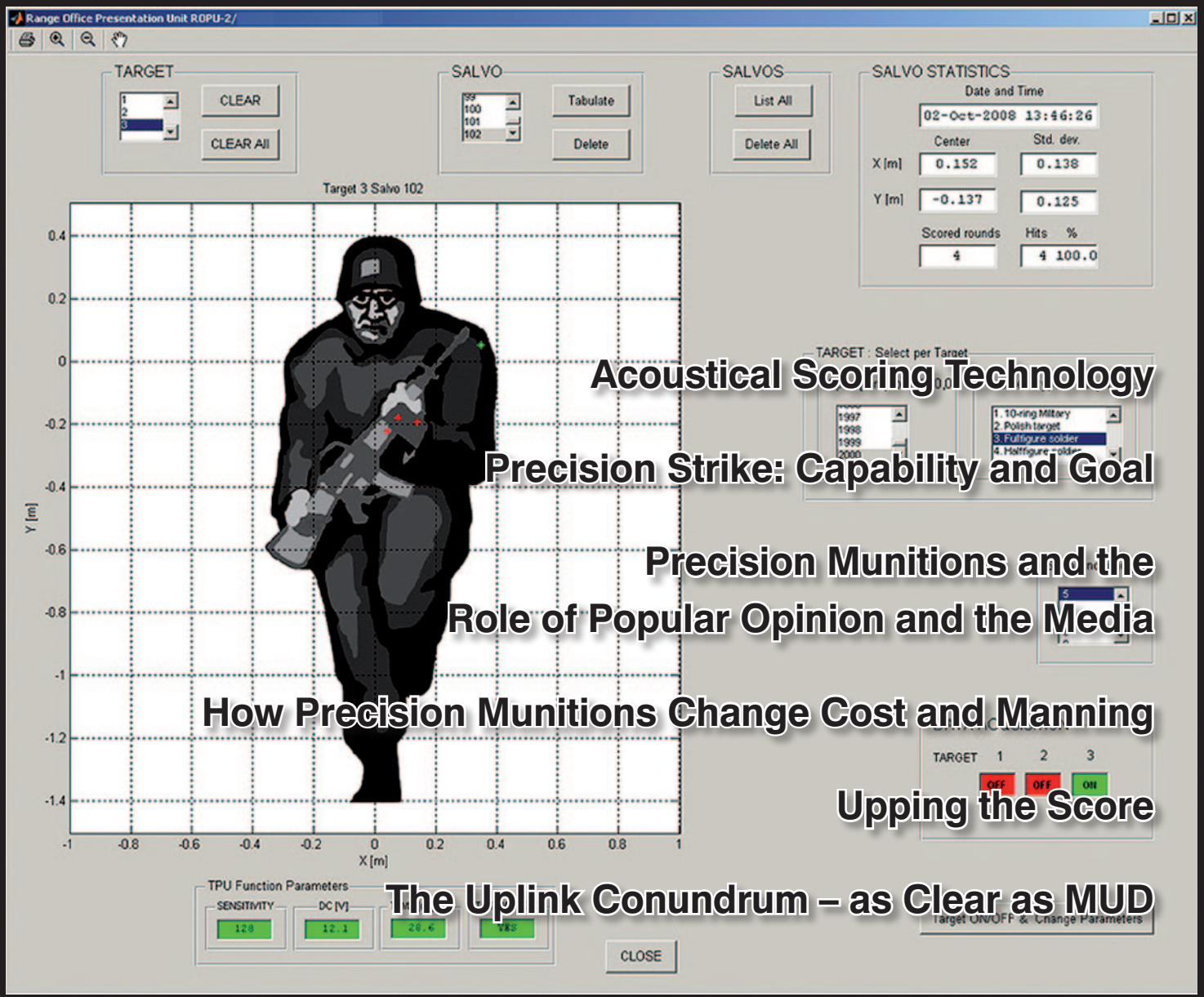
SPECIAL REPORT

Acoustical Scoring Technology



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Precision Strike: Capability and Goal

Precision Munitions and the Role of Popular Opinion and the Media

How Precision Munitions Change Cost and Manning

Upping the Score

The Uplink Conundrum – as Clear as MUD

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SUPPLIER OF ACOUSTICAL SCORING SYSTEMS
FOR ARMIES, NAVIES & AIR FORCES

