SMALL ARMS TRAINING SIMULATORS IN THE NEW ZEALAND DEFENCE FORCE

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ABSTRACT
Contemporary operations require soldiers to be well-trained in all aspects of the employment of small arms, including the ability to make rapid decisions and have experience operating in a wide range of employment contexts. At present, no single small arms training simulator used by the New Zealand Defence Force can deliver all small arms training requirements however the use of multiple systems has proven to offer a flexible and low-cost solution for planning and executing mission-specific training.

Keywords: Small Arms, Training, Simulation, Defence

1. INTRODUCTION

The New Zealand Defence Force (NZDF) operates a number of different simulation systems to support individual training (a process that aims to improve knowledge, skills, attitudes, and/or behaviours in a person to accomplish a specific job task or goal), collective training (a process for a group of people that aims to mould their individual capabilities into an effective team) and mission training (a process that aims to prepare individuals for upcoming deployments).

Small arms simulators in the NZDF typically fall into two categories (Kerry 2010):

- **Live simulation:** Real people operating actual operational weapons and equipment in a typical combat or training environment.

- **Physical simulation:** A simulation in which physical objects are substituted for the real thing. These physical objects are often chosen because they are smaller, safer or cheaper that the actual object or system.

This paper provides a brief summary of the small arms simulators that are used by the NZDF to support small arms training and discusses some of their key benefits and limitations.

2. INDOOR WEAPON SIMULATORS

The NZDF operate two types of indoor small arms simulation training systems. These are the Weapons Training System (WTS) and the Combined Arms Collective Trainer (CACT).

2.1. NZDF Weapons Training System

The Weapons Training System (WTS) produced by Meggitt Training Systems is a multi-lane virtual weapons range that is used for range practices and shooting coaching for all three services.

The NZDF currently operates a 24 lane WTS system at Waiouru Military Camp and 12 lane systems at its Linton and Burnham Camps. There are also mobile variants that can be deployed outdoors.

WTS works by using a computer to generate virtual firing scenarios, which are projected on to fixed screens. Soldiers then sit in a pit in which they operate tethered modified weapons (including assault rifles, light machine guns and anti-tank weapons). Inside these weapons are various electronic sensors that provide information regarding weapon status, such as trigger pressure and orientation. The weapons also employ speakers to emulate firing sound effects and weapon recoil is simulated using pneumatic actuators (compressed carbon dioxide).

Figure 1: The NZDF Weapon Training System

A primary simulation computer is used to analyse and display the fall of shot on the screens, while an instructor control station assists the conduct of training serials.

The original WTS system installed in 2001 had a number of criticisms, these were as follows:

- **Fall of shot.** This was calculated by using accelerometers inside the weapon to estimate where the weapon was being pointed at the time of the trigger being squeezed. Latency issues meant the system did not always result in the fall of shot occurring at the operator's intended aim point.

- **Screen resolution**. The projected image was fairly low resolution (800×600 pixels), making the imagery appear grainy when attempting to represent targets at extended ranges (e.g. greater than 800 m).

- **Tethered weapons.** The weapons were tethered, preventing them from being used in many of the manoeuvres and/or firing positions employed by soldiers in real combat situations.

- **Scenarios.** The system only had one training scenario which consisted of open terrain with pop-up static targets.

In 2009, WTS was upgraded to address some of these issues. Key changes included:

- **Fall of shot detection upgrade.** This was achieved by the addition of an infrared camera and laser pointers on the weapons. The infrared camera monitors the screen and records where the laser beam hits the screen when the trigger is squeezed. This produces a more accurate estimate of where an actual projectile fired from the weapon would impact.

- **Display and scenarios upgrade.** Upgrade of the projection system and simulation software. The projected image resolution was increased by using multiple screens, each with their own high definition projector (1920×1080 pixels). The system also now uses a commercial gaming engine (Steel Beasts Professional), to enable more realistic objects and scenarios to be represented. This helps train soldiers in more realistic environments. For example, scenarios that contains complex terrain and multiple types of battlefield entities.

One of the key benefits of the WTS is that the computer can capture data that can provide immediate feedback to individuals on their marksmanship skills. For example, the system can indicate if the weapon is being held correctly, if the operator is snatching their trigger or flinching on firing (Kilpatrick 2009).

The ability to generate custom scenarios also enables a much wider range of situations for soldiers to practice against. For example, having to make rapid decisions as scenarios evolve/change. This makes WTS well-suited to meeting the training requirements of contemporary operations.

2.2. Combined Arms Collective Trainer

The Combined Arms Collective Trainer (CACT), developed by Laser Shot Inc, is similar to the upgraded WTS, in that it employs a commercial gaming engine (Virtual Battlefield 2, developed by Bohemia Interactive) for scenarios and a thermal imager to record fall of shot. The NZDF is looking to install this system in the near future.

