deployed, they will already know how to move through the environment. The US Army has already built virtual systems of North Korea, South Korea, San Francisco, New York, and Las Vegas and other places. Thanks to this new system, the Army can simply select a region from a map and the virtual environments will automatically generate within a few days.²

Some technology vendors offer advanced war games that involve all branches into the same exercise, a global simulation and training approach that links together various simulators to perform the full spectrum of military operations (offense, defense, stability, and support manoeuvres) in a digitized battlespace environment. Air fighter pilots can practice together in

simulators stationed at different locations. In addition, ships, submarines, aircraft, tanks, personnel carriers, and dismounted infantry can be added to the battlefield.³

Driving is another application for army force simulation training. There is a wide range of driving simulators for many types of platforms such as tanks, light tracked, wheeled and engineering vehicles operating the simulated field. Similar to soldiers, success of their operations including basic survival is heavily dependent on a combination of visual/audio components.



ARMY OPERATIONS ENTAIL A SIGNIFICANT PORTION OF AUDIO INTERACTION. TIMELY IDENTIFICATION OF THE SOUND'S SOURCE IS A CRITICAL FACTOR FOR THE BASIC SURVIVAL. ARMY TRAINING SIMULATORS REPRESENT A SOUND TARGET MARKET FOR THE CLIENT.

Public Services (Firefighting)

Simulation provides education and training for public services, in particular firefighters and ambulance. However, they have mainly been developed for the computer displays and training conducted in classrooms. Another direction for the first responders' training is driving simulators developed specifically for them.

The most recent developments are centred on creating immersive virtual environments for firefighters, which simulate live-fire conditions, allowing firefighters get a sense of how to manipulate equipment without the real-world danger. Virtual reality systems are accompanied by firefighters wearing original uniform and equipment attached to the end of a firehose, allowing trainee firefighters to extinguish virtual fires. The headset features a custom breathing apparatus kit, and a feedback system in the hose also simulates the force of the water flow. The turnouts are even equipped with heat packs that warm the wearer to the presence of the virtual fire.⁴ Other simulations are used to replicate emergency situations resulting from terrorism attacks, nuclear detonations, hurricanes, and pandemic flu outbreaks.



FIRST RESPONDERS' SIMULATION TRAINING HAS A BIG POTENTIAL FOR INCLUSION OF THE [REDACTED] TECHNOLOGY. NATURAL AND MAN-MADE DISASTERS ARE FREQUENTLY ACCOMPANIED BY SOUND IMPACTS. DETERMINATION OF THE EXACT LOCATION OF THE SOUND CAN BE OF A VITAL IMPORTANCE FOR A TIMELY RESPONSE.

Law Enforcement (Police)

Virtual simulation is getting more traction with the police force. Over a long period of time, it has been mainly centered around gun fire training and driving police cars. With the technology advancements, immersive simulation training programs have been introduced to the police force. They provide users a realistic experience simulating a variety of police-citizen scenarios. Some of the examples are⁵ listed below:

- De-Escalation
- Use of Force
- Crisis Intervention
- Human Trafficking
- Active Shooter
- Ambushes
- Terrorism Attacks
- Disturbances
- Domestic Violence
- Emotionally Disturbed Person
- High Risk Entries
- Hostage Situations
- Suicidal Subjects

ADVANCED POLICE SIMULATED TRAINING IS SOMEWHAT SIMILAR TO THE ARMY TRAINING REQUIRING AN ACTIVE SENSORIC PARTICIPATION. AN AUDIO ELEMENT WITH THE EXACT SOUND LOCATION PLAYS A CRITICAL ROLE, ESPECIALLY IN SITUATIONS WITH GUN INVOLVEMENT, MAKING THE USE OF [REDACTED] TECHNOLOGY VERY BENEFICIAL.



Transportation

Virtual simulation training has been on an uptake for drivers engaged in high-risk professions such as policemen, firefighters, military, and heavy duty equipment operators. Recently, virtual simulation has drawn attention from civilian driving authorities who started recognizing the value of more available training systems that can create multiple situations for trainees in a safe environment. Now, simulation technology is gaining momentum in training civilian

transportation personnel including air traffic controllers, maintenance personnel, bus drivers, and train conductors.⁶

Currently, several countries are working on introducing the mandatory simulation training for any driver applying for a driving license for cars and motorcycles. Brazil is progressively introducing a law which mandates the use of several hours of homologated simulators to obtain a driving license. This approach is considered to be extended to Europe for cars, motorcycles or even as a good practice course for bicycles. Planned to be launched at the end of 2020, the SimuSafe Project is funded by the European Union⁷. The intended scope of simulated actors will include not only a wide variety of traffic participants, but also introduce personal behavioural conditions such as the lack of sleep, mood, and use of drugs by various groups of drivers namely elderly people or younger people that recently obtained their drivers' license.



SIMULATION TRAINING FOR DRIVERS, BEING SO MILITARY, POLICE OR REGULAR CIVILIAN PARTICIPANTS, INVOLVES NOT ONLY DEVELOPMENT OF VEHICLE HANDLING SKILLS, BUT ALSO QUICK REACTION TO CHANGING TRAFFIC CONDITIONS, WHICH CAN ORIGINATE IN DIFFERENT LOCATIONS IN RELATION TO THE TRAINEE. AUDIO SIGNALS AND THEIR LOCATION, TIMELINESS AND DISTANCES ARE ALL IN THEIR COMBINATION CRITICAL FACTORS FOR A DRIVER. THE CLIENT'S TECHNOLOGY WILL PROVIDE A SIGNIFICANT VALUE TO THESE TRAINING SYSTEMS.

Education, Museums, Libraries, Planetariums

Immersive simulation is a new- and hardly tapped into- type of training for the education sector, which also comprises museums, planetariums, and libraries. Advanced technology solutions enable educators and curators enhance experiences and add more layers to improve the learning curve via a multi-sensory approach. Now visitors are able to interact with museum artifacts, learn about the universe, collaborate with each other, and immerse themselves in new worlds and eras, technology, and science.

USING IMMERSIVE MULTI-SENSORY SIMULATION TRAINING FOR EDUCATION PURPOSES IS NOT A CRITICAL ASSET BUT IS RATHER COMPLEMENTARY. MEANWHILE, TIMELY AND LOCATION-SPECIFIC EMITTANCE OF SOUND ENHANCES ITS VALUE. [REDACTED] TECHNOLOGY IS WELL SUITED TO PROVIDE THIS ENHANCEMENT.

Qualification of Control Rooms

Control Rooms or Control and Command Centers typically represent a hub where central critical decisions are made on the basis of data that is streamed to this hub from remote locations.

Control Rooms are used by various industries to control and monitor resources, guide operations, and act when a need arises.

Control Rooms differ by the scope of data that is streamed, needs to be analyzed and decisions being made. In the majority of industries, this data is represented by technical parameters indicating conditions of the system and also the flow of commodity through the system. In other applications, this data can be mainly based on imagery.

Usage of Control and Command Centers provide advantages for many different industries that require monitoring of systems and taking over control in an instant. Some of the major sectors that use Control Centers are Utilities, Traffic Control, Public Services and Law Enforcement, Military, and Space.

Utilities

Electricity, water treatment, and natural gas and oil pipeline systems need constant checking by operators. SCADA and automation systems are all monitored 365/24/7.

An example of an electric system is the electric power transmission system operators' control room. Figure 3: demonstrates the 64,000-square-foot control center of the New York Independent System Operator (NYISO) featuring a 2,300-ft² video wall that captures more than 3,000 live status points presenting key electric system operations data and information.



Figure 3: NYISO Control Center⁸

Electric power distribution control centers are similar in their concept to transmission control centers. An example of that is Austin, TX, USA, city distribution center that features one continuous wall display with the entire service network, including every system substation (see Figure 4: Austin).

⁸ NYISO Open-Source Control Center by Intel, Part 1 of 14, 2014, 7



Figure 4: Austin Energy's Distribution System Control Center⁹

Another example of a utility control room is gas pipeline monitoring center, PG&E, is a gas pipeline center that oversees 7,000 miles of gas transmission pipelines and 42,000 miles of distribution pipes. Employees in the center have access to thousands of bits of data that are refreshed every 10 seconds. Figure 5: PG&E Gas Pipeline System Control Center demonstrates this control room.



Figure 5: PG&E Gas Pipeline System Control Center¹⁰

CONTROL ROOMS FOR UTILITIES TYPICALLY STREAM TECHNICAL DATA, WHICH HAS TO BE CLOSELY MONITORED, INTERPRETERED, AND ANALYZED ON A CONSTANT BASIS TO ENSURE SAFE OPERATIONS OF THE SYSTEMS. WHILE THE AUDIO IMPACT IS NOT PART OF THIS TYPE OF OPERATIONS, AUDIO ALERTS DRAWING ATTENTION TO SPECIFIC AREAS OF CONCERNS ON LARGE SCREENS MAKE THE APPLICATION OF [REDACTED] TECHNOLOGY BENEFICIAL.



Traffic Control (Transportation, Airports)

Controlling city traffic entails monitoring a multitude of technical data represented by engineering schemes and real-time video feeds. An example of this is Massachusetts Bay Transit Authority control room shown in Figure 6. Its 70' wide wall supports monitoring one of the world's busiest transit systems.¹¹ Timely identification of congested areas and incidents and prompt actions alleviating issues and sending required assistance improves efficiency and public safety.



Figure 6: Massachusetts Bay Transit Authority Control Room

Ensuring safe and properly scheduled airport traffic is critical to avoid costly delays and potential catastrophes. An example of the most recently developed technology for airport traffic is Solution by Saab, which supports monitoring air traffic remotely. For disproportionately expensive airports in sparsely populated areas, there is a potential for reducing costs by centralising air traffic controllers and combining resources in one place. Large airports benefit from remote air traffic control by guaranteeing the promised traffic capacity effectively and reliably even if the existing control tower is eliminated. An example of this is Schiphol, the largest airport in Amsterdam, with a camera system installed to monitor a runway which is hidden and cannot be seen from the air traffic control tower.¹²



Figure 7: Swanwick Airport Control Centre

Public Services, Law Enforcement

Police departments, crisis, and security control centers have the primary goal of monitoring the environment and checking big crowd movements remotely to ensure that preventive measures are taken by police or security forces. Also, taking control during crisis situations becomes easier when such systems are put in place. Main purpose of these monitoring rooms is to watch live/recorded multiple feeds coming from camera systems to take necessary action. Feeds are automatically saved for archiving for later reference.

Public services include healthcare, firefighting and other services that protect public safety. Main control centers direct ambulances, fire trucks and other resources to reach distress calls in time. These control centers also streamline all regional information related to automatic fire alarm systems, offering instant access to data at the click of a button. Every second is vital in public services and all data is delivered and processed in real-time. During crisis situations such as natural disasters, proper coordination between these centers can potentially save hundreds of lives in an instant.

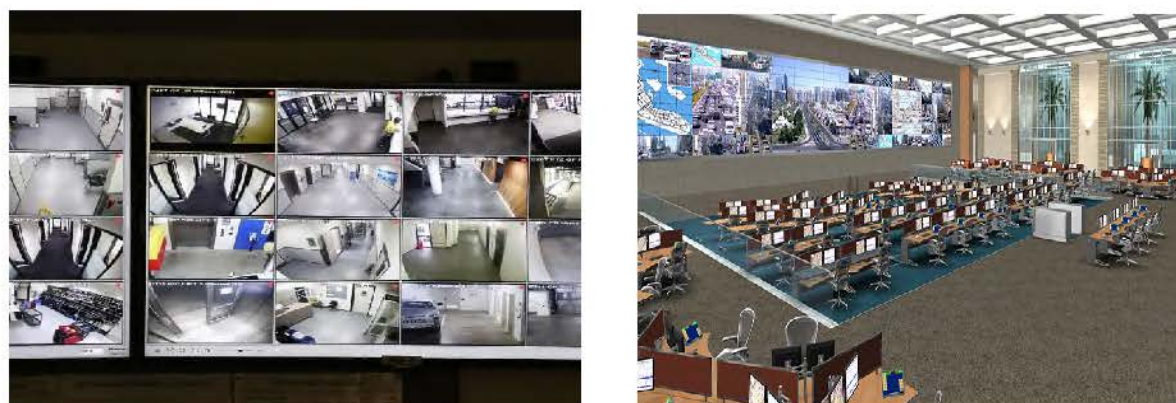


Figure 8: Police Control Rooms in Perth¹³ and Abu Dhabi¹⁴

LAW ENFORCEMENT AND PUBLIC SERVICES CONTROL ROOMS ARE OPERATED BY PERSONNEL OBSERVING REAL-TIME IMAGES STREAMED TO MULTIPLE SCREENS. THEIR OPERATIONAL MODE DEMANDS A VERY QUICK RESPONSE; HENCE THE TIMING IS CRITICAL. AUDIO CAN PLAY A VERY USEFUL PART IN IDENTIFYING CONFLICT SITUATIONS. THE CLIENT'S TECHNOLOGY WILL ADD EXTRA VALUE TO THESE PROCESSES WHEN ALERTS DRAW ATTENTION TO THE SPECIFIC LOCATIONS ON SCREEN.



Military (Defense) and Space

Commonly used for situational control, operations control, planning, simulation, and situational awareness, a military command center serves as a hub where all military communication on weapon systems, air control equipment, radar systems and other data from advanced detection and data transmission equipment is relayed and analyzed.

A large-scale military operation may be conducted by air force components, naval and ground elements, which requires tight coordination and supervision between units frequently located at considerable distances. For example, when several units request air support for their ground troops, command and control specialists must analyze the information, make sure they understand the urgency of each request and prioritize the data to make sure that air force elements will first respond where they are needed the most. At the same time, this information will be sent to troop commanders who will analyze the battlefield situation and decide how to allocate their military resources.¹⁵ Military command centers, as well as space centers are typically situated in large open spaces with a multitude of standard computer screens streaming technical information supported by extremely large display screens usually arranged around the room as shown in Figure 9: Space and Military Command and Control Rooms. These large overhead screens feed the real-time streamed video and analytical information communicating critical developments in the observed areas.



Figure 9: Space and Military Command and Control Rooms¹⁶

MILITARY AND SPACE COMMAND CENTERS USE A WIDE VARIETY OF MEDIA FORMATS. REAL-TIME STREAMED IMAGES / VIDEOS / MAPS ARE TYPICALLY FED TO THE OVERHEAD SCREENS. SIZES OF THESE SCREENS ARE USUALLY EXTREMELY LARGE WITH MULTIPLE ACTIONS OCCURRING SIMULTANEOUSLY, SOMETIMES IN DIFFERENT LOCATIONS. DIFFERENTIATION AMONG THESE LOCATIONS BY SOUNDS CAN HELP DRAW ATTENTION TO THE SPECIFIC LOCATIONS AND EVENTS MAKING [REDACTED] TECHNOLOGY VERY USEFUL.



General Conclusions on Target Market Segments

Review of the basic [REDACTED]'s features and potential industries that use the simulated training technologies led the Consultant to conclude that the most likely industries that would benefit from the Client's technology are Defense (except Air Force), Law Enforcement (Police), Public Services (Firefighters), Transportation, Education (museums, planetariums). Given the limited time allocated to the study, the Consultant reviewed Defense, Police and Firefighting industries. Also, all Air Force-related data is excluded from the analysis.

All control centers reviewed by the Consultant are suitable for [REDACTED] technology.

Current and Forecast Demand of Target Market Segments

Demand for the product is driven by conditions of the industries that it serves. Given the fact that all industries under consideration are state-sponsored, the industry trends are defined mainly by government policies.

