AICW Australia's revolutionary weapon

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Above: Vision of the future? An Advanced Individual Combat Weapon combining magazine feed 5.56mm and 40mm is demonstrated in the hands of an Australian soldier. (DSTO)

Right: Australian infantry rely on their single shot 40mm grenade launchers in the less than ideal 'add-on' M203 weapon. (Defence)

After close to 20 years and $100 million the US Army and some of the biggest defence firms in the world had to give up on the XM-29 Objective Individual Combat Weapon – it was just too big for a soldier to operate.

For the first time in 400 years the kinetic-energy rifle may be superseded on the battlefield – and by a weapon concept being developed in Australia. Combining a standard 5.56mm assault rifle with a multiple-shot grenade launcher integrated into a single weapon, the Advanced Individual Combat Weapon (AICW) represents a revolution in weapon technology. Developed by the Defence Science and Technology Organisation (DSTO) in alliance with Metal Storm and Tenix Defence the AICW received funding primarily through the Government's Capability and Technology Demonstrator (CTD) program.

The idea of a single weapon that combines a kinetic-energy rifle with a grenade launcher is not new nor is it unique to Australia. The M203 40mm grenade launcher is currently the most common weapon of this type, which is an add-on to the assault rifle, fitting beneath its barrel. However, the single-shot M203 has ergonomic disadvantages with two sets of triggers and sights and the operator has to change firing stance to change from firing the rifle to operating the grenade launcher.

The AICW aims to provide the infantry soldier with the ability to fire multiple grenades without having to reload, and to switch between 5.56mm kinetic-energy fires and 40mm grenades without changing sights, trigger or stance.

This is the key new capability of the AICW, according to Stephen Forbes, DSTO Scientific Officer in charge of the AICW CTD.

"It gives the operator the ability to acquire and engage a target with multiple rounds," he said. "You can hold your point of aim and keep engaging through the three shots."

The reality of combat is that the first shot almost always misses; however, automatically reloaded weapons enable the firer to take a second shot. Soldiers can assess where their first, missed shot landed and adjust their fire correspondingly.

"The AICW gives you the ability to hold the target, aim and rapidly engage without having to again go through the manual reload process and cycle," said Forbes. "It's just the flick of a switch, you rotate the safety selector so your finger stays on the trigger and you swap barrels with your thumb. Ergonomically you don't break your firing position."

Since the 40mm grenade launcher entered service in the early 1960s the US Army has being trying to develop a weapon with a capability similar to the AICW. The latest attempt, the XM-29 Objective Individual Combat Weapon (OICW) project, was launched in 1986. OICW aimed to use advances in computer technology in a weapon that fired grenades automatically pre-set to explode above or beside targets hidden from view. Fragmentation from the exploding grenades would defeat the target when normal rifle fire would be ineffective. While the advanced sights, computer control and air bursting grenades worked well the rest of the weapon did not. It was too heavy and too big to be operated effectively by a soldier, and the performance of the 5.56mm kinetic-energy component had been sacrificed to lower overall weight. After spending more than US$100 million on the OICW project it was quietly dropped last year from the US Army's near-future requirements.

With the US heavily investing in OICW the Australian Defence community realised that this kind of weapon was the way of the future. Stephen Forbes said the AICW CTD was a mechanism to generate 'advance-thinking' within the ADF about the future of small arms.

"Historically, we tend to wait till the 'future's now' then we madly scramble to re-position ourselves to make use of technology," he said. "The spirit of this [project] was to put together something that displayed leading-edge technology in a nicely integrated packaged."

The AICW is not a prototype of a new weapon about to enter ADF service, it is really a concept demonstrator, but it has demonstrated that this type of capability is feasible.

The CTD Alliance

The principal reason behind the AICW's success compared to the US OICW is the use of Metal Storm 'stacked-round' technology.

Dr Noel Martin, DSTO's Research Leader for Emerging Weapons Technology, said the starting point in the project was to look at applications for the Metal Storm stacked-round technology.

"Not only was the Metal Storm technology there, but also all sorts of other technologies like sights, recoil springs, electronic ignition for a gun, etc," he said. "The need was to assemble them into some sort of capability technology demonstrator, not just individual technologies, and of course we needed an individual combat weapon to do that."

DSTO's CTD program was established in 1997, and its success has seen annual project funding increase from $20 million to $39 million. Each year, concepts were chosen for further development and funding provided on a contractual basis. The AICW CTD was funded as LAND 143 in the fifth CTD round, 2001/02, with $3.2 million from the Government.

"The consortium was formed about three years ago with DSTO, Metal Storm and Tenix Defence contributing with a defence systems and electronics background," said Dr Martin. "Very quickly, there were other major contributors. An Israeli company, International Technology Lasers (ITL), with their targeting sight, became a major contributor – and another sight company, Vinhøg [from Norway], also made some contributions."