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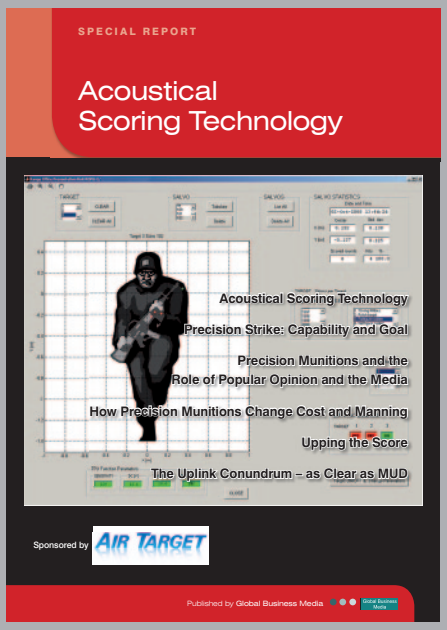

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Foreword

Despite living in an age of budgetary austerity, technological advancement is providing critical assistance on the battlefield. Developments in acoustical scoring technology are vital to aid ISAF and other defence forces to compete in the challenge for ever more precise attack.

Precision attack by missiles from UAVs, manned aircraft or ground launched missiles, rockets or artillery are now seen to win or lose the battle for "hearts and minds" by their level of accuracy and their ability to avoid collateral damage – the killing of civilians. Similarly, with constraints not just on manpower and logistics, but training hours, devices that facilitate enhanced accuracy without excessive call on expensive ammunition will always have a value.

Miss Distance Indicators (MDIs) are ubiquitous in their role in indicating accuracy of opposing force "incoming" and in offering training munition operators an opportunity to improve their standards.

The opening section of this Special Report examines the technological trends and developments in acoustical scoring technology. It describes the importance of ensuring that firing training is carried out under realistic conditions with the ability to provide real-time scoring systems in all firing scenarios whether on land, sea or in the air. It stresses the importance of evaluating not only the rounds that hit their targets, but also knowing what happened to those that missed. The section sets out a check list of the main factors to be taken into account when choosing MDIs and highlights the economic benefits through the lower cost of ammunition used and the consumption of targets. Examples of MDI installations are reviewed as well as a look at advances in acoustical scoring technology.

The next piece looks at the high political importance of precision through the 20th century and how that emphasis has continued to rise in both the strategic and tactical agenda. The third part follows this thought on with an analysis of the complexity of the precision debate and the role of the perception of accuracy by the media in 2011 in Operation Unified Protector in Libya and on the Afghanistan/Pakistan border.

In the fourth section, the intense debate in the United States about the use of types of artillery/munitions relative to the cost of the ammunition and the precision of its delivery in Afghanistan is examined. Despite the huge improvements in precision targeting with smart munitions, GPS and other guidance systems, some in the United States Department of Defense prefer Guided Multiple Launch Rocket Systems (GMLRS).

The fifth article is a glimpse of the new advances and the technological developments in the acoustical scoring systems serving today's most advanced militaries in sea, land, air and space.

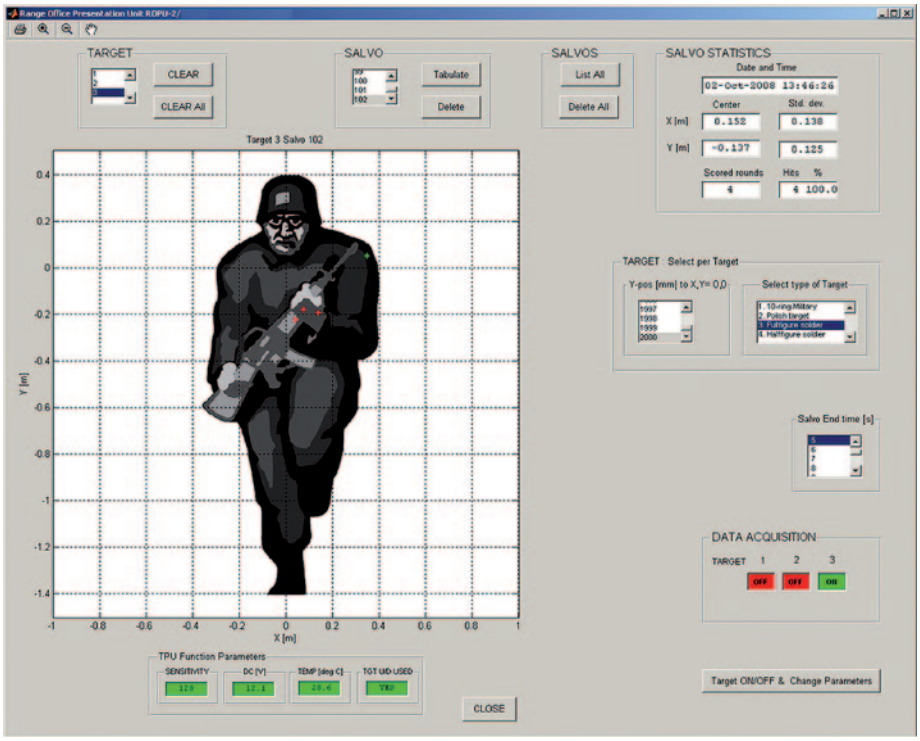
One of the challenges that commanders face - the need for improvements in uplink technology – is addressed in the final section of the Report. DARPA (the Defense Advanced Research Projects Agency) and BAE Systems have been doing advanced research on this issue and may have come up with developments that ease some of the problems.