Defense

General Overview of Defense Training Simulators

Simulation provides significant benefits to military training, improving overall training efficiency and effectiveness while reducing costs. It provides a means to create realistic training conditions that can either not be physically attained or are considered too dangerous or economically infeasible to create. In some cases, simulators can even provide more effective training than other methods can.

According to Strategic Defence Intelligence, in 2016, the global military virtual training market size was US\$ [REDACTED]¹⁷. In terms of segments, the Military Simulation and Virtual Training market is split into three segments representing the three major shares of the overall sector, as shown in Figure 10: Shares of Military Training Simulators, by Military Branches. Flight simulated training comprises, as expected, the largest part of the market, nearly [REDACTED]%, leaving approximately [REDACTED]% each for maritime and combat, respectively.

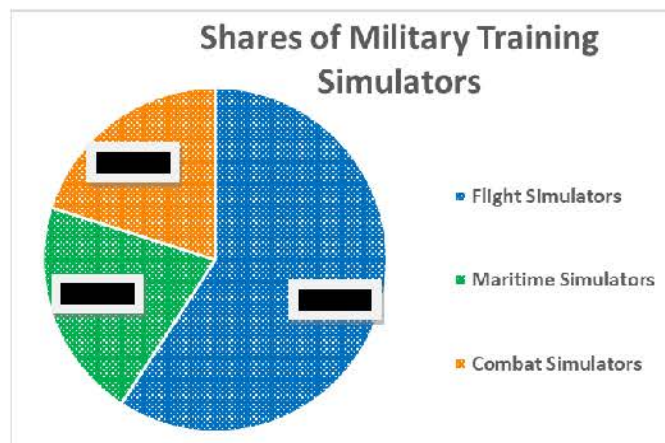


Figure 10: Shares of Military Training Simulators, by Military Branches

Geographically, North America dominates, encompassing over [REDACTED]% of the market, followed by Europe and Asia Pacific, each [REDACTED]%. The Middle Eastern market accounts for [REDACTED]%, followed by the Latin American and African markets with a collective share of [REDACTED]%. the

distribution of world shares is demonstrated in Figure 11: Distribution of Military Simulators Geographically.

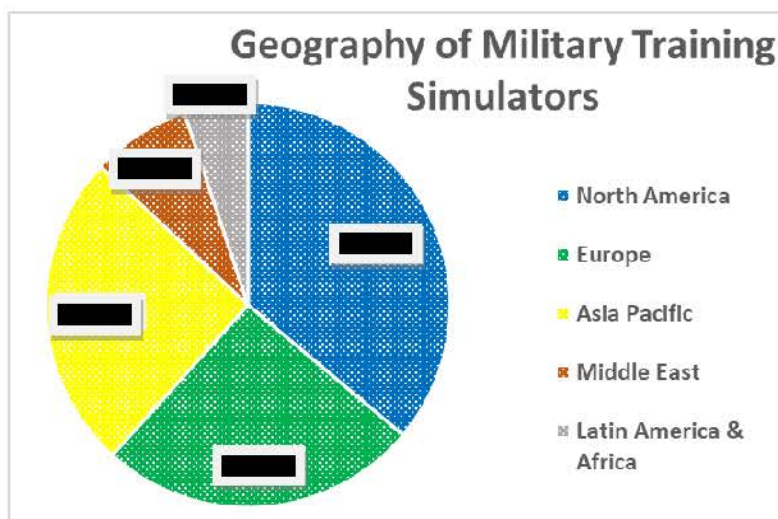


Figure 11: Distribution of Military Simulators Geographically

Military Simulator Census executed by Flightglobal in 2015¹⁸ revealed the following data:

- more than [REDACTED] military aircraft simulation devices were active globally at that time,
- [REDACTED]% of these simulators were supplied by five companies: CAE ([REDACTED]%), L-3 Link Simulation & Training ([REDACTED]%), FSI ([REDACTED]%), Thales ([REDACTED]%), Boeing ([REDACTED]%).
- With more than [REDACTED] simulators, the US Air Force alone accounted for nearly half of the devices in the US – and [REDACTED]% of the world total.
- The US Navy and US Army have shares of [REDACTED]% and [REDACTED]% respectively in the US.
- The US carries [REDACTED]% of the world's aircraft military simulators, with a total of [REDACTED] devices.
- Canada accounts for [REDACTED]% of the world's aircraft military simulators, with a total of [REDACTED] devices.
- Australia has [REDACTED]% of the world's aircraft military simulators, with a total of [REDACTED] devices.

As for the future market growth, there are at least three studies that provide these expectations for the military simulation training.

1. Market Research Future in its Military Simulation and Virtual Training Market Research Report – Global Forecast to 2023¹⁹ of May 2018 projects the global military simulation and virtual training market to grow at approximately [REDACTED]% annually between 2018 to 2023.
2. Strategic Defence Intelligence projects the market to grow at [REDACTED]% annually between 2016 - 2026.

[REDACTED]

3. MarketersMedia expects this market will have an annual growth of █% during 2018-2025.²⁰

For individual countries, the projected future growth for the industry is driven by varying factors such as internal and external security threats, territorial disputes, modernization initiatives, and requirement to cut down on live training programs.

ASSUMPTIONS FOR ALL COUNTRIES' MILITARY FORCES

To develop the future projections for the number of military (excluding flight simulators) installations across different countries, the Consultant assumes the following:

- Three growth rates identified by three studies are considered for three different scenarios.
- The projected future investments will not necessarily be applied 100% to growing the number of simulators.
- It is more likely that at least █% of investments will be used for upgrading existing installations, leaving another half to new installations.
- Given these assumptions, the number of simulators will grow in each country at the following rates, provided the country commits to investing:
 - Low Growth Scenario █
 - Medium Growth Scenario █
 - High Growth Scenario █

Canada

Armed Forces Historical and Projected Growth

Over the last 27 years (1990-2017), Canadian military force has been experiencing an overall decline in the number of armed personnel, dropping from █. In the '90s, the end of the Cold War triggered a relief after the extended arms race accompanied by reduced financing and contracted man force. The last 13 years, starting in 2004, were a period of stability recorded by the Canadian military, as shown in Figure 12: Historical and Projected Military Personnel in Canada (1990-2030) with restored financing and gaining armed forces.



Figure 12: Historical and Projected Military Personnel in Canada (1990-2030)²¹

Despite this period of clear stability, Canadian military officials state that the military is still short about [REDACTED] regular-force members and [REDACTED] reservists²² caused by insufficient government funding.

However, after the U.S. President Donald Trump demanded that NATO's member countries increase their spending on defense forces to meet the NATO goal of spending at least [REDACTED]% of GDP on defense, Canadian Defence Minister Harjit Sajjan announced that military spending will grow [REDACTED]% to reach [REDACTED] ([REDACTED]) in a decade. That means Canada would spend about [REDACTED]% of gross domestic product on defense by 2026-2027, up from about [REDACTED]% now.²³ The current government plan is to increase the regular force to [REDACTED] members from its authorized strength of [REDACTED] and the reserves to [REDACTED] from [REDACTED] to defend against growing global instability and emerging threats such as cyber and terrorism.

Based on the above information, the Consultant believes that state investment into the military force will also contribute to the growth in training spending, including simulation technology.

Major Simulation Institutions

Canada has already set the scene for simulation training by the military. The Canadian Army Simulation Centre (CASC) is the central body²⁴ providing synthetic environment capabilities in support of land operations, training, and concept development. CASC is a support organization that provides support to Canadian Army, Canadian Armed Forces, Royal Canadian Armed Forces, Other Government Department located in Kingston, ON, with Divisional & Centre Simulation Center Simulation Centres located in the following locations:

[REDACTED]

[REDACTED]

[REDACTED]

maintains its commitment to investing in military and modernization of training. The results of estimates are demonstrated in Figure 13: Projected Growth of Army and Navy Simulators in Canada.

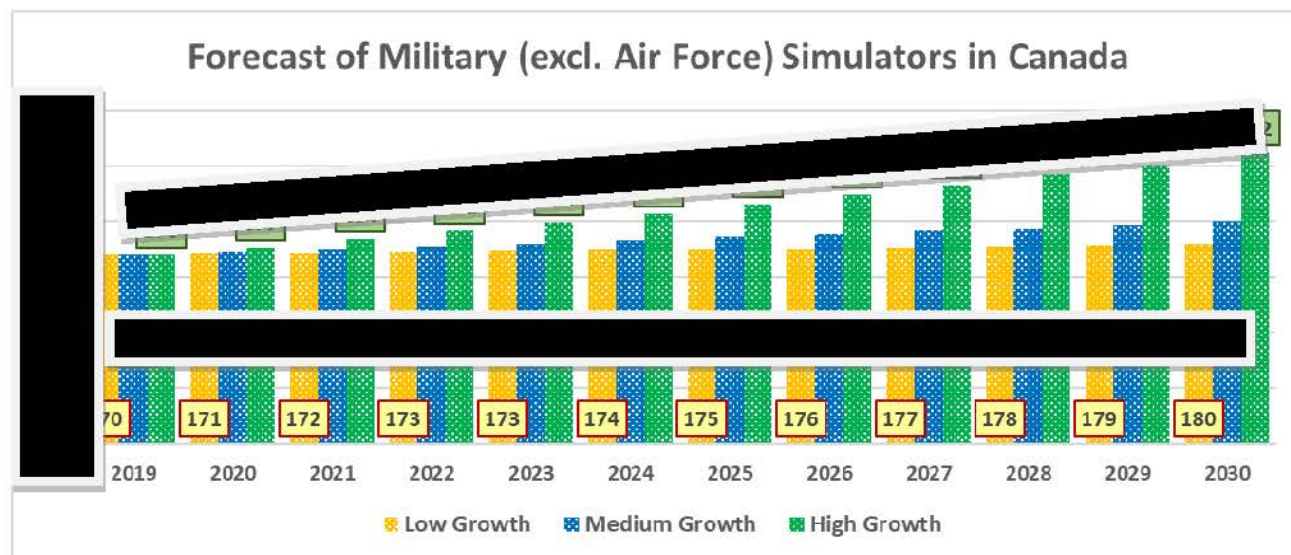


Figure 13: Projected Growth of Army and Navy Simulators in Canada

USA

In July 2007, US House Resolution [REDACTED] officially recognized Modeling and Simulation (M&S) as a National Critical Technology. This was official acknowledgement of nearly seven decades of contributions by M&S to varied areas. The USA has led the world in the application of M&S to several sectors, particularly in defense, where M&S technologies have been used to support analyses of strategic operations and training of military forces. Estimates range from \$ [REDACTED] spent each year by the USA Department of Defense (DoD) on M&S tools, processes, and products.²⁸

Armed Forces Historical and Projected Growth

Similar to other NATO countries, USA sustained a significant drop in military force in the '90s following the end of the Cold War. Some uptake took place in the beginning of 2000s on the wave of Iraq and Afghanistan wars followed by a drop starting in 2010 as shown in Figure 14: Historical Military Personnel in USA (1990-2030).

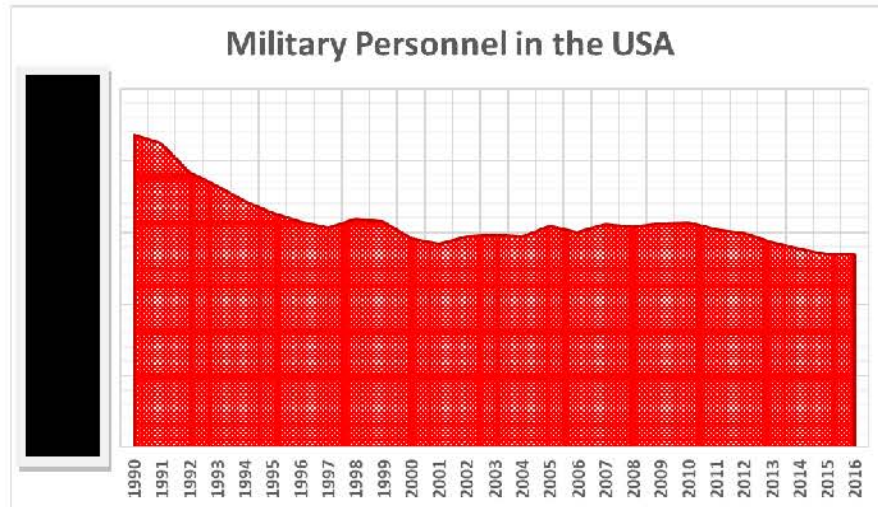
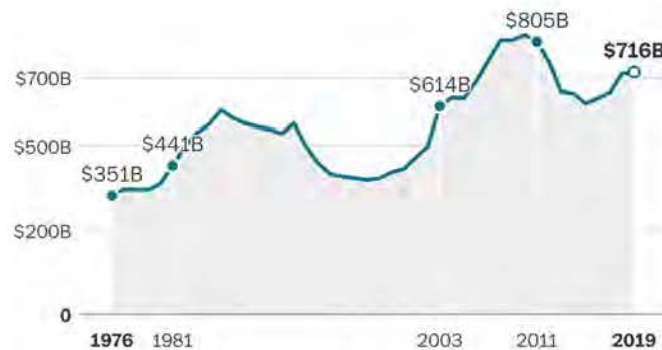


Figure 14: Historical Military Personnel in USA (1990-2030)²⁹

Meanwhile, the current government has pushed the military budget higher. The 2019 military budget gives America's armed forces an \$[REDACTED] increase from 2017 totalling \$[REDACTED] for 2019, about [REDACTED]% of America's \$[REDACTED] federal budget, making it one of the biggest defense budgets in modern American history³⁰, as shown in Figure 15:US Military Spending, 1976-2019.

U.S. military spending is higher than at any time other than the height of the Iraq war, adjusted for inflation



1976 was the earliest year with complete data. Includes the military's overseas contingency fund. Numbers in billions.

Source: Center for Strategic and International Studies

THE WASHINGTON POST

[REDACTED]

[REDACTED]

[REDACTED]

Figure 15: US Military Spending, 1976-2019³¹

According to the Congressional Budget Office's analysis, if the Trump Administration's goals for increasing the readiness, size, and capabilities of the military were pursued, cumulative costs would be \$ [REDACTED] (or [REDACTED]%) higher from 2018 through 2027 than costs of the Obama Administration's final budget plan for those same years. About half of that difference would result from implementing the Trump Administration's goals for expanding the size of the military after 2018. The other half of that difference would accrue primarily because more spending is planned for readiness and for research and development.³²

Breakdown of the major cost lines, as shown in Figure 16: demonstrates a budget increase in Acquisition in years 2019 – 2027. This is a positive sign for simulation manufacturers as new training installations are likely to be allocated under this cost section.

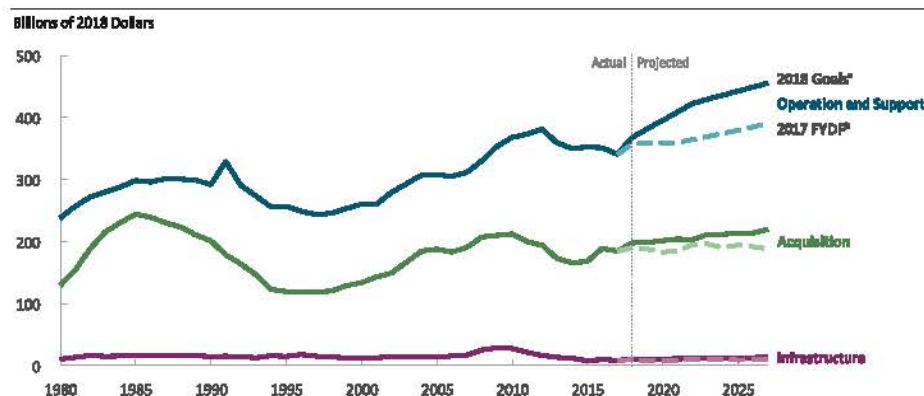


Figure 16: Operation and Support, Acquisition, and Infrastructure Costs in DoD's Base Budget under CBO's Projections of the Administration's Goals for the Military, 2018 \$billion

Also, assignment of the budgeted increases among different military branches, as shown in Figure 17: CBO's Projections of the Differences in Costs in Selected Years That Would Result from Increasing the Size of the Force After 2018 to Meet the Administration's Goals, 2018 Billion, the largest increase are planned for army and navy, military branches which are the Client's target markets.