The key difference with CACT compared with WTS is that un-tethered weapons can be used. This enables soldiers to conduct manoeuvres and drills while wearing full combat gear. In addition to lasers, the infrared camera can also be used to detect the impact of non-lethal training munitions, such as Simunition® or AirSoft® rounds. This is achieved by the use of rubber coated walls, which when hit by projectiles, leave a minor thermal signature. This is sufficient enough for a thermal imager to detect the point of impact and relay its position back to the computer running the simulation engine. The use of real projectiles also provides the weapon with more realistic firing characteristics compared to using a laser.

Much like WTS, the system allows for users to create custom scenarios. Examples from the manufacturer include:

Close-Quarter Combat. A virtual shoot house can be constructed using multiple projectors and thermal imagers. This enables soldiers to practice missions that demand rapid assault and the precise application of lethal force (e.g. building clearance, hostage rescue).

Figure 2: Virtual Shoot House example

Reaction Speed Trainer. Pop-up targets appear that are either friendly or hostile. These are then used to assess and improve engagement reaction speeds.

Branching Video. Video is presented which changes along different possible outcomes depending on the actions taken by soldiers. This is used to train soldiers on having to make rapid decisions under pressure.

Lead Time Trainer. This software presents different sized targets that move at different speeds across a presented scene. This allows operators to practice estimating lead time adjustments when engaging moving targets.

Figure 3: Lead Time Trainer

Virtual Firing Range. Emulates a standard firing range, where virtual paper targets are either static or can move towards the weapon operator.

Figure 4: Virtual Firing Range

Another feature that adds more realism compared with WTS, is that the Virtual Battlefield (VBS2) entities and terrain features are responsive. For example, missing a target will result in damage to terrain features behind them (e.g. walls) and the targets react to being fired at (e.g. diving behind a table for cover). Entities will also react differently depending where they are hit, such as dropping to the ground if a leg is hit, or switching their weapon to the other hand if hit in the arm. The system can also be programmed to allow entities to react to virtual less-than-lethal weapons (e.g. Tasers and flash bangs), allowing tactics and procedures for these systems to be developed and rehearsed.

Laser Shot Inc are also currently working on new features to make their system even more realistic. Examples include:

- **Blue tracking.** Small tracking devices will be attached to soldiers providing the computer with information that will allow the digital enemies to react to their presence.
- **Physiological effects.** Soldiers will be able to wear clothing that will deliver a sharp thud when a virtual bullet hits them, allowing the virtual enemies to fight back.
- **Three-dimensional display.** The use of polarised projectors and glasses will allow enemy units to appear as if they are a few meters away from the wall (i.e. in the room).

2.3. Indoor Summary

Indoor systems have a number of training advantages over traditional weapon ranges.

- They enable training to occur at reduced cost by reducing ammunition overheads, wear on weapons and transportation costs.
- There is less risk to personnel and equipment than live-fire activities.
- Training can still occur during adverse weather conditions (e.g. heavy rain, snow, fog).
- They provide the ability to rehearse techniques and procedures that cannot be achieved with static paper targets.
- Terrain and entities can be customised to reflect a wide range of operational scenarios.

The drawbacks of such systems are:

- They are not compatible with magnified optics. This is due to parallax errors associated with the weapons proximity to the screens (typically less than 10 m) and the resolution limit of the displays. Injection sights have been offered as a possible solution. This is where a display screen is positioned inside the sighting system of the weapon itself.
- Additional personnel are required to maintain the system and customise scenarios.
- There is limited ability to train with night vision equipment (due to the use of projectors).

3. OUTDOOR WEAPON SIMULATORS

The NZDF operate several types of outdoor small arms simulation training systems. These include the Man Marking System (MMS), the Improved Tactical Engagement Simulation System (I-TESS) and the Small Arms Retaliatory Target (SART).

3.1. Man Marking System (MMS)

The Man Marking System (MMS) works by incorporating a modified barrel (including paint ball rounds) onto the current- in-service NZDF assault rifle (Steyr AUG). Players then compete, in teams or individually, to eliminate opponents by tagging them.

Figure 5: NZDF Man Marking System

Game fields are often scattered with natural or artificial terrain, which players use for tactical cover. Game types vary, but can include capture the flag, elimination, ammunition limits, defending or attacking a particular point or area, or capturing objects of interest hidden in the playing area. Depending on the variant played, games can last from minutes to days.

Advantages:

- Soldier can use their own personal weapon.
- The system provides instantaneous kinetic and visual feedback to players (i.e. a visible and uncomfortable mark is left when hit).
- It puts soldiers in real environments with their actual standard issue weapons, clothing and equipment.
- Training can occur at lower cost than using real ammunition.

Disadvantages:

- Personnel can still be wounded (e.g. the use of masks and minimum engagement ranges need to be enforced).
- Weapon firing characteristics (e.g. recoil) are different to the real weapon

3.2. Instrumented Tactical Engagement Simulation System (I-TESS)

The Instrumented Tactical Engagement Simulation System (I-TESS) is an eye-safe laser-based tactical training system produced by Cubic Defense Systems.