Mary Dub
Editor

Mary Dub *has covered the defence field in the United States and the UK as a television broadcaster, journalist and conference manager. Focused by a Masters in War Studies from King's College, London, she annotates and highlights the interplay of armies, governments and industry.*

Acoustical Scoring Technology

Air Target Sweden AB



Technological Trends and Developments

Initially there were only towed targets in the form of sleeves which were easier to handle than banners. As they were more difficult to hit, the need for an indication of hits was required. The early acoustic scoring indicators only recognized a projectile that passed somewhere in the vicinity of the target, but they functioned as if the gunner had a target larger than merely the aiming aid provided by the sleeve. Demands increased both in respect of target speeds as well as feed-back to the gunner as to where his fire reached and, also, when he missed the target. The higher target speeds called for calculation of projectile trajectories in relation to targets and the types of training needed for systems that could present a real time score board.

Calculation accuracy has vastly improved over the years because of the access to fast sensors, fast microprocessors and memories and sophisticated mathematic algorithms. Speed of calculation and the possibility to present real time scoring results has been brought about through the development of computer technology that is available today.

GPS and roll angle information from the Miss Distance Indicator (MDI) are two important factors used to improve scoring accuracy. Earlier systems used only GPS information to plot the MDI position on a mowing map.

Nowadays, we enter a new era where budget restraints for defense training are becoming challenging in many countries. It is becoming increasingly important to show the results of any shooting activity to bring down costs. By using scoring equipment, it is possible to save targets as well as ammunition. Fewer rounds in a salvo enable more targets to survive. The scoring system knows where all bullets went, and a true kill probability can be calculated so that the gunner can be credited as if a full salvo had been fired. The gunners get real time feedback of how they performed during their firing mission.

How Gunner Training Requirements for Modern Combat Operations are Changing

The performance of a weapon, as with any man-made machine, is no better than the ability of the person operating it. Because of this, firing

Calculation accuracy has vastly improved over the years because of the access to fast sensors, fast microprocessors and memories and sophisticated mathematic algorithms.

training in realistic conditions, with the possibility to get real time feedback from a scoring system, is essential. This requirement is valid for all firing situations within the defense forces in many countries, e.g. for an air force pilot firing at a ground target or at an aerial target; firing from a naval ship at a surface or at an aerial target; for a soldier firing at a ground target etc. Furthermore, firing at several targets at the same time is also a requirement demanded today.

Why Acoustical Scoring?

There is all too often a disparity between money spent on expensive weapon equipment and the basic training of the gunners using that equipment. Without excellent performance of human operators, the cost of the weapon itself is all but wasted.

In many cases, the weapon is assumed to have the required performance, operators are taught the technical aspects of using and maintaining it, and eventually they are trained in loading live ammunition and firing rounds at stationary or moving targets. All too often, however, the result of the training is measured in the number of targets killed, but no track is kept of where all the other rounds went.

It is more important to know where the rounds went that missed than it is to count just the hits.

In every learning process, feed-back and the measure of progress is essential to motivation, improvement and the acquiring of lasting skills. This is the important reason for using scored practice targets, but there are numerous other reasons also, not the least of which is the economic aspect. In short the following must be borne in mind:

- Feed-back of results is essential for the learning process
- Simulator acquired skills are verified in the real situation
- Inert and lower cost ammunition can be used
- Consumption of targets is reduced
- Full firing rate kill probability can be calculated when firing at reduced rate
- Firing results over a long period can be stored and statistically evaluated
- The total cost of training can be reduced without compromising quality

Next Generation Acoustical Scoring Systems

Next generation acoustical scoring systems will be fully automatic, i.e. there will be no need to feed the mission firing profile geometry into the scoring station software as this data will be taken in real time using the GPS receiver in the Miss Distance Indicator (MDI).

The MDIs will also get a new generation of roll angle electronics. The roll angle electronics makes it possible to compensate for the sector error when a target is rotating around its x-axis because of a damaged sleeve target. The enhanced roll angle measuring accuracy is also a very important feature for a new target under development.

Finally, new smaller and faster pressure transducers will be introduced in next generation MDIs. All these factors will increase the scoring accuracy considerably with regard to miss distance and location (sector), and also will increase the scoring area.