[REDACTED]

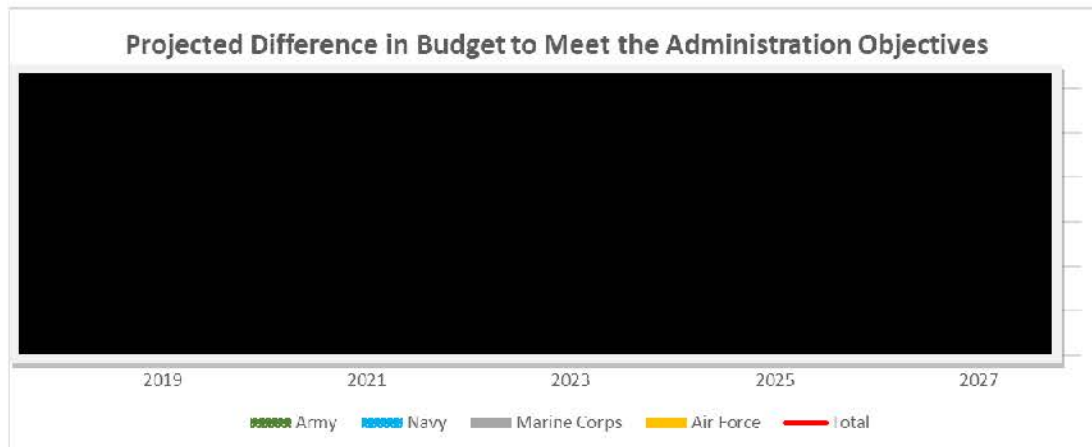


Figure 17: CBO's Projections of the Differences in Costs in Selected Years That Would Result from Increasing the Size of the Force After 2018 to Meet the Administration's Goals, 2018 Billion\$

Major Simulation Institutions and Schools

The US Department of Defense (DoD) and United States Department of Homeland Security established a centralized system that would streamline the process of providing the simulation training technologies. Some of the founded entities are:

- The Simulation and Training Technology Center³³, in Orlando, Fla, a provider of applied research to develop simulation technologies.
- The Simulation Training Center³⁴ at Fort Lee, Virginia, provides individual and collective training and simulations.

Developments by simulation technologies centers are then shared with the educational institutions. The U.S. military operates many types of schools to train members of the U.S. military, foreign militaries, and civilians in certain fields. The military academies are colleges that train future officers. Some of the military schools include:

- National Defense University
- Army War College
- Naval War College
- Air Force Institute of Technology
- Air University
- Defense Acquisition University
- Defense Language Institute



- Naval Postgraduate School
- Defense Information School

There are five military academies:

- United States Military Academy — Army
- United States Naval Academy — Navy and Marine Corps
- United States Coast Guard Academy
- United States Merchant Marine Academy
- United States Air Force Academy

Forecast of the US Defense Simulators

ASSUMPTIONS FOR THE USA DEFENSE

To develop future projections for military (excluding flight) simulators in the USA, the Consultant assumes the following:

- The number of Air Force simulators in 2015 was [REDACTED] as reported by the Flightglobal's Military Simulator Census.
- The share of flight simulators is appr. [REDACTED]% of the total number of military simulators, per Strategic Defence Intelligence, as described in section General Overview of Defense Training Simulators, thus bringing the number of military simulators (excluding flight) to approximately [REDACTED].
- The growth rate of the USA military simulators is the same as that determined in Assumptions for all countries in section General Overview of Defense Training Simulators.

The Consultant estimates the maximum number of simulators between now and the year 2030 to reach [REDACTED] under Low Growth Scenario and [REDACTED] under High Growth Scenario provided the USA maintains its commitment to investing in military and modernization of training. The results of estimates are demonstrated in Figure 18: Projected Growth of Army and Navy Simulators in the USA.

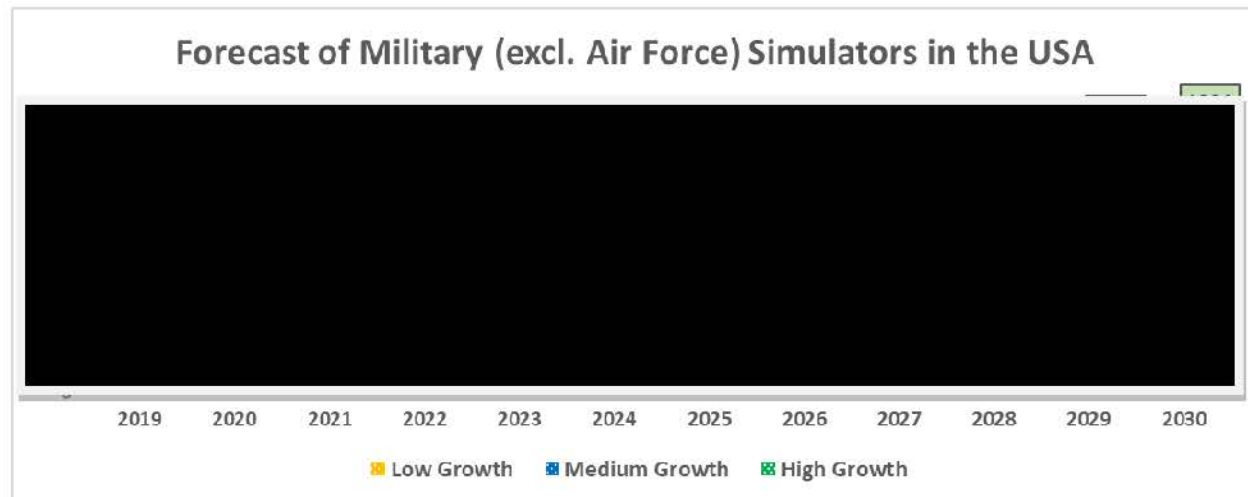


Figure 18: Projected Growth of Army and Navy Simulators in the USA

Australia

Armed Forces Historical and Projected Growth

Following the trend of other NATO nations, Australia's military sustained a dip in the 90s', which was partially recovered by the mid-2010s, as shown in Figure 19: Historical and Projected Military Personnel in Australia (1990-2030)

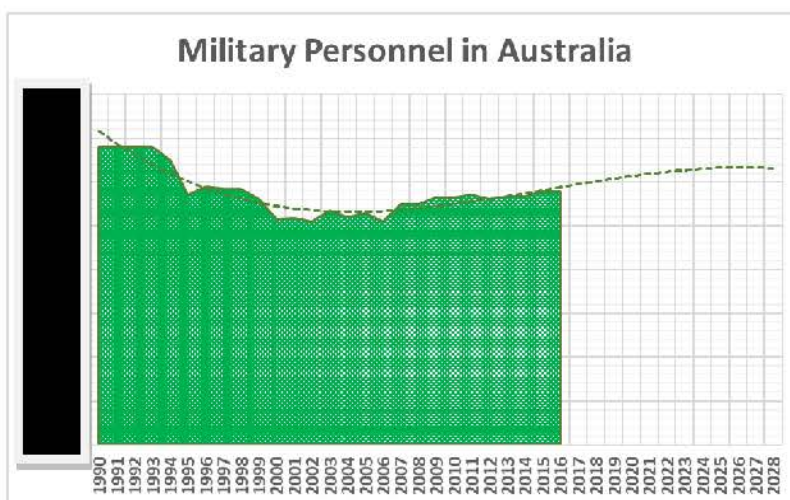


Figure 19: Historical and Projected Military Personnel in Australia (1990-2030)³⁵

Similar to the USA and Canada, the Australian military budget is expected to experience an upward movement. According to the public announcement by the Australian Department of Defense, Australia's defense spending increase from A\$ [REDACTED] in fiscal year 2016-17 to A\$ [REDACTED] in 2025-26. That is an [REDACTED] % jump in expenditure over the next decade.³⁶ Defense spending is slated to grow to A\$ [REDACTED] by 2020-21, reaching [REDACTED] percent of Australia's GDP. Overall spending in the next ten years for "investment in new and enhanced capabilities" will add up to A\$ [REDACTED]; this is the cost that includes, among others, simulation technologies.

Major Simulation Institutions

Australian military³⁷ has been building simulation capability. Some of the better-known centres are Thales Ocean Lab, and the ADI/Thales Australian Transformation and Innovation Centre. Some of the more significant publicly reported centres that support simulation training are listed below.

Army. Army is supported by the Army Simulation Wing to manage, develop, and foster simulation within the Army. Army's significant simulation capabilities include at least 5 major centers and a lab:

- Battle Simulation Centres – based in Puckapunyal, Brisbane, Townsville and Darwin, these centres use virtual and constructive simulation to deliver individual and collective training to support units within Army.
- Combat Training Centre – based in Townsville, this centre uses live and constructive simulation to support the delivery of collective training for Army.
- Land Command Battle Laboratory – has the role of maximising campaign planning, force preparation and operational capabilities through the exploitation of simulation, modelling, operational analysis, and war gaming in order to win the land battle.

Navy. Navy is supported by the Navy Simulation Office to coordinate simulation activities within Navy. Navy's significant simulation capabilities are:

- Maritime Warfare Training System (MWTS) – is primarily a training capability to enhance Warfare Command Team Training and combatant fleet operational readiness. It supports synthetic training exercises with other states.
- Maritime Warfare Bridge Training Facility – located in Sydney, uses a simulator to provide realistic training required for Junior Seaman Officers to become fully capable of carrying out the duties of the Officer-of-the-Watch in all classes of RAN ships.

[REDACTED]

[REDACTED]

- Navy Experimentation – uses constructive simulation (JSAF, HARPOON) to examine Navy force preparation and operational capabilities.
- Australian Defence Simulation Training simulators for its fleet air arm of Sea King, Sea Hawk, and Seasprite helicopters.

Aside from the internal training centres, Australia is a part of the NATO network that provides joined training. In 2006, the Defense Information Systems Network Security Accreditation Working Group approved U.S. Joint Forces Command's request allowing the command to connect the Joint Training and Experimentation Network and Australia's Defence Training and Experimentation Network (DTEN).³⁸ This new capability allows nations to link simulation networks so they can train together in a live, virtual and constructive environment which blends live tactical forces with manned simulators and sophisticated computer models.

Figure 20: Australia Defence Training and Experimentation Network demonstrates military bases that are connected to the DTEN Network. Simulation centers that are used for the internal simulation training, mentioned above, are part of DTEN Network so it will be safe to conclude that these 30 bases marked on the map are the prime locations with the installed training simulators of varying scale.

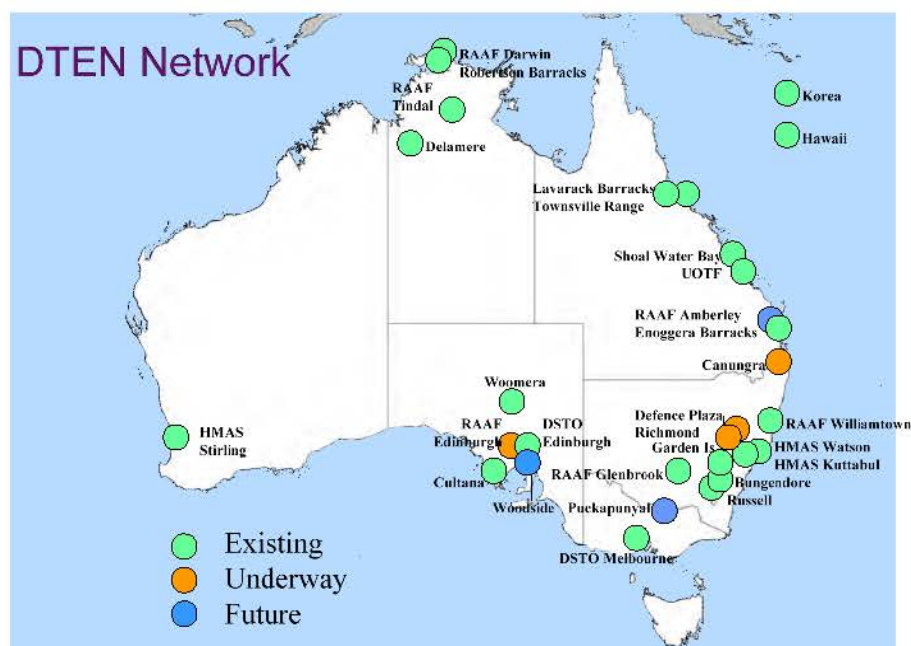


Figure 20: Australia Defence Training and Experimentation Network ³⁹

Australian Defense ministry dedicates significant resources to modernize training by expanding its simulation training capacity.

[REDACTED]

In 2017, Ministry of Defense entered into two contracts with Rockwell Collins Australia on simulation technology. These simulators form part of a larger joint fires training system that offers dedicated facilities for eight fully immersive training centers.

- On March 22⁴⁰, a \$ [REDACTED] contract to supply Digital Terminal Control System simulators to be installed at bases in Brisbane, Townsville and Darwin and complement an existing simulator at RAAF Base Williamtown was announced.
- In October⁴¹, a contract of \$ [REDACTED] was signed to install new simulators at bases in Brisbane, Townsville, Darwin, Perth, Sydney, Williamtown, and Puckapunyal.

The Australian Defence Portfolio Budget 2018-19⁴² also included a proposed project for a new simulation system. The proposed construction of a new purpose-built facility located at HMAS Harman, or for the lease and fit out of a commercial facility within Canberra is subject to Government and Parliamentary approval. Construction is planned to commence in early 2021 and be completed by early 2022.

Forecast of Australian Defense Simulators

Appendix B: Australian Major Defense Force Bases and Dispositions lists [REDACTED] major military ([REDACTED] of which are Air Force) bases and dispositions, which also include educational institutions⁴³. It is likely that all [REDACTED] of them (excluding Air Force), will have simulation installations at some point.

ASSUMPTIONS FOR AUSTRALIAN MILITARY

To develop the future projections for military (excluding flight) simulators in Australia, the Consultant assumes the following:

- The number of Air Force simulators in 2015 was [REDACTED], as reported by the Flightglobal's Military Simulator Census.
- The share of flight simulators is appr. [REDACTED]% of the total number of military simulators, per Strategic Defence Intelligence, as described in section General Overview of Defense Training Simulators, thus bringing the number of military simulators (excluding flight) to approximately [REDACTED].
- The growth rate for the Australian military simulators is the same as that determined in Assumptions for all countries in section General Overview of Defense Training Simulators.

The Consultant estimates the maximum number of simulators between now and the year 2030 to reach [REDACTED] under Low Growth Scenario and [REDACTED] under High Growth Scenario provided Australia maintains its commitment to investing in military and modernization of training.

[REDACTED]

The results of estimates are demonstrated in Figure 21: Projected Growth of Army Simulators in Australia.