I-TESS laser projectors attach to the small arms systems that NZ soldiers utilise, while hits are recorded by I-TESS laser detectors attached to the soldier's webbing. The system is powered by lithium ion batteries, which can last up to 10 days without recharging. Similar systems can also be fitted to NZDF vehicles, enabling large-scale training exercises involving multiple force elements to be conducted.

There are also a wide range of different replica weapon options, including claymore mines.

Figure 6: The NZDF Instrumented Tactical Engagement Simulation System

Advantages:

- Provides real-time feedback on 'hits' to game control
- It puts soldiers in real environments with their actual standard issue weapons, clothing, vehicles and equipment
- Soldiers can transition from one weapon type to another seamlessly
- Training can occur at less cost due to not using physical rounds.

Disadvantages:

- Limited amount of equipment available to allow larger formation activities (e.g. pre-deployment training).
- The hardware itself is wearing out quite rapidly
- Weapon firing characteristics are different to the real weapon.

3.3. Small Arms Retaliatory Target (SART)

The Small Arms Retaliatory Target (SART) was developed by SAAB Training Systems and has been in service in the NZ Army since about 2009. The system can be on either a Gazetted Range (normal rifle range) or in a live field firing situation. It can be used for both live firing and blank firing.

When live firing, a human torso-sized rigid plastic target is placed in the target holder. There is a 'hit sensor' (vibration sensor) that is situated at the bottom of the target holder to sense the shock of the round as it passes through the target. The sensor will only sense a vibration from a round going through the target so things like stones being flicked up will not set it off. Once a hit is registered, the target drops (folds down). The target will then lift up after a predetermined time or when instructed to via a wireless signal.

Figure 7: NZDF Small Arms Retaliatory Target

When using the SART for blank firing the plastic target is replaced with an aluminium one with a laser sensor on it. It is then used in conjunction with I-TESS. This is good for urban environment training when live rounds cannot be used.

The system uses batteries for power, allowing them operate autonomously, and it can operate in hot and cold environments. There is also a speaker system to produce sound effects, such as emulating enemy gun fire.

Figure 8: NZ Army soldiers practising section tactics using SARTs.

Advantages:

- Provides real-time feedback to operators and game control, including operator reaction times and hit statistics.
- It provides a realistic target for live firing, with targets being able to be controlled to follow group instructions.
- Soldiers can use their actual standard issue weapons (and ammunition), clothing and equipment
- Operators have flexible control over how and when the targets appear. This has pros pertaining to variety in training and also practising rules of engagement.
- It is fairly reliable. There are few reports of any issues with either the software or hardware.
- It has the flexibility for the user to be able to programme complex scenarios or control the targets manually.

Disadvantages:

- It is often difficult to tell who in the group got the hit. It is also difficult to isolate where rounds hit on the target because if a shot lands anywhere on the target it will react.
- Targets require replacement (or repair) over time.
- The system is unable to emulate common human behaviours e.g. suppression, movement.
- It can take a long time to set-up a live field firing situation, especially if you have to dig pits to put the targets in.
- The sound simulator is separate to the targets themselves however it would be more beneficial if each target had its own speaker.

3.4. Outdoor Summary

Outdoor small arms training simulation systems have a number of advantages over traditional weapon ranges.

- They enable training to occur at reduced cost (mainly by reducing ammunition overheads).
- They provide the ability to rehearse techniques and procedures that cannot be achieved with static paper targets.
- Units can train in real environments, such as in urban or jungle terrain, and in a variety of conditions (e.g. poor weather, low light).
- Most systems allow the use of standard issue combat gear and equipment.

The drawbacks of such systems are:

- Most of the outdoor systems require batteries to operate.
- A trade-off usually exists between either using real weapons or real enemy units to train against, with most of the systems being based around emulating one or the other.
- Severe weather may prevent outdoor training activities.
- The size of the training area and number of targets is limited. This limits the size of the training exercise to section level.

4. DISCUSSION

In 2010, a review was conducted by the New Zealand Ministry of Defence on the NZDF's use of simulation as a training tool. One of the key findings from this report is that simulation has been used as an integral part of training across the NZDF for many years and is a well-established and essential element for the delivery of its outputs (Ministry of Defence 2011). The Army Land Training and Doctrine Group is preparing a simulation Action Plan which will outline its future requirements for weapons and combat simulation and the simulation capabilities required to achieve this.

5. CONCLUSION

The NZDF employs a number of different small arms training simulation systems, with each offering different benefits and disadvantages. None of the systems on their own offers a full training solution but collectively they enhance the small arms skill that operators should possess in order to deal with the complex spectrum of challenges they are likely to face on the modern battlefield. Examples include rapid decision making, the use of multiple weapons, cooperative tactics and conducting operations around non-combatants. Many of these skills are difficult to acquire when using traditional small arms training techniques i.e. static paper targets on a weapons range.

Although the NZDF claims that small arms training simulators have improved marksmanship skills, very little analysis appears to have been done to support this claim. It is therefore likely that more quantitative assessments will be done in the future.

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