The Impact of New Developments in Acoustical Scoring Technology on Current Weapon System Operator Training Programs

Next generation acoustical scoring systems as described above will have a great impact on operator training. As both the scoring accuracy and scoring area will be increased, the weapon operator training will be more efficient because both the training time and consumption of ammunition will be reduced.

A further advantage is that possible faults in the weapon or in the fire control equipment can more easily be detected and corrected thanks to the increased scoring area.

Key Factors to Consider When Choosing Miss Distance Indicators (MDIs)

- Which MDI system to choose depends on which aerial targets are available in the particular country where they are to be used e.g. Will it be a manned civil or military aircraft towing a hard or a sleeve target equipped with an MDI system, or an unmanned aircraft (UAV) with an MDI, or a UAV towing a hard or sleeve target with an MDI? Examples of different targets are shown below. The target towing service can be rented from many companies if not available in the country concerned. To rent this service is a fast and cost effective way to get started.
- How many targets are required for the firing mission, e.g. Will several targets be fired at the same time? The scoring station can handle up to 6 targets simultaneously.
- A manned aircraft is capable of towing two targets at the same time. Many UAV suppliers offer the possibility of flying several UAVs in the firing area at the same time.
- Select a scoring system that presents true 12 sector scoring information. Many scoring systems can only present true 12 sector information in attacking or passing target courses. A true sector scoring system makes it possible to fire at a target coming from any direction.

- Select a scoring system that can present a large scoring area. The ability to score the widest area is essential to be able to record as many rounds fired in a salvo as possible.
- Select a scoring system that transmits raw data from the MDI and not calculated results. Raw data coming from an MDI makes it possible to analyze and correct the scoring results after the firing has taken place.
- Select a scoring system that allows recalculation of the scoring results. This is important to increase the scoring accuracy if some of the data entered in is incorrect or if the operator has made an error.
- Select a scoring system that presents the result in real time.
- Select a scoring system that can be remotely operated from an external computer via network.
- Select a scoring system where it is possible to download the scoring data for later analysis on an external computer with analyzing software.
- Select a scoring system with uplink possibility. From an Uplink Command Unit it is possible to send commands to the MDI provided it is equipped with an uplink receiver, enabling the MDI sensitivity to be changed, switching on and off, a built-in lamp, change to the MDI frequency etc.

There is all too often a disparity between money spent on expensive weapon equipment and the basic training of the gunners using that equipment. Without excellent performance of human operators, the cost of the weapon itself is all but wasted.

Examples of MDI Installations

MDI AS-135/12U installed in the SCRAB TARGET

MDI AS-113/12U installed in the ALBA TARGET

New smaller and faster pressure transducers will be introduced in next generation MDIs. All these factors will increase the scoring accuracy considerably with regard to miss distance and location (sector), and also will increase the scoring area.

MDI AS-133/12U installed in the TGX-2 TARGET

Example of MDI used with a Sleeve Target

MDI AS-131/12U EQUIPPED WITH A UPLINK CONTROLLED HALOGEN LAMP FOR NIGHT FIRINGS

SLEEVE TARGET S30Z43

Scoring Stations

MINI MARQUE SCORING STATION

MARQUE 19" SCORING STATION

New Possibilities with Uplink Technology

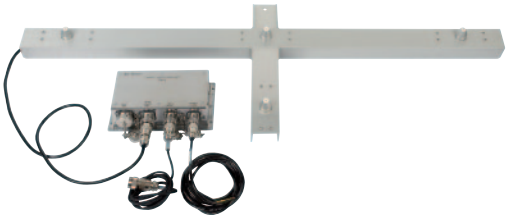
MDI with smoke or IR flares is something customers have required and which can be achieved with the uplink. To release the sleeve from the MDI via the uplink is another possibility. These are only examples of possibilities available using an uplink. There are actually no limitations to what this technology can offer – only the imagination!

UPLINK COMMAND UNIT UCU

Advanced Acoustical Scoring Technology in Use

The LOMAH system, (Location Of Miss And Hit) is a calibration-free system used for soldier training on firing ranges. Only simple mechanical alignment with the target is needed. It is a modular system that easily can be built out to cover more than 20 firing lanes and with multiple firing distances in each lane. With LAN-technology, virtually any number of targets is possible. The system can be used with pop-up and moving targets.

In addition to presenting the scoring result with very high accuracy, fire effects evaluation including suppressive fire and hit zones can easily be added. The system has a very ruggedized design to withstand harsh environments.



Target Area Equipment

BEAM SENSOR UNIT BSU-4/9 &
TARGET PROCESSOR UNIT TPU

The Visual Display Unit VDU gives the gunner necessary real time feedback. Firing results are shown on targets such as 10-ring or different types of soldier targets. Touch screen use and targets illustrated by jpeg-pictures give easy handling and great modularity and adaptability to user needs. Printing of results is done in the Windows environment.