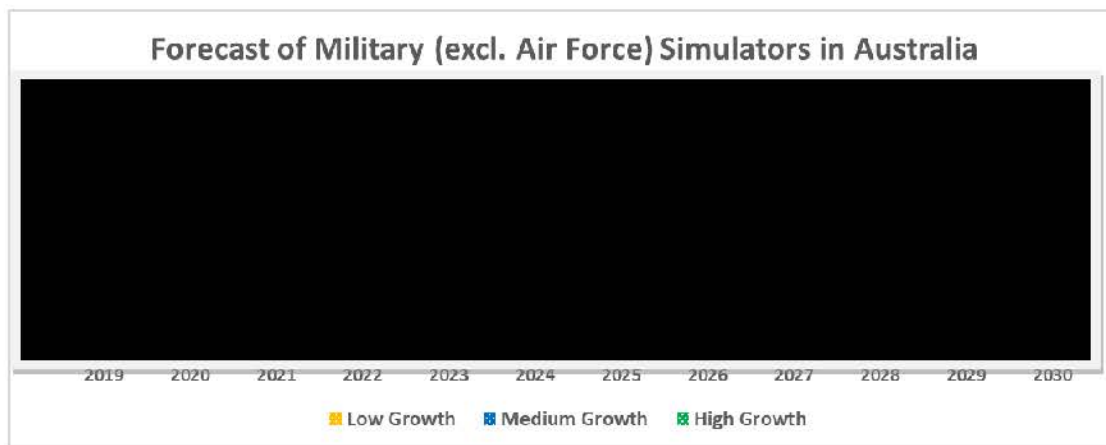


Figure 21: Projected Growth of Army Simulators in Australia

Police

General Overview of Police Training Simulators

The history of using simulation training technology by police forces (law enforcement) can be dated back to 1973 when the Los Angeles Police Department first announced the launch of the firearms training simulator at its police academy facility in the city's Elysian Park⁴⁴.

In the mid-'90s new training came into play that used video scenarios on a big screen and you would have to interact with it (MILO | FATS). Those scenarios were not very interactive for the law enforcement officers being trained, because the people in the video did not respond appropriately to the commands that were being given out.⁴⁵ Virtual reality changed that. With the advent of virtual reality goggles, virtual reality training has taken off in law enforcement training. The technology comes from the gaming industry. The vendors that develop the training programs are all mostly current or previous gamers. The scenarios are typically set in 360-degree photos of actual locations, such as schools or city halls that you would really respond to, which makes the situation very realistic.



Figure 22: Virtra 300 wraparound simulator to improve shooting and judgment skills⁴⁶

Virtual reality simulators serve several purposes for the police force.

- Budget: reduce the travel costs, facility and ammo expense, and instructor fees associated with live training and support. Although the initial cost can be significant to a department, simulators significantly cut the overall costs for training long term.
- Improved skills: essential training, especially marksmanship training, is typically conducted live a few times a year resulting in diminished shooting skills. Simulators fill that gap by allowing departments year-round access to realistic shooting programs that keep their officers proficient.
- Reduces officer risk and agency liability. Distributed workforces can be trained to perform complex tasks with less risk to staff or equipment. One of the biggest improvements is the reduction in lawsuits.

There are four major types of simulation training for police officers:

Driving: various scenarios allow trainees to practice dangerous police-driving manoeuvres in a risk-free environment. The simulators can be customized to feature adverse driving situations and extreme traffic conditions.

Shooting: synthetic firing ranges are becoming necessary facilities for police force training.

Situational judgement: video-based synthetic situations immerse trainees into real-world settings, using critical thinking skills to manage risks while under stress. The simulator provides the opportunity to experience a taste of that stress, in the most controlled environment possible.

Terrorism: this is the most recent addition to the police force training scope. With the number of terrorist-related incidents increasing, and the method of attacks evolving, regular proactive

Training of police officers is performed in structured educational institutions (Police academies), as well as onsite (police agencies); both of these locations use simulation technology. Hence, the assessment of police simulation training technology covers police agencies and police training institutions.

Overview of Policing Authorities in Canada

There are 706 RCMP detachments⁴⁸, ■■■ stand-alone municipal police services and ■■■ First Nations (self-administered services created under agreements with the federal, provincial, and territorial governments along with the communities looking to administer their own police service). The summary of all levels of policing in Canada is in the table below:

Province	Federal (## of detachments)	Provincial	Municipal, First Nation
British Columbia	152	Managed by RCMP	11 departments: • Abbotsford Police Department • Central Saanich Police • Delta Police Department • Nelson Police Department • New Westminster Police Service • Oak Bay Police Department • Port Moody Police Department • Saanich Police Department • Vancouver Police Department • Victoria/Esquimalt Police Department • West Vancouver Police Department
Ontario			
Alberta.			
Manitoba			

The police force in Canada is sustained on a stable level with the ratio of over [REDACTED] police officer per [REDACTED] population. Reported by Statistics Canada⁵², the number of police officers continues to grow, as shown in Figure 23: Historical Police Force in Canada and Expected Future Trend, 1962 - 2030. It is highly likely that an overall growing trend in the number of police officers will continue supporting investing into police training.

S2 Statistics Canada: "Trends in police personnel, Canada, 1962 to 2016", <<https://www150.statcan.gc.ca/n1/pub/85-002-x/2017001/article/14777Ab1Ab101-eng.htm>>



Figure 23: Historical Police Force in Canada and Expected Future Trend, 1962 - 2030

Police Simulation Training Facilities

Police training in Canada takes place mainly through Police Academies, some of which offer both recruit and in-service type training for sworn police officers currently employed in public police services. There are seven federal and provincial academies in Canada, out of which only three offer simulation training experience.

Justice Institute of British Columbia, New Westminster, BC

JIBC offers the Dr. Donald B. Rix Public Safety Simulation Building and the award-winning Praxis computer simulation technology. Using these and other resources, JIBC incorporates immersive, interactive, problem-based experiential computer simulation scenarios for programs and courses across the Institute, as well as in customized contract training. JIBC has worked with government agencies and private industry to produce simulation scenarios of catastrophic events and critical incidents. The building includes six specially designed and equipped rooms adjoining a central meeting room with large screens for projection of information, plus a control room that digitally monitors and directs the delivery of simulations.

Holland College, Charlottetown, PEI

In association with Holland College, the Canadian Centre of Public Safety Excellence offers five programs: Basic Firefighting, Conservation Enforcement, Correctional Officer, Police Science (Cadet), and Sheriff and Public Safety Officer.

Canadian Centre of Public Safety Excellence⁵³ boasts Use of Force simulator, from Ti Training Corp. The system provides in excess of [REDACTED] interactive training scenarios from Active Shooter to routine patrol calls, for police, corrections, sheriff's, and conservation officers. The system interacts with baton, OC spray, Taser®, pistol and carbine allowing the participant to experience real life training situations, including a shoot back option, when called for. With a scenario

⁵³ The Canadian Centre of Public Safety Excellence <<https://ccspe.ca/>>

Driving Simulator: six monitors provide 360 degrees of graphics and visibility, and combined with surround sound, an interactive driver's seat and console, the user will experience as near to a real life experience as possible.

In addition to training new RCMP regular members, Depot has also been a major continuing-education centre for police in Canada. It delivers updated and highly specialized training to experienced RCMP officers and to members of other forces from around the world. Many Canadian municipal and provincial police forces hire police officers who graduated from the RCMP Academy. Its Technology Support Services⁵⁴ have added several simulations and synthetic (virtual) environments:

- Saskatchewan Police College, Regina, SK

Ontario Police College, Aylmer West ON

École nationale de police du Québec, Nicolet, QC

Canadian government institution which offers continuing-education courses for currently employed police officers, the college is a national police service of the RCMP.

The survey conducted by the Canadian Police College (CPC) in 2003 examined how simulator systems were used by the Canadian police community⁵⁵. Questionnaires were distributed to 100 police agencies of which 60 responded. Of these 60 agencies, 30 had access to a simulator, with an additional 10 agencies reporting that they planned to start using a simulator in the next year.

Forecast of Canadian Police Simulators

ASSUMPTIONS FOR CANADIAN POLICE

To develop the future projections for police simulators in Canada, the Consultant assumes the following:

- The total number of simulators used by [REDACTED] surveyed police agencies was [REDACTED] in 2004, which constitutes [REDACTED]%; this percentage is applied to calculate the total number of simulators used by all police agencies at the beginning of the forecast period.
- By the end of the forecast period, [REDACTED]% of all municipal and RCMP agencies will have at least one simulator.
- The total number of municipal and police agencies will increase from [REDACTED] in 2018 at a half rate of the police force growth over the same period of time in the past, the total is equivalent to [REDACTED]% annual.
- All [REDACTED] police training academies will have at least [REDACTED] simulators by the end of the forecast period.

The results of the calculations are shown in Figure 24: Forecast of Police Simulators in Canada. As expected, the total number of simulators in agencies and academies will be close to [REDACTED] by year 2030.

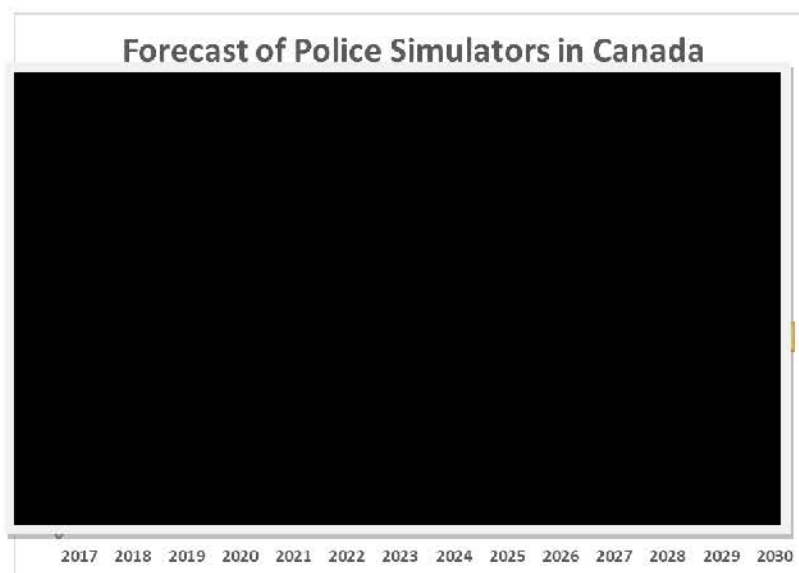


Figure 24: Forecast of Police Simulators in Canada

USA

According to the data reported by the U.S. Department of Justice⁵⁶, the police force in the USA has been growing at a steady pace between 1992 and 2012. The number of police officer per [REDACTED] of population, however, has been dropping since 2007 from [REDACTED], which means that the police force cannot grow at the same rate as the population. This is also aggravated by a slight decrease of [REDACTED]% in the total number of officers between 2009 and 2014. Number of police agencies also has been on an uptake, growing from [REDACTED] in 1992 to [REDACTED] 2012. The historical data and projected trend are shown in Figure 25: Historical Police Force and Police Agencies in the USA and Projected Future Trend, 1992 - 2030.

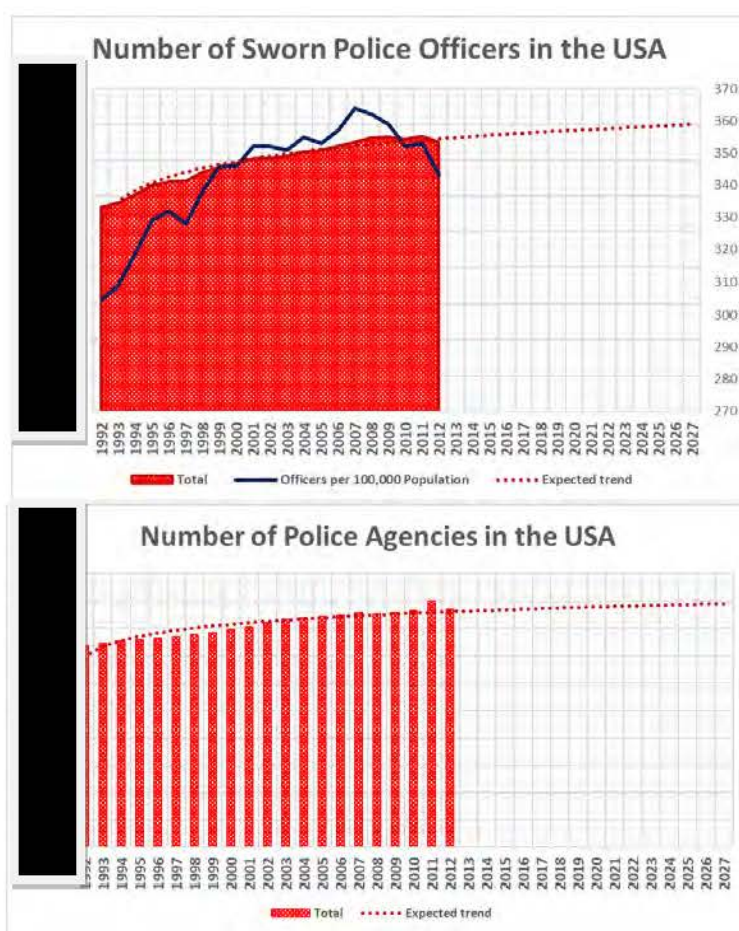


Figure 25: Historical Police Force and Police Agencies in the USA and Projected Future Trend, 1992 - 2030

Policing in the United States is conducted by federal, state, local and city departments. Every state has its own nomenclature for agencies, and their powers, responsibilities and funding varying from state to state.

⁵⁶ US Department of Justice: "National Sources of Law Enforcement Employment Data" of 2016, <https://www.bjs.gov/content/pub/pdf/nsleed.pdf>

The San Francisco Police Department is one of 200 law enforcement agencies nationwide to purchase a simulator from VirTra for \$467,000, which also outfits branches of the military with 300-degree units. Beyond the immersive experience, users can be equipped with an electroshock device so when they're theoretically shot, they get zapped with enough volts to drop them to their knees. Trainees are also given real-time feedback and can pull up a report and discuss each scenario with the officer.

That emphasis on de-escalation comes as the department adopts recommendations by the Department of Justice following controversial fatal police shootings, including the 2015 killing in the Bayview of Mario Woods.

Police in the USA has been under severe scrutiny by the public recently. One of the key issues the US police has been facing is damage to its public image caused by multiple police shooting at civilians, sometimes unarmed. Rates of fatal police shootings in the U.S. are among the highest of any other developed country, with about [REDACTED] civilians killed each year. This data comes from the Washington Post's "Fatal Force Database," which is typically used by researchers:

- 2015: [REDACTED] civilians were shot by American police;
- 2016: [REDACTED] civilians were shot by American police;
- 2017: [REDACTED] civilians were shot by American police.

In some places, the situation got so serious, that local lawmakers are establishing rules for police to have simulator training in de-escalation. Thus, in March 2016, Utah passed a [bill](#) that explicitly authorizes the attorney general to fund and support a statewide virtual reality training center for use of force and de-escalation policies for agencies across the region.⁵⁷

Training centers across the US are now using virtual reality to train officers to shoot more accurately – it also helps them to decide whether to shoot at all.⁵⁸

Federal Law Enforcement Training Centers

On Federal level, the Federal Law Enforcement Training Centers (FLETC), a component of the Department of Homeland Security (DHS), serves as an interagency law enforcement training organization

for 95 Federal agencies. headquartered in Glynco, Georgia, near the port city of Brunswick, the FLETC also provides services to state, local, tribal, and international law enforcement agencies.

In addition to Glynco, the FLETC operates two other residential training sites in Artesia, New Mexico, and Charleston, South Carolina. The FLETC also operates a non-residential in-service requalification and advanced training facility in Cheltenham, Maryland, for use by agencies with large concentrations of personnel in the Washington, DC area.

[Glynco, GA](#), has firearm simulators and a total of [REDACTED] MPRI's PatrolSims driving simulators installed.⁵⁹ The Strategic Plan 2016-2018⁶⁰ promises the site a new simulation building to deliver

training using simulation technology in areas such as driving and firearms. The current facility was designed more as a proof-of-concept facility than an actual training facility. The new facility would be designed specifically with training as the end goal. Another facility for use-of-force simulators is also included in the Strategic Plan. Funding for construction or renovation of a facility to house the VirTra simulators is presumed to be provided to FLETC from CBP.