Ian Gillespie, Metal Storm General Manager, said the basis of their involvement in the CTD was an industry alliance signed with DSTO in November 1997.

"Out of that agreement flowed two CTDs, and Metal Storm has jointly funded both these programs," he said. "We put $750,000 cash into each of those projects on top of our in-kind support."

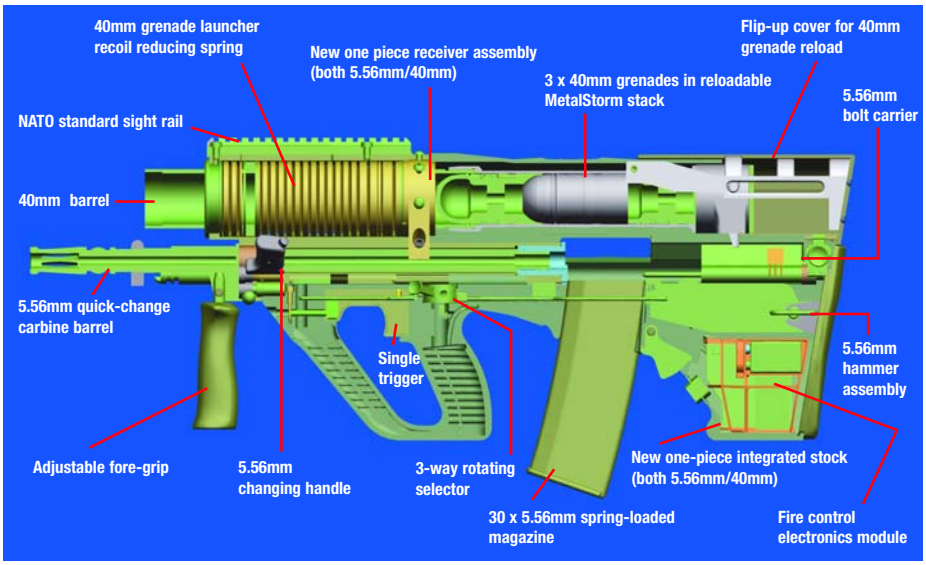
While the AICW CTD explored using 'stacked round' technology in an individual weapon, another CTD, the Area Denial Weapon System (ADWS), applied the technology to remote-controlled system to replace landmines.

The potential of the AICW concept encouraged the Australian Army to offer additional funding, and industry increased its support with in-kind contributions and foregoing payment for some equipment.

"They had developed new technology, which we were paying for in parts but they were also contributing in kind," said Dr Martin. "These were not off-the-shelf technologies but were new developments in their own right."

With a combination of Metal Storm stacked-round technology, the legacy Steyr F88 kinetic-energy rifle along with computerised Fire Control Systems from ITL and Vinhøg, all that was needed was a team of engineers to integrate the elements into one package.

"Over the three years the CTD ran we were able to bring these all together in one place at one time into a sort of futuristic individual combat weapon," said Dr Martin. "Stephen's technical team were able to demonstrate that."



AICW VX3 layout and design

The most advanced alternative to AICW type weapons is this Mk16 Mod 0 Special Operations Combat Assault Rifle (SCAR) fitted with a single-shot 40mm grenade launcher that is about to enter US Special Operations Command service.

Designing the AICW

Despite the combination of Metal Storm stacked-round technology, project funding, an alliance and additional industry support, all these components had to be utilised to create a single weapon system. With the US OICW effort flagging the Australian project began under the leadership of Stephen Forbes.

"The starting point was a non-functioning weapon mock-up," said Forbes.

It comprised a Metal Storm barrel grafted onto a Steyr F88 rifle. To develop the concept a series of AICW generations VX1 to VX3 were developed.

"Each of these generations built on the levels of functionality from VX1 which was an early 40mm grenade launcher with non-functioning Steyr components," said Forbes. "As we went through we gradually refined the designs adding more and more functionality and overcoming some of the limitations from the testing programs."

Even so, the original Steyr rifle required considerable engineering to work.

"What we essentially did was translate as many of the mechanical workings over to the new weapon," said Forbes. "We had new stocks created, made in a rapid-prototyping system translated from a 3D CAD file and built in a one-piece structure."

"We spent a lot of time when it came to final integration, getting things in place so it would work within the confines of the redesigned elements for the 40mm systems," said Forbes. "So integration turned out to be a lot trickier than it originally appeared."

While physically fitting the two weapons into one package was an achievement in itself, ensuring that the integrated weapon could be operated safely by a soldier, responding appropriately to inputs, was a separate challenge.