VISUAL DISPLAY UNIT VDU

Whereas the VDU gives the individual gunner real time feedback of the firing results, the Range Office Presentation Unit ROPU gives to the range officer real time feedback of the ongoing firing results on any one of the range's targets.

Advances in Acoustical Scoring Technology

A successor to our present LOMAH system is under development.

Key features of the new system will be:

Multipurpose usage:

- High precision individual skills scoring
- Tactical field firing.

Deployable – for fixed as well as for deployable applications:

- Variable firing positions relative to target with maintained accuracy.
- Applicable with moving targets as it handles dynamic firing angles with maintained accuracy.

Improved accuracy:

- 5 mm accuracy in center of target.

Calculation of projectile:

- Position X, Y in the target.
- Side and dive angles with high accuracy.
- Velocity.

Precision Strike: Capability and Goal

Don McBarnet, *Staff Writer*

"The enemy: During the 2015-2024 timeframe, the threat will likely be able to gain ground in the technological spectrum…The operational environment of these conflicts will be complex, intricate, and demanding… Information age technologies will provide potential adversaries with capabilities to apply military force with greater precision, lethality, agility, and survivability throughout an expanded environment…"

And United States capabilities to respond: "Capability to provide fire support to joint, Army, and allied munitions to include precision engagements, brilliant and precision munitions, improved lethal and nonlethal effects, scalable munitions, and munitions utilizing in-flight corrections."

United States Military Operations INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE CONCEPT CAPABILITY PLAN 2015-2024

Precision in targeting and enhanced specific lethality is the goal of munitions in the 2015-24 Operational Plan and has been for centuries.

PRECISION IN targeting and enhanced specific lethality is the goal of munitions in the 2015-24 Operational Plan and has been for centuries. In the last decade, in limited warfare in Iraq, Afghanistan and Libya, precision attack and therefore the protection of civilians in the area has become an intrinsic part of achieving the political goals of the conflict. But it is only in the last 60 years that artillery gunners, munitions experts and pilots have been able to make significant strides, through technological development and training, so that in 2011 many forces are able to achieve very high levels of accuracy indeed.

How?

During World War Two there was a belief that the result of precision bombing would deliver critical advantage:

"Britain's Bomber Command believed not only that bombing could win the war but that 'precision bombing' could win the war."[1]

But the reality of the effect of precision bombing was very different:

"Precision bombing proved markedly imprecise. In the first year of British bombing more than two thirds of the sorties failed to hit their targets. Even large targets, such as rail yards, could be hit only on moonlit nights. By the end of the first year the Bomber Command had admitted that precision bombing alone could not do the job (although later in the war inventions such as the British Pathfinder force and the American Norden bombsights made precision bombing much more precise), and Allied bombers turned increasingly to area bombing, which was to culminate in the horrors of Hamburg (45,400 dead), Dresden (50,000), Hiroshima (118,661), and Nagasaki (73,884). (Tallies are from The Oxford Companion to World War II.) Bombing could not produce victory except through civilian slaughter—unpalatable to people who wished to think of themselves as civilized." [2]

The Conclusion: Precision Did Not Work

So there was a conclusion that precision did not work and that without it there would be barbaric slaughter of civilians on a mass scale. But almost exactly 50 years later in 2005, in the first published U.S. National Defense Strategy, Donald Rumsfeld, the then Secretary of Defense, laid out a range of emerging threats and irregular challengers and re-emphasized the American goal of short wars and "precision-attack technology as the principal means of defeating challengers."[3] Some like Hoffman thought that this could be attributed to the success of the invasion of Afghanistan in 2001 in Operation Enduring Freedom (OEF):

"A combination of precision strike in Afghanistan, coupled with helpful target designation from

a small contingent of U.S. Special Operations Forces, renewed claims about the breakthrough in ''pinpoint'' bombing."

This "pinpoint bombing" was achieved through the establishment of a version of network-enabled warfare using JSTARS in Tornado aircraft. The United Kingdom's, Air Chief Marshal Sir Stephen Dalton takes up the narrative:

"Adopting a system-of-systems approach, it blends together a range of multi intelligence ISTAR capabilities, including high resolution IMINT, tactical reconnaissance and SIGINT, with a range of tunable kinetic effects, from 'shows of presence' through to swift and assured precision attack… The Tornado also provides a genuine combat-ISTAR capability, data-linking video imagery to troops on the ground in real time and attacking a wide range of often time sensitive targets. Critically the ability to provide comprehensive photographic and Infra Red images of the whole Sangin valley in 45 minutes and employ its targeting sensors, launch precision dual-mode seeker Brimstone missiles, and use the internal cannon, all on the same sortie and over a very wide geographical area, demonstrates the value of genuine multirole Combat ISTAR aircraft."[4]