[Artesia, NM](#), site has judgmental pistol shooting simulators and several PatrolSim™ driver training simulators. Also, according to the Strategic Plan 2016-2018, it will receive a new simulator building to house and centralize various simulators for firearms and driver training.

[Charleston, SC](#), according to Strategic Plan 2016-2018, will have a new ship simulator to support training that currently occurs on the Cape Chalmers by FLETC partner organizations. This facility will alleviate scheduling conflicts for maritime training and will be available for use by all maritime training entities.

[Cheltenham, MD](#) has firearm and MPRI's PatrolSims driving simulators installed.⁶¹

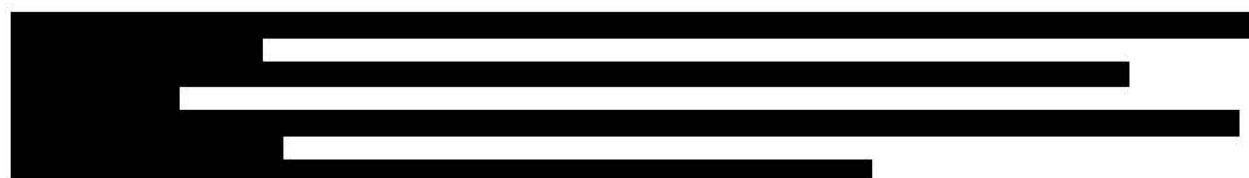
[Orlando, Florida](#) site is specialized specifically in evaluating new and existing training technologies for their ability to meet law enforcement training needs and is dedicated in developing various simulation training systems.

A grant from the Urban Areas Security Initiative Program funded the \$95,000 simulator, which will be used to train Arlington high schoolers and officers in over 600 customizable scenarios at the district's Dan Dipert Career and Technical Center. The Ti Training Corp. TL-102 system includes a 32-foot screen, three projectors, and a virtual arsenal of a flashlight, gun, Taser and mace.

*Dallas News, Sept 1, 2018:
"\$95K simulator puts Arlington students, police to the test with*

State and Local Training Centers and Academies, Usage of Training Simulators

Local law enforcement entities are under jurisdiction of the state or municipality and some of them develop training programs independently. For example, California has a program, Regional Skills Training Centers⁶² under which [24 Regional Skills Training Centers](#) (RSTCs) provide a cost-effective way to meet the perishable skills training needs of more than [REDACTED] sworn California officers. The sites are equipped with Law Enforcement Driving Simulators and/or Force Options Simulators, as well as skid training cars and platforms, training



mannequins, computers, LCD projectors and other related training equipment. Implementation costs for each site are about \$[REDACTED]. Total equipment cost is approximately \$[REDACTED].

Summary of California-based police training facilities using simulators for training purposes is below.

Alameda County Sheriff's Department 6289 Madigan Road Dublin, CA 94568-3315 (925) 551-6970 Law Enforcement Driving Simulator and Force Options Simulator	Redding Police Department 1313 California Street Redding, CA 96001-0698 (530) 225-4285 Force Options Simulator	Santa Rosa Junior College Public Training Center 5743 Skylane Boulevard, Windsor, CA 95492 (707) 837-8843 Mobile Law Enforcement Driving Simulator and Force Options Simulator
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Simulation training has become a standard mode of training in police academies. The 2002 Census of Law Enforcement Training Academies was the first effort by the Bureau of Justice Statistics to collect information from the US law enforcement training academies, which included, among other data, information on simulation technology used by them. The census was also conducted in 2006 and 2013. Summary of the findings is below.

- In 2002⁶³, [REDACTED] state and local academies were operating in the United States that offered basic law enforcement training to individuals recruited or seeking to become law enforcement officers. In addition to basic recruit training, [REDACTED]% of the academies provided in-service training for active duty, certified officers. Simulated firearm training has been encompassing a larger part of the training compared to other types of simulated training. In 2002, less than [REDACTED] of all academies had access to a driving simulator ([REDACTED]%) and [REDACTED]% had access to firearms training simulator.
- In 2006⁶⁴, [REDACTED] state and local law enforcement academies were providing basic training to entry-level recruits in the United States. Of them, [REDACTED], ([REDACTED]%) were operated by an academic institution, such as a 2-year or 4-year college, a university, or a technical school. Municipal police departments were the primary operating agency for [REDACTED] academies, [REDACTED]% of the total. Sheriffs' offices operated [REDACTED] academies ([REDACTED]%), and state police and highway patrol agencies operated [REDACTED] academies ([REDACTED]%). State Peace Officer Standards and Training (POST) Commissions, the agencies typically responsible for certifying law enforcement officers in each state, operated [REDACTED] academies ([REDACTED]%) nationwide. By 2006, the number of driving simulators increased to [REDACTED]% of all training institutions while the access to firearm training simulator has not changed, percentage-wise.

- By 2013, the total number of training academies increased to █. Nearly half (█%) of the academies that provided basic training for new recruits were based at an educational institution such as a 2-year college (█%), 4-year college or university (█%), or technical school (█%) (table 1). Municipal police departments operated █% of academies, sheriffs' offices operated █%, and state police or highway patrol agencies operated █%. State Peace Officer Standards and Training (POST) agencies, which typically certify peace officers, operated █% of academies.⁶⁵ In 2013, the number of driving simulators increased to █% and firearms – to █% of training institutions.

The total number of police academies increased between 2002 and 2013, as shown in Figure 26: Number of Police Academies in the USA, 2002-2013. The data demonstrates that the highest (█%) growth between 2002 and 2013 took place in Municipal/City Academies.



	2002	2006	2013
State POST*	█	█	█
State police/patrol	█	█	█
Sheriff's office	█	█	█
County police	█	█	█
Municipal police	█	█	█

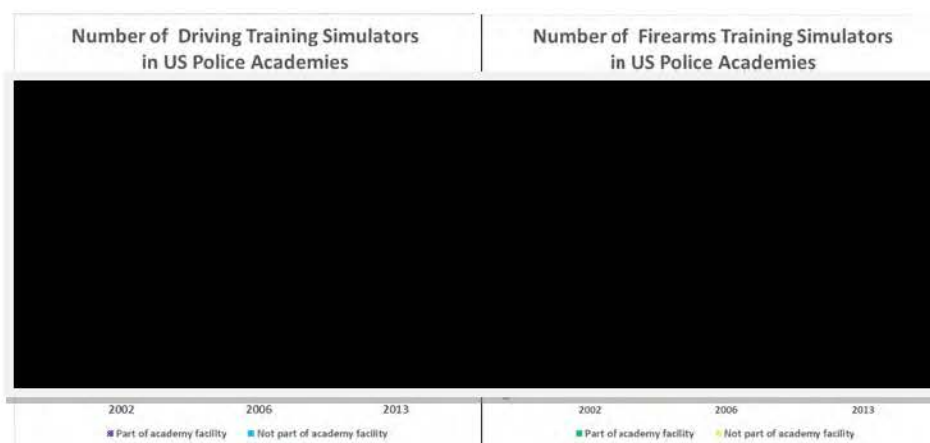
U.S. Customs and Border Protection (CBP) conducted a comprehensive redesign of the U.S. Border Patrol's Basic Training program, including curriculum updates and a focus on reality-based training. The new program began in 2016. CBP also installed 18 use-of-force training simulators at training facilities throughout the country. The simulator training incorporates ten scenarios based on CBP specific, real-world events.

CBP Border Security Report, December 22, 2015

	2002	2006	2013
College/university	■	■	■
Multi-agency	■	■	■
Other	■	■	■
TOTAL	■	■	■

Figure 26: Number of Police Academies in the USA, 2002-2013

Figure 27: Number of Police Simulators Used by the USA Police Academies, 2002-2013 demonstrates how the numbers of simulators, used either onsite or offsite, have been growing since 2002. In fact, the number of onsite firing simulators has increased by ■% and driving – by ■% over this period of time.



		2002	2006	2013
Firearms training simulators	■	■	■	■
	■	■	■	■
Driving simulators	■	■	■	■
	■	■	■	■

Figure 27: Number of Police Simulators Used by the USA Police Academies, 2002-2013

Richard A. Wright of University of South Florida in his Graduate Theses and Dissertation of 2013 observed that approximately ■% of law enforcement academies used reality-based scenario training to teach arrest techniques and ■% used scenario-based training to teach self-defence. Only about ■% of the academies used scenario-based training for cognitive development. Eighty-eight percent of law enforcement academies used scenario-based training as a means of teaching firearms skills. There was some indication that law enforcement academies have been using virtual simulations as a means to teach these skills; however, there are no exact statistics to provide.⁶⁶

Forecast of Police Simulators in the USA

The Consultant estimated the future number of simulators to be used by the police academies and police agencies separately.

ASSUMPTIONS FOR THE USA POLICE ACADEMIES

To develop the future projections for simulators used by the USA police training academies, the Consultant assumes the following:

- The number of simulators used for firearms and driving training is equivalent to that reported by academies.
- The growth rate of these simulators will be similar to the actual historical growth between 2002 and 2013 and will diminish along the timeline.

The resulting estimates are shown in Figure 28: Projected Number of Training Driving and Firing Simulators in the US Police Academies.

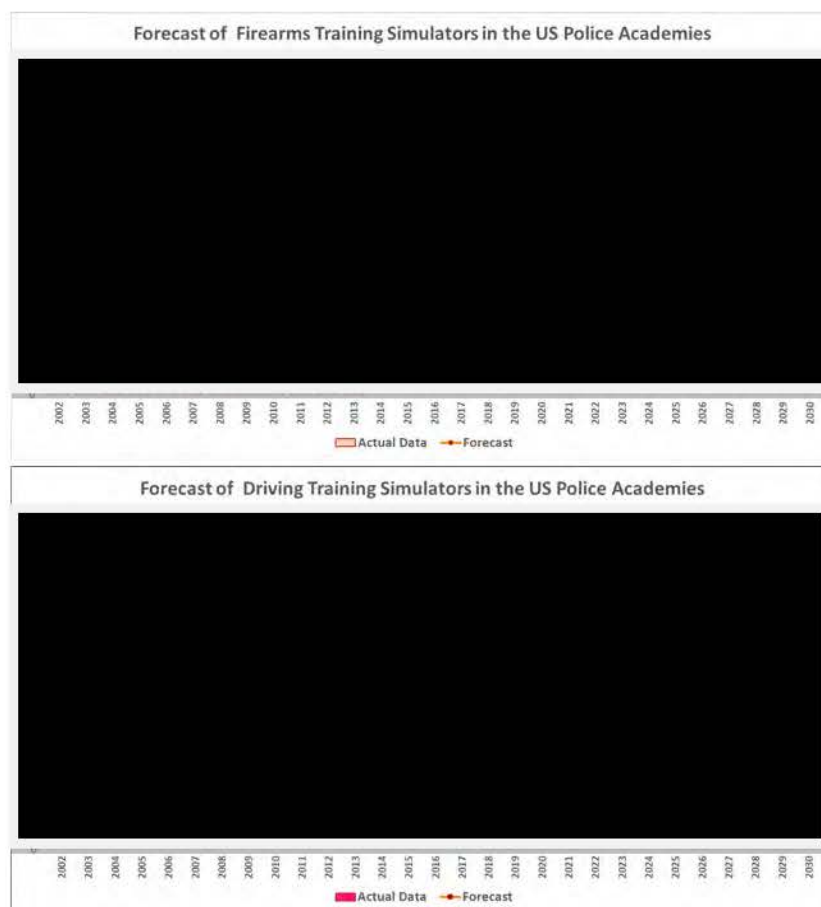


Figure 28: Projected Number of Training Driving and Firing Simulators in the US Police Academies

According to the calculations, the US police training academies will have, either onsite or offsite, approximately ████ firing and ████ driving simulators by the year 2030.

ASSUMPTIONS FOR THE USA POLICE AGENCIES

To develop the future projections for simulators used by the USA police agencies, the Consultant assumes the following:

- █% of police agencies have at least one training simulator.
- The number of agencies will grow at the rate similar to the last five years of the rate reported by the US Department of Justice⁶⁷.

The resulting estimates are shown in Figure 29: Forecast of Police Simulators Used by Agencies in the USA, 2013 - 2030. It is likely that the total number of training simulators used by the USA police agencies will comprise █ in 2030.



Figure 29: Forecast of Police Simulators Used by Agencies in the USA, 2013 - 2030.

Australia

Overview of Policing Authorities in Australia and Training Simulators

The number of the sworn police officers in Australia has been increasing consistently at the rate of █%, at least since 2001, per the data reported by the Australian government⁶⁸, also depicted in Figure 30: Historical and Projected Police Force in Australia, 2001-20. The number of police officers per 100,000 of population has been increasing along the timeline. It is likely that the same trend will continue.



Tempe, Ariz. October 4, 2017 — VirTra, Inc. announced the company had signed contracts worth more than \$750,000 with three law enforcement agencies in Australia — the Australian Border Force, New South Wales Police Department and South Australia Police Department. Together, the new contracts include the sale of multiple virtual training systems and accessories, including two V-ST™ PRO systems, V-Author™ PRO training, service and warranty contracts. VirTra's portable V-ST PRO is a scalable firearm shooting and skills training simulator. The system's flexibility supports a combination of marksmanship and use of force training on up to five screens from a single operator station. The V-ST PRO is also capable of displaying 1 to 30 lanes of marksmanship featuring real world, accurate ballistics. Use of force continuum training includes support for officer presence, verbal commands, OC, TASER®, less lethal impact weapons and deadly force options.

commands operating in six regions from [REDACTED] police stations.⁷¹ The New South Wales Police College features simulation facilities. The Police Academy boasts the virtual reality training system for law enforcement (VirTra). Officer presence, verbal skills, less lethal force options, and deadly force, are all available for simulation use. Simunition/Tactical Options



Figure 30: Historical and Projected Police Force in Australia, 2001-2030

Australia⁶⁹ is served by police agencies assigned to states and the Northern Territory, with the Australian Federal Police (AFP) being responsible for policing the Australian Capital Territory (ACT). The Consultant calculated over [REDACTED] police stations operating in Australia at the time of the study.

In Australia, each of the states and mainland territories runs a centralised academy for training of law enforcement agencies within the state or territory. Police academies ensure that officers meet basic local, state, and federal standards. Of eight training academies, five, at the time of developing the study, were equipped with virtual reality simulation training equipment: New South Wales, Victoria, Queensland, South Australia, and Western Australia.

- ACT Policing, the community policing arm of the [Australian Federal Police](#) (AFP) has [REDACTED] police stations⁷⁰. Australian Federal Police College located in Barton, Canberra trains AFP initial recruits, reports no simulators on site.