"It's the first time you are really looking at trying to provide safety functionality for both electrical and mechanical systems in the one common framework," said Forbes. "The Steyr system of safety is pretty straightforward but we had to redesign and integrate something that provided that dual functionality. So the 40mm and 5.56mm are entirely safe in one setting, with the ability to select between calibres to fire through a common trigger.

The core technology of the AICW is the 40mm stacked-round grenade launcher. Ian Gillespie says the key advantage of this technology is it essentially means the weapon has no mechanical parts.

"We are able to stack rounds in the barrel one on top of the other and fire them from that barrel in sequence using electronic ignition." said Gillespie.

The AICW has three 40mm rounds pre-packaged in a tubular column or stack loaded into the rear of the barrel, much like a single shot or double barrel shotgun. After each round is fired the next becomes available for instant firing, without the need to load a new fresh round into the barrel as is the case with conventional weapons.

"All you have is a tube loaded with rounds and a very small and lightweight electronics package to drive it," said Gillespie.

Because the rounds are fired by an electronic ignition system rather than the traditional mechanical 'firing pin' it integrates extremely well with electronic fusing of ammunition.

"Metal Storm works, it's well beyond proof of concept stage," said Gillespie. "We've proved through the two CTD projects with DSTO and other demonstrations in the US that stacked rounds can be fired without destroying the column."

So far, only fired inert and sensitive pyrotechnic rounds have been fired, the next step will be rounds with High Explosive (HE) warheads.

"This year we expect to demonstrate firing HE rounds in the stacked configuration," said Gillespie. "Once we have the HE rounds tested and demonstrated we have a full package ready for product qualification process."

The legacy 40mm grenade requires some re-design to operate in the Metal Storm system as each round snugly fits up against the next, and there can be no shell-casing left behind in the breech.

"Current grenade designs generally have a pretty strong nose cone, so there is very little that needs to be changed in the front half of a round," said Gillespie. "Only the tail end of the round where the propellent goes has to be changed. In our system the whole body of the round leaves the barrel."

Part of the appeal of the 40mm grenade launcher is its versatility, as grenades come in a range of applications including HE, Illumination, Fragmentation and, importantly, non-lethal projectiles for complex warfighting.

"We can generally take conventional grenade rounds and convert them to Metal Storm configuration, we don't need to design rounds from the ground up," said Gillespie.

This AICW is fitted with the ITL Viper Multi-Purpose Rifle System, ITL provided significant in-kind support to the demonstrator with their multi-function laser capability. (DSTO)

AICW fitted with the sophisticated Vingsight that provides a range of 'Forward Observer' type systems to the soldier and their weapon. (DSTO)

The AICW demonstrator is readied for firing at the Proof and Experimental Establishment, Port Wakefield, from a trainable testbed. Performance was high despite being a concept demonstrator. (DSTO)

AICW vs OICW

An AICW demonstrator beside an XM-29 OICW prototype would be hard to identify as the same class of weapon. The grenade launcher on the OICW is mechanically operated and fed by a conventional magazine. By utilising the Metal Storm system, weight has been drastically reduced on the AICW and its ergonomic feel improved compared to the OICW.

Stephen Forces said the technical team aimed to keep the AICW as simple as possible and keep the mass down to something that was more acceptable in an assault weapon, "In its raw form unloaded, it's 6.48kg, and you could probably drive that down closer towards say about 6.1–6.2 kilograms fairly conservatively," said Forbes. "Beyond that you would have to get fairly aggressive and start taking more and more risks in changing the fundamental Steyr components."

The OICW weighed in at 8.2kg loaded, compared with a prototype AICW that would probably weigh around 7.5kg with ammunition. Advances in materials technology will also drive down the weight of any AICW type operations weapon. To achieve 8.2kg the OICW cut back on the 5.56mm kinetic-energy rifle, reducing its barrel to an ineffective 25cm and only carrying 20 rounds of ammunition, while AICW retains a 45cm barrel and 30-round magazine. Significantly, 5.56mm bullets require a barrel length of 45-51cm to achieve enough velocity to 'fragment' upon hitting a target at ranges of 200m. Without fragmentation, the bullet is usually unable to incapacitate a human. The capability of the OICW's kinetic-energy rifle in anything more than close quarter battle would be limited.

The other difference was the choice of calibre, opting for a system that projected a grenade out to the 1,000m mark in a flatter trajectory.

The AICW's 40mm grenade launcher is a marked improvement over the legacy M203 round, firing at a muzzle velocity of 95 metres per second (mps) compared to 75mps. AICW is also fitted with a recoil reducing spring to stabilise the weapon in rapid fire.