The Key Importance of the Linkage of a Myriad of Technological Improvements

So the improvements in precision bombing were obtained not only by technological developments and enhanced platforms, for example, the Tornado, but also a host of other smaller improvements, which worked towards enhancing the precision capability. Michael O'Hanlon singles out key intelligence and technological step changes that were demonstrated during OEF:

"First, there was the widespread deployment of special operations forces with laser rangefinders and GPS devices to call in extremely precise air strikes. Ground spotters have appeared in the annals of warfare for as long as air planes themselves, but this was the first time they were frequently able to provide targeting information accurate to within several meters and do so quickly. Second, U.S. reconnaissance capabilities showed real improvement. Unmanned aerial vehicles (UAVs), together with imaging satellites and JSTARS, maintained frequent surveillance of much of the battlefield and continuous coverage of certain specific sites."[5]

Such was the effect on tactics of the new precision capability especially with UAVs that since President Obama came to office in 2008, there was been regular use of the precision capabilities of missiles from Predator UAVs to attack leaders of the Taliban in Afghanistan and inside Pakistan.

The improvements in precision bombing were obtained not only by technological developments and enhanced platforms, for example, the Tornado, but also a host of other smaller improvements.

"During the first year of the Obama administration there were 51 reported uses of unmanned Predator drone against targets housing alleged terrorists in Pakistan alone, more than the 45 used during the entire presidency of George Bush. In 2010 this number more than doubled to 118, and by the middle of May 2011 there had already been 27 such attacks in Pakistan."[6]

So in the 60 years from WW2 there has been a radical change in precision strike capabilities. ISAF fighting a counter-insurgency war in Afghanistan is depending on the precise effect of its use of missiles from Predator UAVs or aircraft to deliver focused attack with minimized collateral damage to civilians, because as Major Steven L. Basham, USAF pointed out:

"Precision strike is the capability to attack targets with the exactness and intensity required for achieving the desired military effect with minimum collateral damage and a relative economy of force. Due to decreasing numbers of available assets, the military must achieve maximum desired effects from each weapon system to ensure efficiency and economy of force."[7]

Precision Munitions and the Role of Popular Opinion and the Media

Meredith Llewellyn, *Lead Contributor*

The key point is that allied awareness of the precision of their missiles, bombs or mortar fire are a critical ingredient in prevailing and appearing to prevail in the complexity of modern warfare in 2011.

KABUL, Afghanistan, August 6, 2011 — In the deadliest day for American forces in the nearly decade-long war in Afghanistan, insurgents shot down a Chinook transport helicopter on Saturday, killing 30 Americans, including some Navy Seal commandos from the unit that killed Osama bin Laden, as well as 8 Afghans, American and Afghan officials said. The helicopter, on a night-raid mission in the Tangi Valley of Wardak Province, to the west of Kabul, was most likely brought down by a rocket-propelled grenade, one coalition official said.

'The New York Times' by Ray Rivera, Alissa J. Rubin and Thom Shanker

ZLITAN, Libya (Reuters) August 9, 2011 — Libyan officials said Tuesday that dozens of civilians had been killed in a NATO strike on a cluster of farmhouses east of the capital, Tripoli, but the alliance said it had hit a legitimate military target. A spokesman for Col. Muammar el-Qaddafi's government who took foreign reporters to the site said 85 people had been killed when missiles struck farm compounds in the village of Majar, about 90 miles east of Tripoli. He said 33 children, 32 women and 20 men had been killed.

'The New York Times' by Reuters

THESE TWO news clips reporting from Afghanistan and Libya illustrate from these two current conflicts how critical precision and knowing your own sides and the opposing forces' precision capabilities are in modern conflict. In the first example, in Afghanistan, there had been an ISAF assumption that helicopter transport was a relatively lower risk means of transport because Taliban attacks with small arms on takeoff and landing, hitherto, had low effectiveness, because of low levels of precision and lethality. The Taliban had only very rarely been able to bring down a helicopter on take off or landing before. However, subject to ISAF revealing exactly what happened that night, it appears that the assumption that ISAF forces had control of the air was incorrect, that is, they had inadequate intelligence. The opposing forces, the Taliban, had weapons with greater precision and lethality than they anticipated, giving the Taliban a media victory for their own supporters in Afghanistan.