- New South Wales Police has [REDACTED] local area commands operating in six regions from [REDACTED] police stations.⁷¹ The New South Wales Police College features simulation facilities. The Police Academy boasts the virtual reality training system for law enforcement (VirTra). Officer presence, verbal skills, less lethal force options, and deadly force, are all available for simulation use. Simunition/Tactical Options

training utilises specially designed Glock 17T training firearms designed to fire small non-lethal die marking projectiles, inert defensive sprays, and soft batons in a realistic force-on-force environment. The simunition building is a purpose-built facility that can be configured into multiple layouts to replicate real life scenarios, providing an interactive learning environment for students.⁷²

- Northern Territory Police has [REDACTED] police stations⁷³. Northern Territory Police Academy reports no training simulators.
- Queensland Police Force has [REDACTED] police stations and six Headquarters and Regional offices⁷⁴. The Queensland Police Service Academy is the central point for developing recruits into Police Officers. Part of Education and Training, the Academy (both Oxley and Townsville campuses) is also the central point for the education and career development of police officers and staff members around the State.⁷⁵ Simulation training building is part of the academy.⁷⁶
- The South Australian police force, the oldest centrally controlled police service in Australia and one of the oldest in the world, has [REDACTED] metropolitan police stations and [REDACTED] regional police stations⁷⁷. In July 2017, South Australia Police Academy⁷⁸ acquired a \$[REDACTED] simulator for firearms training⁷⁹ of Special Task and Rescue officers. The technology features a 300-degree screen that plays out real-life situations such as a domestic violence or drug-related incidents.
- Tasmania Police comprises [REDACTED] police stations in three geographical police Districts, with five specialised support districts and three SES regional areas, which are supported by a State Headquarters⁸⁰ Tasmania Police Academy reports no simulators.
- Victoria Police provides policing services to the Victorian community via [REDACTED] police stations in [REDACTED] Police Service Areas (PSAs), within [REDACTED] divisions and four regions - North West Metro, Southern Metro, Eastern and Western⁸¹. Victoria Police Academy reports simulation training facilities in its premises.⁸²
- Western Australia Police Force⁸³ is responsible for policing the world's largest single police jurisdiction, covering Western Australia's 2.5 million square kilometres with [REDACTED] police stations across [REDACTED] metropolitan and [REDACTED] regional districts. Western Australia Police Academy's Operational Safety and Tactics Training Unit is responsible for all Critical Use of Force Skills and Operational Safety training and maintains a training facility which includes a fully

[REDACTED]

computerised firing range and a Police Interactive Training area for realistic scenario training and empty hand soft fall training area for self defence training⁸⁴.

Forecast of Police Simulators in Australia

Australian police, while boasting a very well-structured organization and effective performance, has a rather limited access to simulation technology. With over [REDACTED] police stations, consistently growing police force and healthy distribution of police officers, of over [REDACTED] per 100,000 population, absence of any serious controversial issues with the public, there could be a limited interest by the local authorities to invest heavily in virtual training.

ASSUMPTIONS FOR THE AUSTRALIAN POLICE

To develop the future projections for simulators used by the Australian police agencies, the Consultant assumes the following:

- [REDACTED] % of police agencies use at least one training simulator.
- The number of agencies will grow at a rate similar to the last five years of the rate reported by the Australian government.
- Currently, five academies have training simulators.
- By the end of the forecast period, all eight academies will have simulators, at least three per entity.

Results of the calculations show nearly [REDACTED] simulators to be in use by the Australian police agencies and academies by 2030 as shown in Figure 31: Forecast of Police Simulators in Australia.

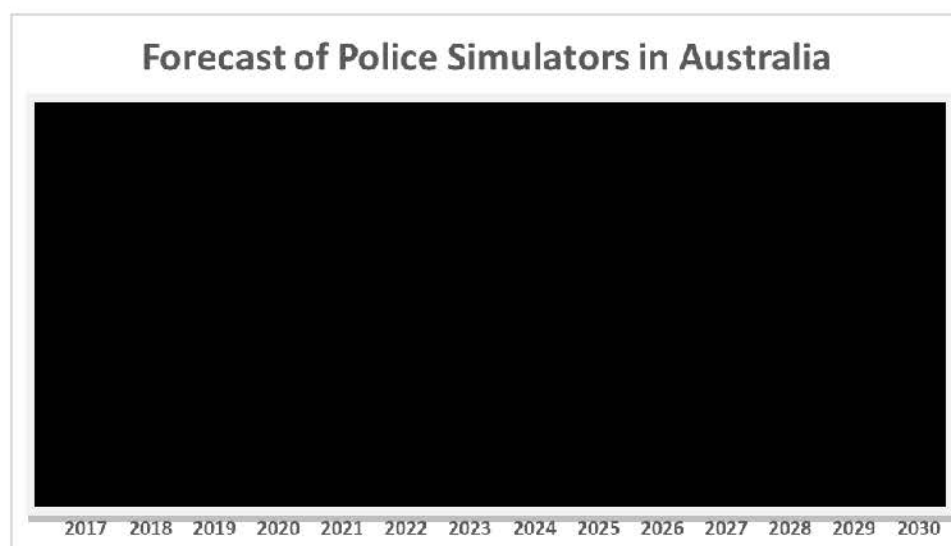


Figure 31: Forecast of Police Simulators in Australia

Public Services (Firefighting)

Canada

Firefighting service is typically delivered via two streams, professional (career) and volunteer firefighters. Career firefighters include full-time uniformed firefighters regardless of assignments, e.g., suppression, prevention/inspection, administrative. The majority of career firefighters operate in public fire departments that protect people, their residences, and public buildings. Volunteer firefighters include any active part-time (on call) firefighters.

According to the Canadian Fire Department Profile, 2014-2016 by National Fire Protection Association,⁸⁵ an overwhelming majority of firefighting services is provided by volunteers, as shown in Figure 32: Volunteer vs. Career Firefighting in Canada. In 2016, there were [REDACTED] fire departments in Canada. The breakdown by the organizational type is as follows:

- [REDACTED] departments - all career firefighters,
- [REDACTED] - mostly career,
- [REDACTED] - mostly volunteer, and
- [REDACTED] - all volunteer.

Of the total number of firefighters, [REDACTED] were career firefighters, while [REDACTED] were volunteers in 2016.



Figure 32: Volunteer vs. Career Firefighting in Canada, 2016

[REDACTED] departments provided no EMS service, [REDACTED] provided EMS service, and [REDACTED] departments provided EMS and advanced life support.

All career fire departments represent [REDACTED]% of departments and protect [REDACTED]% of the population. Conversely, all volunteer fire departments represent [REDACTED]% of departments and protect [REDACTED]% of the population. Department type varies considerably by population protected. For community sizes above [REDACTED] the percentage of departments classified as all career or mostly career ranged

from [REDACTED] while for community sizes less than [REDACTED], the percentage of departments classified as all volunteer or mostly volunteer ranged from [REDACTED]

Compared to the United States or Australia, Canadian departments had a higher percentage of all or mostly volunteer centres for most community sizes.

There were approximately [REDACTED] firefighters in 2014-2016, which is a decrease of [REDACTED]% from the previous reported period 2013-2015. Meanwhile, this decrease is attributed to volunteers (from [REDACTED]) only as the number of career firefighters actually increased over this period, from [REDACTED], as shown in Figure 33: Change in Firefighter Types in Canada, 2013-2016.



Figure 33: Change in Firefighter Types in Canada, 2013-2016

Firefighters' training is mainly on-site, on-job based; there is a limited number of structured training facilities. On the federal level, there are two schools that provide training for firefighters⁸⁶:

- The Canadian Forces Leadership and Recruit School in Saint-Jean-sur-Richelieu, Quebec: basic training common to all trades. A goal of this course is to ensure that all recruits maintain the CAF physical fitness standard; as a result, the training is physically demanding.
- The Canadian Forces Fire Academy in Borden, Ontario: occupational qualification training on the topics of aircraft rescue firefighting operations, wild land operations at the site of a fire and hazardous materials, among others.

There are also training schools at the provincial level, such as Lakeland College Emergency Training Centre in Alberta, the Ontario Fire College, and the Nova Scotia Firefighter School. There are a total of [REDACTED] firefighting training institutions in Canada⁸⁷.

Forecast of the firefighting simulators include those used by the training facilities as well as detachments.

[REDACTED]

ASSUMPTIONS FOR THE CANADIAN FIREFIGHTERS

To develop the future projections for simulators used by the Canadian detachments, the Consultant assumes the following:

- “Only career” and “mostly career” detachments use firefighting simulators as they serve predominantly large communities with more complicated firefighting conditions.
- The number of career detachments will grow at a similar rate to that of 2013-2016⁸⁸.
- Only a fraction of detachments, █%, have simulators as majority of them have access to police training facilities which provide some relevant training.
- At the beginning of the forecast period, █% of training entities have simulators.
- At the end of the forecast period, █% of training entities have simulators.

The resulting estimates show that the number of simulators owned by the Canadian firefighting detachments and training facilities will increase from █ between 2017 and 2030.

USA

According to the data reported by the US Bureau of Labor Statistics^{89 90}, the number of career firefighter has been growing significantly between 2013 and 2017. In fact, during this period, their number increased by █%. If the same trend sustains, their number will continue growing into the forecast period, as shown in Figure 34: Historical and Projected Trend of Career Firefighters in the USA, 2013-20.

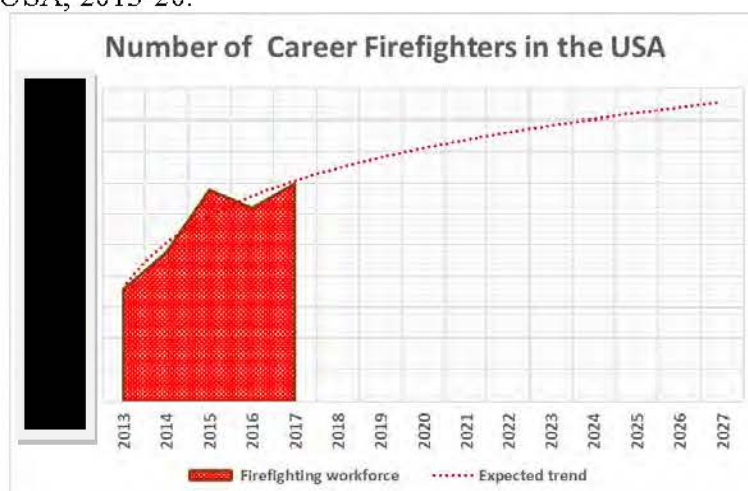


Figure 34: Historical and Projected Trend of Career Firefighters in the USA, 2013-2030

According to the US Fire Administration, as of November 1, 2018, there were [REDACTED] fire departments listed with the National Fire Department Registry. This is about [REDACTED]% of all U.S. fire departments⁹¹ bringing the total number to [REDACTED] of the following organizational types:

- [REDACTED]% are career,
- [REDACTED]% are mostly career,
- [REDACTED]% are mostly volunteer,
- [REDACTED]% are volunteer.

There are a total of [REDACTED] active career, volunteer and paid per call firefighters. Of the active firefighting personnel, [REDACTED] were career firefighters, [REDACTED] were volunteer firefighters, and [REDACTED] were paid per call firefighters, as shown in Figure 35: Volunteer vs. Career Firefighting in .



Figure 35: Volunteer vs. Career Firefighting in the USA

According to the National Fire Protection Association⁹², in 2015, most of the career firefighters ([REDACTED]%) worked in communities that protected [REDACTED] or more people. Most of the volunteer firefighters ([REDACTED]%) were in departments that protected fewer than [REDACTED] people.

In the U.S., [REDACTED] departments provided EMS with basic life support, [REDACTED] departments provided EMS with advanced life support and [REDACTED] departments did not provide EMS.

The combination of volunteer and career firefighters in the USA is similar to that in Canada; however, the Canadian firefighting force is geared even more towards volunteers.

Firefighting in the US is becoming more of a profession with most states requiring both career and volunteer firefighters to complete a certificate program at a fire academy. The U.S. Fire Administration operates the National Fire Academy, which provides specialized firefighter training via the National Emergency Training Center (NETC). The campus is equipped with the Simulation/Exercise Lab.

[REDACTED]

States are viewed as partners with the NFA, deliver NFA courses via Regional, and NFA Direct Delivery Programs. States have sole control and responsibility to deliver courses.

Enfranchisement establishes that State Fire Training Systems are the NFA in their State, with or without Federal funding. Those States that have a need for courses that the NFA cannot develop because of time constraints, develop their own programs to be endorsed by NFA or a peer review process using geographically distant States to perform the assessment. There are [REDACTED] local firefighting schools in the USA, as reported by Fire Recruit Magazine⁹³.

Emergency responders use training simulators to learn and practice skills for on-the-job preparedness. Simulators provide interactive, audio-visual simulations of various situations using computer-controlled configurations and can replicate emergency situations that may be too costly or too dangerous to reproduce with live scenarios. Simulators may be configured for individual skills or team skills training. To assist emergency responders making procurement decisions, the U.S. Department of Homeland Security, Science and Technology Directorate, established the System Assessment and Validation for Emergency Responders (SAVER) Program.⁹⁴ Across the country, incident commander training is viewed as a critical part of fire scene readiness and safety.

Local emergency departments have been adding simulation training equipment to their training portfolios. An example of this is O'Hare International Airport, which in 2015 acquired a \$[REDACTED] simulator allowing a safer and more cost-effective way to train for calamitous events in an on-going, virtual-reality manner. Software creates a variety of different firefighting scenarios - from an aircraft on fire to a field blazing in flames.

ASSUMPTIONS FOR THE US FIREFIGHTERS

To develop the future projections for simulators used by the US firefighters, the Consultant assumes the following:

- “Only career” and “mostly career” departments use firefighting simulators as they serve predominantly large communities with more complicated firefighting conditions.
- The number of fire departments will grow at a half of the historical rate of 2013-2017.
- Only a fraction of departments, [REDACTED]%, have simulators as the majority of them have access to police training facilities which provide some relevant training or state-run training facilities.
- [REDACTED]% of federal and state-run training entities have at least one simulator at the beginning of the forecast period.
- [REDACTED]% of federal and each state-run training entity will have at least one simulator by 2030.

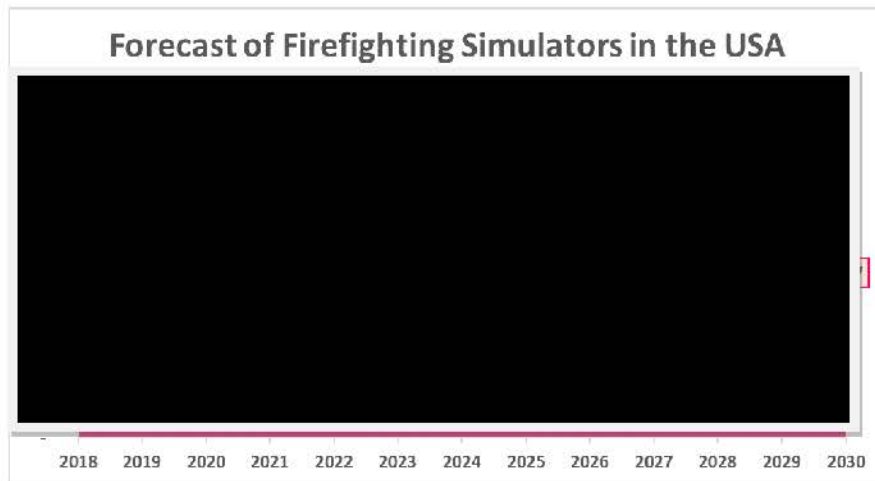


Figure 36: Forecast of Firefighting Training Simulators in the USA

The resulting estimates demonstrate a growth in the number of simulators used by the US firefighting departments and training institutions from [REDACTED] between 2018 and 2030, as shown in Figure 36: Forecast of Firefighting Training Simulators in the USA.

Australia

Australia has been enjoying a continuous increase in its firefighting force. As reported by the Australian Government⁹⁵, their count has been on a constant upward trend, which is likely to continue, as shown in Figure 37: Historical Number and Projected Trend of Fire Officers in Australia.