"But the trade-off is in terms of the warhead design," said Forbes. "The terminal effects of the 20mm is pretty minimal, and we have a historical precedent with the 40mm in terms of its five-metre kill radius."

The reduction in on-target effects for longer range is hard to justify considering the wealth of evidence showing infantry combat rarely occurs at ranges over 200m.

Another key difference between the OICW and AICW is in the ergonomics of the system. The OICW is much larger weapon, 890mm versus 738mm, with the trigger much farther away from the body.

According to DSTO, Army observers at the AICW live-fire provided positive feedback from the handling trials. The AICW mimics the ergonomic layout of the standard non-grenade firing rifle while the standard ADF grenade-launching weapon, the F88GL fitted with a RM Equipment M203PI under-barrel grenade launcher, has a different centre of gravity and 'feel' to the standard rifle.

"The F88GL is forward loaded so the AICW brings the weapon back into line with the bull-pup centre of mass, which is closer to the shoulder or hip," said Forbes. "Even though at 6.48kg it's still quite a heavy weapon compared to the Steyr the weight distribution means you wouldn't perceive that weight as problematic."

Weight distribution is important, as a soldier would have to be extensively retrained to be comfortable firing the F88GL over the standard F88 due to its different balance. The AICW only has a 15-20 per cent increase in weight over F88GL, not inclusive of sights and ammunition, which is a small price to pay for the huge increase in functionality.

Making pre-programmed air bursting grenades work on the OICW and AICW is the job of the Target Acquisition/Fire

Control System (TA/FCS). The AICW demonstrator utilised two sighting systems that also measure the range to the target and automatically display a corrected aiming point for the correct elevation for accurate lobbing fire. The TA/FCS also predicts time of flight to the AICW electronics module that sets the grenade's time delay fuse to enable airburst detonation at a preset altitude over the target. The TA/FCS can also set the fuse to explode at a preset delay after impact. This enables penetration of soft barriers such as windows.

ITL, manufacturer of Night Aiming Devices (NAD) for the ADF, produced the Viper Multi-Purpose Rifle System (MPRS). The Viper has additional C4I functions, including a digital compass and laser pointer, and it can be fully integrated into an advanced tactical command and control system. Information from the Viper can be linked to the soldier by a bi-directional RF 'wireless' unit. The soldier then views this information on a heads-up display or can datalink it to other ADF communications systems.

The Vingsight FCS (FireControl System) by Vinghøg is similar to the Viper but with additional features. The sight can slew up and down 20° to allow a direct view of the target when lobbing grenades. The Vingsight also has a graphics overlay of the sight picture integrated into an advanced tactical command and control systems. Other features include motion and temperature sensors and a image story capability.

"The Vingsight was originally proposed more as a Forward Observer aide," said Forbes. "While it looks large and cumbersome it has a lot of capability and is part of a larger sensor mechanism."

Other simpler sights such as those currently used on ADF F88s could be fitted to the AICW to lower all-up weight yet still provide accurate aiming.

With the success of the AICW CTD it is now up to industry to develop the concept into a prototype and production weapon and the ADF to realise a firm requirement. (DSTO)

The Future Demonstrated

In July this year, a live firing demonstration at Port Wakefield tested the AICW VX3. Firing from a trainable test-bed the AICW fired 40mm projectiles at targets ranged at 100m, 200m and 300m. Stephen Forbes and the AICW alliance were "pleasantly surprised" with its accuracy. The 5.56mm rifle element was also fired at targets at a range of 300m.

"The munitions themselves were only early concept devices," said Forbes. "The groupings from the demo were pretty good."

The AICW demonstrated an ability to consistently hit a door or window sized target at 100m, with all the technology convincingly demonstrated.

Dr Noel Martin said that DSTO don't want the AICW to end with the Port Wakefield firings.

"We want the project to go on and be developed by industry, and of course become available to the ADF," he said. "Also, the project is in its own right a mechanism by which DSTO can provide advice to the ADF. The guys here have learned a lot and now we can provide informed advice on both our system and other systems, if the ADF considers buying this sort of technology and they want more advice than that in the glossy magazines."

Part of the Defence Capability Plan (DCP) is LAND 91, the small arms life-of-time extension, which could see the ADF acquire an AICW-type system in 2010/12. Complex warfighting, with the need for both increased lethality for the soldier plus the flexibility to fire non-lethal weapons, is creating a demand for this type of weapon.

Ian Gillespie agrees. "There clearly is a need, operationally, for an integrated combat weapon that fits within the weight and size envelope that is manageable by a person," he said.

The AICW demonstrator is a significant achievement for Australian science and industry. If a weapon of this type is fielded by the ADF in the future it will be a world first and a revolutionary milestone in the nature of infantry combat.