The second news clip is from 'The New York Times'' coverage of NATO's 'protective' bombing of Gaddafi forces in Libya. This illustrates a similar media victory, this time for the Gaddafi forces, as a result of lack of precision in targeting. Bombing from the air by NATO under UN resolution 1973 is intended to protect civilians in Libya against the forces of their own Gaddafi government. It is unclear why NATO forces hit civilians. It is possible NATO forces had imprecise intelligence on civilians around the target, failed to hit the target precisely or hit a military target, which was being shielded by civilians to deliver a media victory to Gaddafi. The reality will only emerge with time, if at all. The key point is that allied awareness of the precision of their missiles, bombs or mortar fire are a critical ingredient in prevailing and appearing to prevail in the complexity of modern warfare in 2011.

How Precision Munitions Change Cost and Manning

Marushka Dubova, *Defence Correspondent*

UNDER THE Obama administration and Cameron leadership there is no doubt that defense budgets for munitions and manning are under constraint. The costs of manning, maintenance and munitions are now assessed on the battlefield when commanders review military options. The arrival of a host of precision munitions with differing ranges and capabilities has resulted in a heated and relevant debate in the artillery community about the relative cost and military effectiveness of artillery and rocketry options on the battlefield. Capt. Alan J Moore, formerly an officer in the USAFAS (United States Army Field Artillery School), assesses the complexity of the arguments.

First, there is the comparative cost effectiveness of precision cannon, rocket and mortar fire. The direction of Capt. Moore's argument is in favour of the precision Guided Multiple Launch Rocket System (GMLRS) with Unitary or DPICM warheads over the precision guided Raytheon Excalibur and laser guided mortar munitions. Here the relative merits of different types of precision munitions are put to the test.

Table 1 source Defense News[8]

Programme	Description	Guidance	Range	Status	Cost/Round
Excalibur	155mm	GPS	30km	In service this year	$30,000
Guided Multiple Launch Rocket System	200lb Rocket	GPS/Inertial	70km	In service since 2005	$157,000
Precision Guided Mortar	120mm Mortar Round	Laser-homing	7km	2008 funding terminated	$7000-$8000
Munitions					

Capt. Moore argues from the evidence of this table and other analysis that, despite the higher unit costs of the munition, the GMLRS has significant cost advantages. Why?

"The main premise in this article is that fire support – composed of precision Guided Multiple Launch Rocket System (GMLRS) rockets with Unitary or DPICM warheads, as well as precision guided mortar munitions – is less expensive (force structure and cost of engagement), has greater utility on the battlefield, and requires fewer individual systems/units (lower cost of ownership) when compared to precision 155mm cannon artillery."

He puts forward other arguments, first on manning levels. He argues that:

"It is clear that the number of soldiers required by the 155mm Howitzer Tower battery exceeds that required by both the 155mm Self-Propelled Howitzer and the GMLRS batteries."

But he argues that only approximately 40% of the force structure in an artillery regiment actually operate the weapon system, while the remaining 60% of the personnel are assigned to perform basic unit functions. Therefore, the accuracy and precision of the weapon, in this case the rocket, is key.

He describes types of measurement of accuracy/inaccuracy: Target Location Errors (TLE) and the Circular Error Probable (CEP). He argues that the rocket has a 'very small CEP' and a given minimum TLE compared to the other two munitions.

"If one were to assume equal quantities of explosive on target, the cost of precision would be a comparison of four (3.67) Excalibur rounds at $30,000 each (Table 1), or $120,000, versus the cost of a single GMLRS Unitary round at $157,000, everything else being equal. But as noted above, the accuracy (CEP) for the rockets has been shown in deployed operations to be better, so the number of Excalibur rounds required to 'kill' the designated target will probably be greater than that shown."

Finally, on the matter of angle of attack at range, where the target is high in a building or low in a shielded valley, the rocket offers key advantages. Moore concludes:

"The main premise in this article is that fire support – composed of precision Guided Multiple Launch Rocket System (GMLRS) rockets with Unitary or DPICM warheads, as well as precision guided mortar munitions – Is less expensive (force structure and cost of engagement), has greater utility on the battlefield, and requires fewer individual systems/units (lower cost of ownership) when compared to precision 155mm cannon artillery."[9]

Upping the Score

Don McBarnet, *Staff Writer*

Scoring systems have to meet the same challenges as the weapons they are measuring – the weather and the environment in which they are going to be used land, sea, air and space.

SCORING SYSTEMS have to meet the same challenges as the weapons they are measuring – the weather and the environment in which they are going to be used land, sea, air and space. Meggitt Defense Systems, earlier in 2011, publicized a contract to produce the QF-16 Vector Scoring System with Boeing, St. Louis. The subcontracting deal covers development, ground test and flight test. According to the press release:

"It is a non-cooperative, on-target, aerial scoring radar system which, in conjunction with a ground station, provides three dimensional trajectory information on intercept vehicles. Comprised of an airset, a ground station, and a suite of support equipment, the system enables intercept scenarios to be "scored" by providing scalar and vector data to the user for weapon systems or training evaluation."