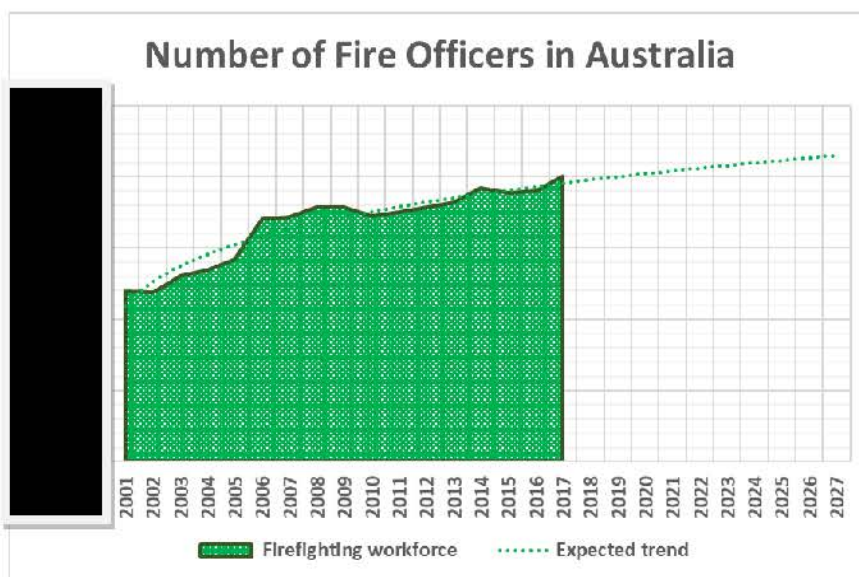


Figure 37: Historical Number and Projected Trend of Fire Officers in Australia

Fire Stations and Brigades in Australia

Figure 38: Volunteer and Career Firefighting Stations in Australia

There have been some public announcements of the fire authorities acquiring firefighting training simulators:

- Both the Victoria Country Fire Authority and the New South Wales Rural Fire Service have been using virtual reality training. XVR Simulation has built for them geo-specific content, including environments, vehicles, and fire officers. This virtual content includes specific plots of land with high-risk situations, for instance with forest areas near housing areas. These virtual environments were built using GIS data from the local authorities.¹⁰²
- Western Australia purchased two driving simulators and a mobile transport facility to ensure emergency services drivers have the necessary skills to respond to incidents under 'emergency conditions'.¹⁰³

ASSUMPTIONS FOR THE AUSTRALIAN FIREFIGHTING DEPARTMENTS

To develop the future projections for simulators used by the Australian firefighters, the Consultant assumes the following:

- Only career departments use firefighting simulators.
- The number of career departments will grow at a half rate of Firefighters.
- Only a fraction of departments, █%, has simulators as majority of them have access to police training facilities which provide some relevant training or state-run training facilities; this number increases to █% by 2030.
- █% of training entities have at least one simulator at the beginning of the forecast period.
- █% of training entity will have at least one simulator by 2030.

The estimated number of simulators to be used by the firefighting departments and training facility is likely to increase from █ between 2018 and 2030, as shown in Figure 39: Forecast of the Firefighting Simulators in Australia.



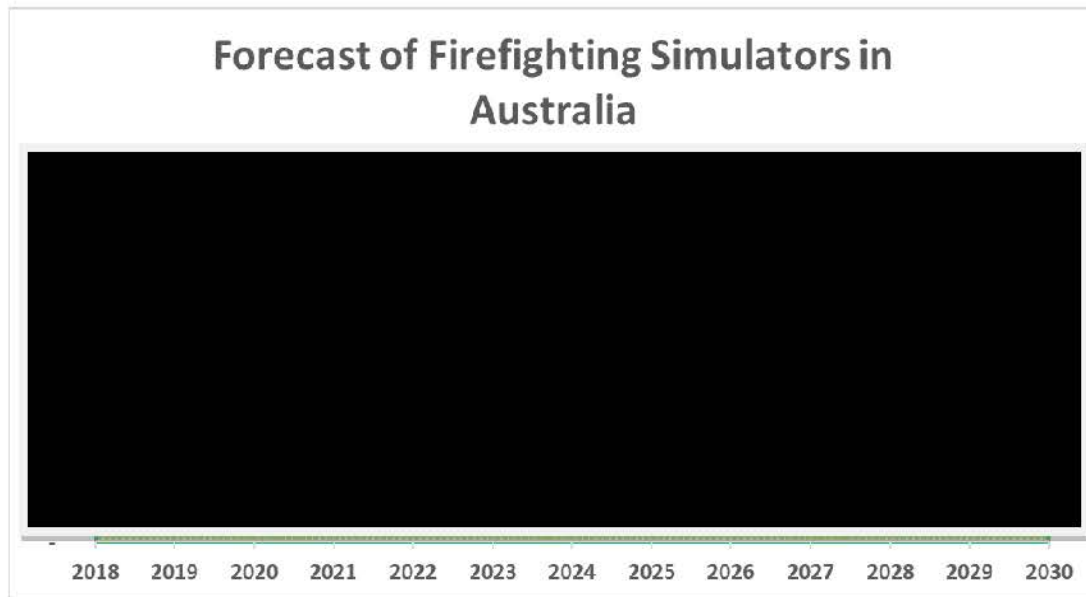


Figure 39: Forecast of the Firefighting Simulators in Australia

Control Rooms

Military Command Centers

The Consultant estimated the number of military control and command centers in the following steps:

- 1) Number of individual nation-run centers;
- 2) Number of joined operations centers.

Nation-run Centers

A military command and control center is typically a secure room or building in a government or military facility that operates as the agency's dispatch center, surveillance monitoring center, coordination office and alarm monitoring center all in one.

A developed nation has at least one centralized command center and individual centers for each military branch:

- a national defense center, which monitors and guides the operations of all military branches (e.g., Pentagon in the USA)
- Air Force
- Army
- Navy
- Coast Guard

ASSUMPTIONS FOR THE MILITARY CONTROL AND COMMAND CENTERS

The approximate number of the military control and command centers is calculated on the basis of the following assumptions:

- Countries with high military budgets ($>1\%$ of the total world's military expenditures) have at least five command centers;
- Countries with medium military budgets ($>0.1\%$ and $<1\%$ of the total world's military expenditures) have three command centers;
- Countries with low military budgets ($>0.0001\%$ and $<0.1\%$ of the total world's military expenditures) have one command center;
- Countries without any reported military budget are unlikely to have any command centers.

According to the data reported by the World Bank¹⁰⁴, there are

- ■ nations with the military budget exceeding 1% of the total world military expenses;

- The total estimated number of national military control and command centres is [REDACTED]

1. North American Aerospace Defense Command (NORAD, a combined organization of the United States and Canada that provides aerospace protection for Northern America. Headquarters for NORAD and the NORAD/United States Northern Command (USNORTHCOM) center are located at Peterson Air Force Base in El Paso County, near Colorado Springs, Colorado.
2. Alaska NORAD (ANR) Region - to detect, validate and warn off any atmospheric threat in its area of operations from its Regional Operations Control Centre at Joint Base Elmendorf-Richardson, Alaska.
3. Canadian NORAD (CANR) Region - 1 Canadian Air Division is at CFB Winnipeg, Manitoba responsible for providing surveillance and control of Canadian airspace.

[REDACTED]



The Consultant identified 47 Space Control Centers listed below:

1. NASA's Kennedy Space Center on Merritt Island, Florida, USA
2. NASA's Mission Control Center (MCC-H), at the Lyndon B. Johnson Space Center, in Houston, TX, USA
3. CAPE CANAVERAL AIR STATION, Patrick AFB, Florida, USA



46. Alcantara Launch Center, on the Atlantic coast outside Sao Luis, Brazil

47. Woomera, Australia

Non-Military Control Rooms

Data on non-defense control rooms, provided by IHS Markit via the Client, is broken down based on number of users as shown below:

	2015	2016	2017	2018
100+				
21-100				
5-20				
1-4				
TOTAL				

Since small control rooms, with the operating personnel of less than 20 people, are unlikely to be equipped with large monitoring screens, it is assumed that only those served by 21+ users represent the target market. Share of each non-military control room target segment (Utilities, Transportation, Public Safety) is demonstrated in Figure 40. According to the data, electric plants constitute the largest portion of medium- and large- size control rooms.

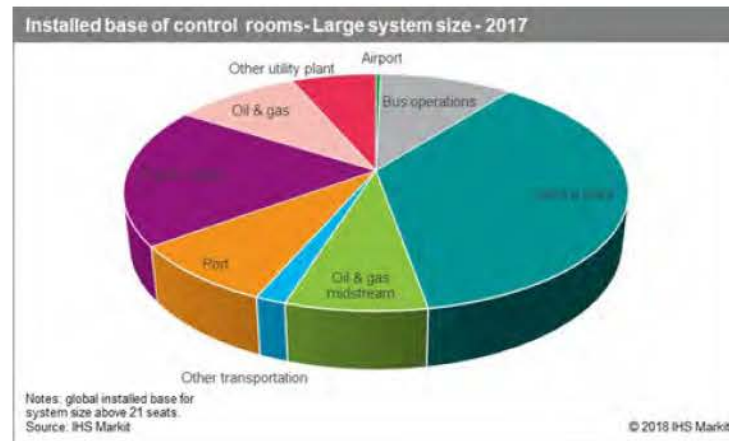


Figure 40: Non-military Control Rooms by Sector, IHS Markit

Between 2015 and 2018, the number of control rooms has been growing, on average, at █% annually. At the same projected growth rate, the number of non-military control rooms will reach █ in 2030, as demonstrated in Figure 41.

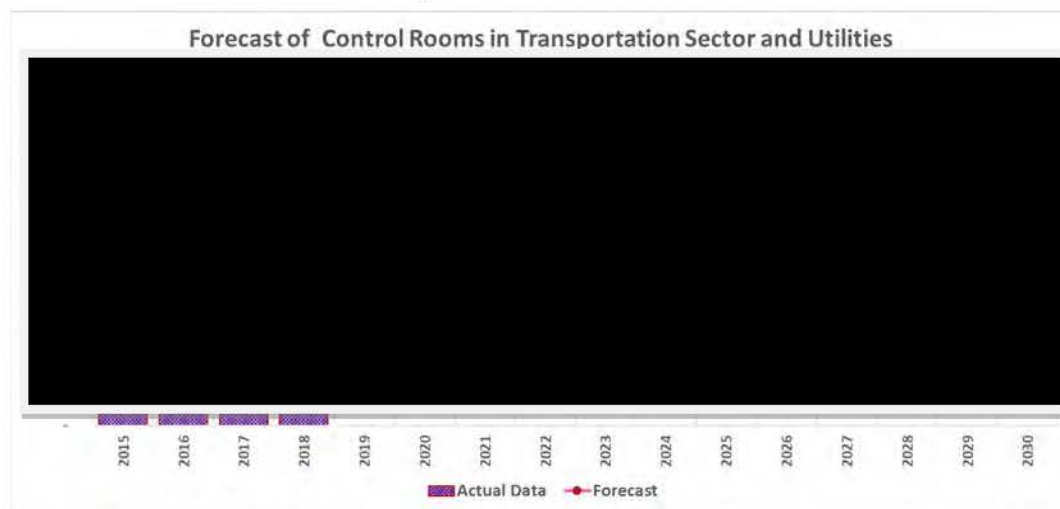


Figure 41: Historical Data and Forecast of Non-military Control Rooms (2015 – 2030)

Pricing

There is a wide array of manufacturers of simulation training technologies who are specialized in different industries and applications. Appendix C: Comparison of Simulation Training Solutions contains summaries of some of the manufacturers and their market offering. Pricing structure of their solutions can be complex due a multitude of various combinations of hardware and software.

This section contains publicly available pricing information on military training simulators. There are three tables below containing various data aggregation levels:

- announcements on the acquisition contracts with generic description and total amounts;
- bid order placements on the government purchasing site on each individual manufacturer product/service offering;
- detailed pricing and description of each individual product and service option by one manufacturer.

Table 1: Military acquisition announcements on simulation training technology ¹⁰⁶

Date	Announcement	Content	Price
22-Aug-18	Lockheed Providing Modernized Combat Tactical Trainer Module for the Army	Lockheed Martin Corp., Orlando, Florida, was awarded a hybrid (cost, cost-plus-fixed-fee, firm-fixed-price, and fixed-price-incentive) contract for Close Combat Tactical Trainer Manned Module modernization. Bids were solicited via the internet with three received. U.S. Army Contracting Command, Orlando, Florida, is the contracting activity	\$ 356,300,000
05-Apr-18	Cubic Global Defense Supporting Simulation Training for the Marines	Cubic Global Defense, San Diego, California, is awarded a firm-fixed-price modification under a previously awarded contract for Marine Air-Ground Task Force (MAGTF) Training Systems Support (MTSS), managed by Program Manager Training Systems, Orlando, Florida. MTSS provides pre-deployment training to Marine Corps (USMC) operating forces within a joint and combined environment to improve USMC warfighting skills.	\$ 11,605,378
16-Mar-18	Army Adds Simulation and Training Aids	Lockheed Martin Corp., Orlando, Florida, was awarded a firm-fixed-price contract for Army training aids, devices, simulators and simulations, maintenance, sustainment, operations and support of instrumentation systems and live-fire ranges. Bids were solicited via the Internet with two received. U.S. Army Contracting Command, Orlando, Florida, is the contracting activity	\$ 3,531,926,800

Date	Announcement	Content	Price

Date	Announcement	Content	Price
			\$ 427,078,399
			\$ 424,232,240
			\$ 8,730,370
			\$ 45,000,000
			\$ 30,575,466
			\$ 55,000,000
			\$ 37,584,481

Date	Announcement	Content	Price

Table 2: Training simulator bid quotes by various manufacturers¹⁰⁷

Manufacturer	Product	Description	Price
INDUSTRIAL SMOKE & MIRRORS	FLASH/BANG & SIMULATION HOUSING UNIT	16'x40' Flash/Bang and Simulation Housing Unit (FBSHU) is an ISO 9000 certified complete fabricated self-contained safe environment designed to test and train with Flash/Bang device...	\$238,408.83
GLOBALSIM	SIMULATION TRAINING SOFTWARE AND HARDWARE	These electronic training aides are used to provide training of the critical tasks associated with localized equipment movement, handling, and transportation preparation of non-containerized Emergency Preparedness and First Responders equipment. This includes (but is not limited to): Decontamination kits and showers, Mass casualty containment systems, Hazardous material detection equipment, Radioactive/nuclear detection, monitoring, and analysis equipment, Flood control equipment.	\$279,092

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Manufacturer	Product	Description	Price
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
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Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Manufacturer	Product	Description	Price

Table 3: Detailed Price List of VirTra Systems, Inc.¹⁰⁸

VirTra LE™ Series Simulators - Law Enforcement

Part Number	Description	Price
V-100LE-1	Includes projector, shot tracking equipment, low light kit, scenario authoring software, collapsible screen, laptop computer and a hard case for easy transport. One-year warranty and support services included.	\$ 15,595.00
VST-PRO-LE	The VirTra VST-PRO-LE shooting skills trainer is a flexible simulator allowing customization of courseware and systems. Provides a real-world 3D experience of indoor and outdoor, up to 6-lane marksmanship range allowing 1 to 6 trainees with multiple weapons in each lane. Accurate and verified programmable ballistics module allows the user to customize the system to the projectile used in each firearm. The system comes with high-definition video on a 16' screen (smaller screens available and will limit number of trainees permitted). Configurable to support 5 integrated systems totaling 30 individual lanes. Includes software, hardware, scenarios to train marksmanship courses of fire, judgment (video), collective and video scenario authoring software. One-year warranty and support services included.	\$ 63,587.00

Part Number	Description	Price
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Part Number	Description	Price

VirTra MIL™ Series Simulators – Military

Part Number	Description	Price
V-100MIL-LT	VirTra Systems 100 MIL Lite is our most portable MIL judgmental use of force simulator. System includes one high-resolution projector, hi-speed shot tracking equipment and a laptop computer. Complete library of Military/LE judgmental and engagement scenarios are included in the VirTra 100 MIL Lite. Entire system fits into hard sided case that is easily transported and included. One-year warranty and support services included.	\$ 32,495.00
V-180MIL-1	VirTra Systems 180 MIL-1 simulator system uses three interconnected screens to produce a more immersive training environment. Multi-directional training allows for scanning, situational awareness, acquiring and engaging moving targets and overcoming distractions. System includes complete real-world Military/LE content library, marksmanship software, hi-speed shot tracking and UPS backup. System customizable to fit in a variety of available spaces (within minimum requirements). One-year warranty and system service included.	\$ 111,793.00

Part Number	Description	Price
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
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Hardware Upgrades

Part Number	Description	Price
VHU-BS-180	Eliminates the 5-inch black border between screens to increase immersion on VirTra 180 systems.	\$ 7,540.00
VHU-BS-300	Eliminates the 5-inch black border between screens to increase immersion on VirTra 300 systems.	\$ 8,599.00
VHU-TSM	Touch screen monitor and software upgrade.	\$ 5,148.00
VHU-IWS	Instructor workstation – Ergonomic chair and desk.	\$ 1,341.00

Standard Rifle/ Handgun Recoil Kits (Weapon not included, must specify pressure supply)

Part Number	Description	Price
SRK-B92	Handgun recoil kit for Beretta 92, Model 96 and M9- 9mm or S&W .40 caliber. Requires air supply of CO2 or compressed air (All recoil kits convert real firearms which must be supplied by the customer).	\$ 2,699.00

Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Part Number	Description	Price
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
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[REDACTED]	[REDACTED]	[REDACTED]

Tetherless Recoil Kits (Weapon not included, all kits drop into real weapon)

Part Number	Description	Price
VTRK-BE92	Micro-switch activated tetherless handgun recoil kit for the Beretta 92, 92FS and M9- 9mm. Includes one magazine (All recoil kits convert real firearms which must be supplied by the customer).	\$ 4,155.00
VTRK-BE92-MAG	Additional magazine for use with the VTRK- BE92 recoil kits.	\$ 551.00
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[REDACTED]	[REDACTED]	[REDACTED]

Part Number	Description	Price
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Part Number	Description	Price
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[REDACTED]	[REDACTED]	[REDACTED]

Weapons Support Accessories

Part Number	Description	Price
VWSA-RFS	Table-top refill station for all refillable magazines. Includes automatic push button activation and one CO2 tank which must ship empty.	\$ 4,004.00
VWSA-WS	Required for wireless recoil kits and the Threat-Fire™ to connect to the VirTra simulator (Only one wireless station needed per system).	\$ 1,508.00

Part Number	Description	Price
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Laser Inserts

Part Number	Description	Price
VLSI-9MM	Laser insert designed for use with most 9 mm handguns.	\$ 1,144.00
VLSI-45 C	Laser insert designed for use with most .45 caliber handguns.	\$ 1,144.00
VLSI-40 C	Laser insert designed for use with most .40 caliber handguns.	\$ 1,144.00
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]

Training and Installation

Part Number	Description	Price
V-300-INSTL	VirTra installation and training for one (1) V-300 system. Includes all travel and expenses in the CONUS.	\$ 5,700.00
V-180-INSTL	VirTra installation and training for one (1) V-180 system. Includes all travel and expenses in the CONUS.	\$ 5,400.00
V-100-INSTL	VirTra installation and training for one (1) V-100 system. Includes all travel and expenses in the CONUS.	\$ 2,600.00

Conclusions

Simulators are gaining more traction for training purposes. Their numbers are especially growing in the industries that enjoy government support and can significantly reduce long-term cost and liability concerns. These are the main factors that drive the highest growth in training simulators for the US military and US police.

In general, virtual simulation technology is set to continue gaining a high acceptance rate by those industries where training quality is critical for public safety and security and helps reduce public cost. Below is the summary of training simulator forecast for military, police and firefighters in the USA, Canada, and Australia.

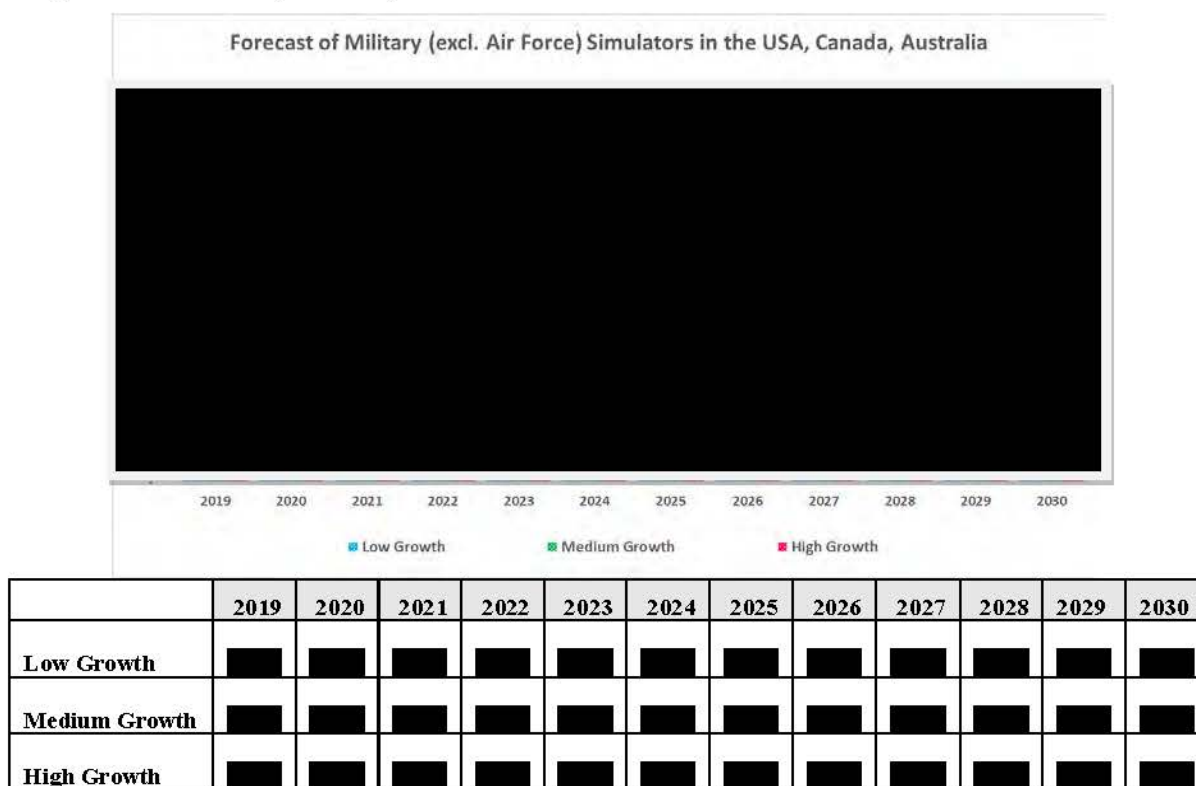


Figure 42: Forecast of Military (excl. Air Force) Training Simulators in the USA, Canada, and Australia

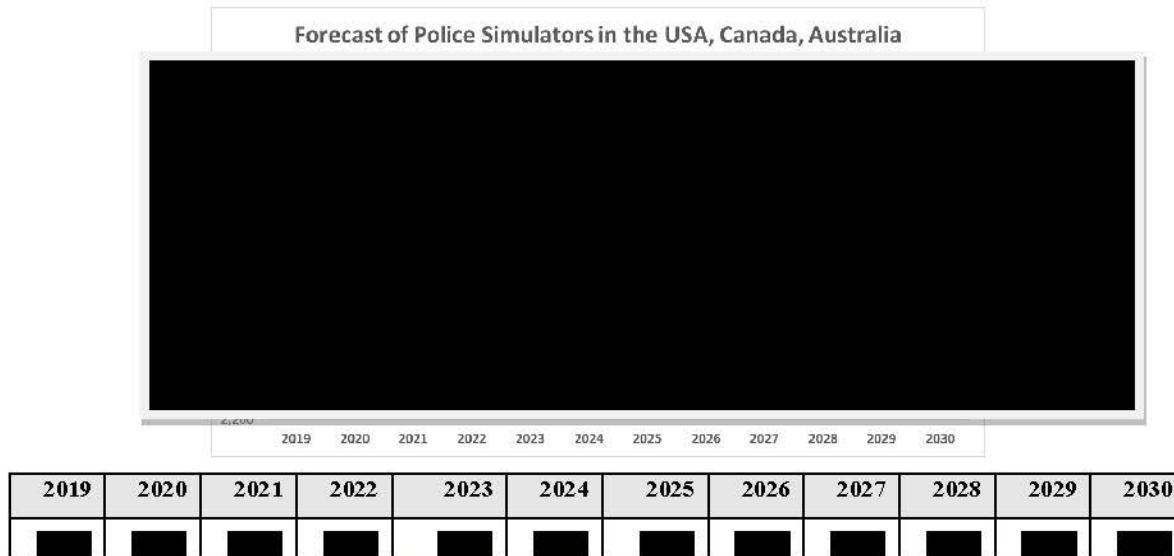


Figure 43: Forecast of Police Training Simulators in the USA, Canada, and Australia

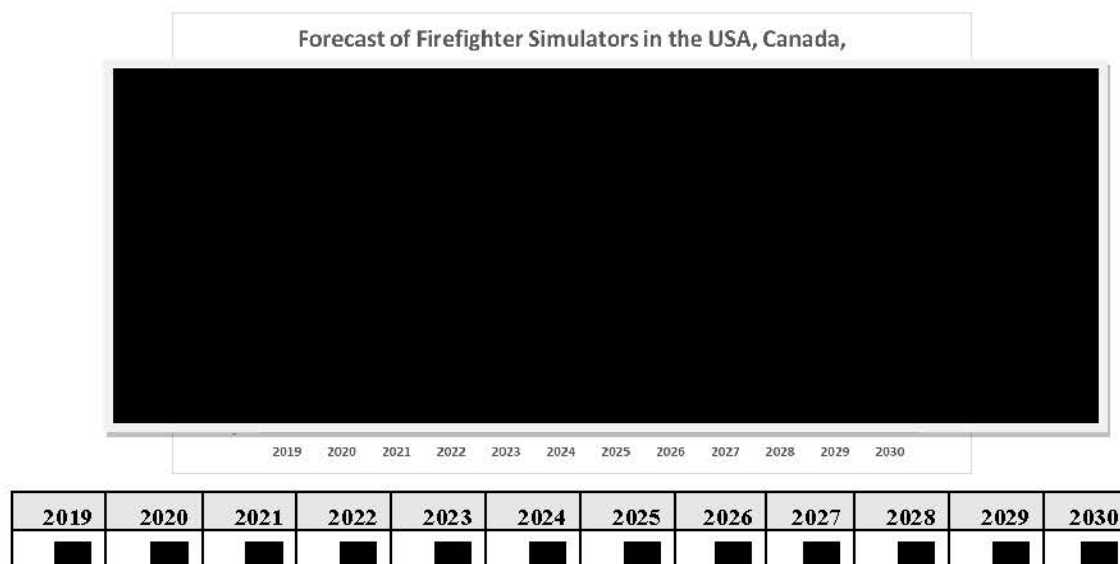


Figure 44: Forecast of Firefighting Training Simulators in the USA, Canada, and Australia

More control rooms are equipped with the modern monitoring technology equipment. By the year 2030, military command centers are projected to surpass the ■-mark, space command centers – ■ and non-military - approach ■ globally.

[illegible]

Base or support unit	Type	Province/Territory
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]		[REDACTED]

[REDACTED]

[REDACTED]

Northern Territory

20. Larrakeyah Barracks / HMAS Coonawarra, Larrakeyah: Includes Northern Command HQ, Darwin Naval Base and HMAS Coonawarra (Navy patrol boat operations) and Norforce.

[REDACTED]

[REDACTED]

[REDACTED]

Queensland

24. Army Aviation Centre, Oakey: Army pilot and aircrew training activities.

25. Borneo Barracks, Cabarlah: Army's 7 Signal Regiment.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

South Australia

32. RAAF Base Edinburgh / Edinburgh Defence Precinct, Edinburgh: Operational flying and training base for the Orion maritime patrol aircraft fleet, Aerospace Operations Support Group, Army's 7 RAR, and DSTO Edinburgh.

33. Woodside Barracks, Woodside: The Army's 16 Air Defence Regiment.

Tasmania

34. Anglesea Barracks, Hobart: ADF Reserve and administrative elements.

Victoria

35. Albury Wodonga Military Area, Albury-Wodonga: Major training base for Army, including Bandiana and Bonegilla.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Western Australia

40. HMAS Stirling, Garden Island: The Navy's west coast operational, ship repair and maintenance base, including the submarine force.

[REDACTED]

[REDACTED]

[REDACTED]

Appendix C: Comparison of Simulation Training Solutions

Name	Website	About Company	Technology Partners	Served Industries / Applications	Features, Description
MineLife VR	https://www.llamazoo.com	Since 2014, MineLife VR develops mining 3D visualization solutions. First company developed EasyAnatomy – a 3D anatomy learning tool. Currently, company develops visualization solutions within mining, oil and gas, forestry.	Microsoft, VR/AR Association http://www.thevrara.com , Partner Network Gold https://www.esri.com/en-us/about/esri-partner-network/overview , Canada's Digital Technology Supercluster https://www.digitalsupercluster.ca	Mining	Allows for stakeholders to visualize the 50 years of mine planning data which goes into an open pit mine. Includes recreation of an explorable 10x10km region from GIS data, with year cycling to show terrain deformation, points of interest labels, and natural user interface for navigating the environment similar to Google Earth VR, without producing motion sickness. 9Gb of textures are streamed on 10 streaming landscapes equal to 30m polygons, with simulated ground level details such as grass and trees. Viewing live data, such as trucks and shovels, loaded train cars and material stockpiles, in real-time. Displaying real-time grade control data over scheduling activities provides critical information in context.
Unimersiv	https://unimersiv.com	Unimersiv creates VR Training	The Oculus Rift www.oculus.com/rift/ and touch controllers with a powerful laptop	Equipment Operations / Merchandise Oil & Gas Sport / Life improving skills	VR applications tethered to sensor-based rig monitoring systems can help mechanical engineers keep an eye on the equipment without needing to be present onsite and provide faster, more accurate diagnosis. Geoscientists and operators can also leverage VR to visualize seismic data and get a better idea of where to drill. Drilling sites can be virtually drilled and tested before actual operations are performed to test feasibility that can result in huge cost savings and reduce the likelihood of failure.

Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Name	Website	About Company	Technology Partners	Served Industries / Applications	Features, Description
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

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Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Name	Website	About Company	Technology Partners	Served Industries / Applications	Features, Description
[REDACTED]	[REDACTED]	[REDACTED]		[REDACTED]	[REDACTED]
		[REDACTED]			[REDACTED]
		[REDACTED]			
		[REDACTED]			
		[REDACTED]			
		[REDACTED]			
[REDACTED]	[REDACTED]	[REDACTED]		[REDACTED]	[REDACTED]

Name	Website	About Company	Technology Partners	Served Industries / Applications	Features, Description
[REDACTED]	[REDACTED]	[REDACTED]			[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]		[REDACTED]	[REDACTED]

Name	Website	About Company	Technology Partners	Served Industries / Applications	Features, Description
		[REDACTED]			
[REDACTED]	[REDACTED]	[REDACTED]		[REDACTED]	[REDACTED]
[REDACTED]	[REDACTED]	[REDACTED]		[REDACTED]	[REDACTED]

Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Market Study of the New Sound Technology for Simulation Training Solutions and Control Rooms

Name	Website	About Company	Technology Partners	Served Industries / Applications	Features, Description
[REDACTED]		[REDACTED]			[REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED]