Designated for Targets at Sea

Meggitt has also produced a product that meets the growing need for scoring laser-designated targets at sea with the Surface Target Laser Aim Scoring System (STLASS system). The STLASS was developed to meet a critical need for high fidelity non-destructive training with laser-designated weapons against moving targets at sea. Their product provides:

"high fidelity reconstruction of laser designated weapons' training engagements. The system consists of three major elements: a weapon platform subsystem with Digital Data Recording Unit (DDRU), which interfaces with the weapon and avionics data buses. The DDRU records weapon platform data on removable media for transfer to the debrief subsystem at completion of the training exercise."[10]

Miss Distance Sensors for Sea

Again, for the Navy or Marines is the Miss Distance Sensor Set AN/DSQ-50A, also from Meggitt. It is the airborne element of a radar calar scoring system and is designed for installation on US Navy craft to acquire scoring information on passing missiles and projectiles. This MDI provides near real time, accurate MD, time and closing velocity data for high and low altitude intercept scenarios. It can measure projectiles as small as 76mm as well as high performance missiles.

Universal Target Systems Ltd (UTSL) a UK company, offer another MDI which works at a range of up to 10 meters (32 feet).

"When a shell passes through the sensing zone its generated shock wave is picked up by the sensors mounted in the front nose cone. The trigger data is added to the live telemetry stream. This telemetry data is received by the telemetry receiver, decoded and sent to the computer which processes the data and displays and records the information in an easy to understand and simple interface. Missions can be recorded together with ballistic and any other information, a print out of which can be made for post firing analysis."[11]

As "Smart" as the Targeting Information

Seeing the issue from the missile manufacturers' side, Rockwell Collins, the missile manufacturer, makes a valid point about trying to achieve accuracy:

"As "smart" as they are, today's guided weapons are only as good as the targeting information they receive. Targets can be extremely close to Coalition Troops, In Contact or located intermixed with innocent civilians making their prosecution a threat both to coalition forces and to innocent civilians. That is why Forward Air Controllers (FACs), Tactical Air Control Parties (TACPs), Forward Observation Officers (FOOs) and Joint Terminal Attack Controllers (JTACs) need total confidence that the accuracy of the geolocated targeting information they are passing to Close Air Support (CAS) aircraft and ground force strike assets is totally accurate. That confidence is especially important when calling in strikes to provide "danger close" support missions to coalition troops, where just a few meters of error could have catastrophic consequence."[12]

The Uplink Conundrum – as Clear as MUD

Marushka Dubova, *Defence Correspondent*

"Cutting through the fog of the drone war is important in part because the drone aircraft deployed in Pakistan are the leading edge of a revolution in robotic warfare that has already expanded to Yemen and Somalia, and that military experts expect to sweep the world."

'The New York Times' by Scott Shane – August 11 2011

THE ACCELERATION of the use of UAVs for attacks by the CIA, and for ISR and attacks by ISAF has meant that there has been a proliferation of both small and large UAVs loitering over the battlefield in Afghanistan and elsewhere. According to the Defense Advanced Research Projects Agency (DARPA) this has created severe co-channel interference issues with today's radio technology. DARPA and BAE Systems are addressing this issue by equipping CDL (Common Data Link) radios with MUD (Multi User Detection) receiver technology.[13]

What Does This Mean in Practice?

According to DARPA, the forward link used for command and control data is critical because it navigates the aircraft (frequently from the USA). The forward link to the air is relatively easier to jam because of the absence of obstructions. The return link to the ground delivers the ISR material. There is a proliferation of UASs many of them now quite small. Some of the smaller aircraft cannot support the bulky large aperture antennas, so designers are forced to use smaller aperture antennas with larger beam widths. The large number of CDL terminals in the same area creates the need for more bandwidth to avoid uplink interference. The lack of bandwidth results in time delays in information reaching the UAV for steering or camera adjustment and similar delays in relaying the data down to the ground.[14]

"Multi-User Detection (MUD) technology developed on the DARPA Interference Multiple Access (DIMA) program solves the uplink interference problem by allowing multiple users to operate in each frequency bin while maintaining the jam resistant, spread spectrum uplink."

And it is not just UAVs, small and large, that exacerbates the problem – the needs of the dismounted soldier must also be recognised. DARPA argue that they may have a solution to the problem:

"MUD is a new paradigm in receiver technology. Instead of avoiding interference, through time, frequency, or code division, interference between signals is allowed and is jointly demodulated in the receiver by the MUD."

This is only one solution to what is a complex and growing problem, but DARPA and BAE engineers are hoping that it may ease the system. If it adds speed to decision-making and action when "danger close" requires fast air back up or when drones can conserve resources by attacking in contested airspace with increasing accuracy, progress is being made.

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